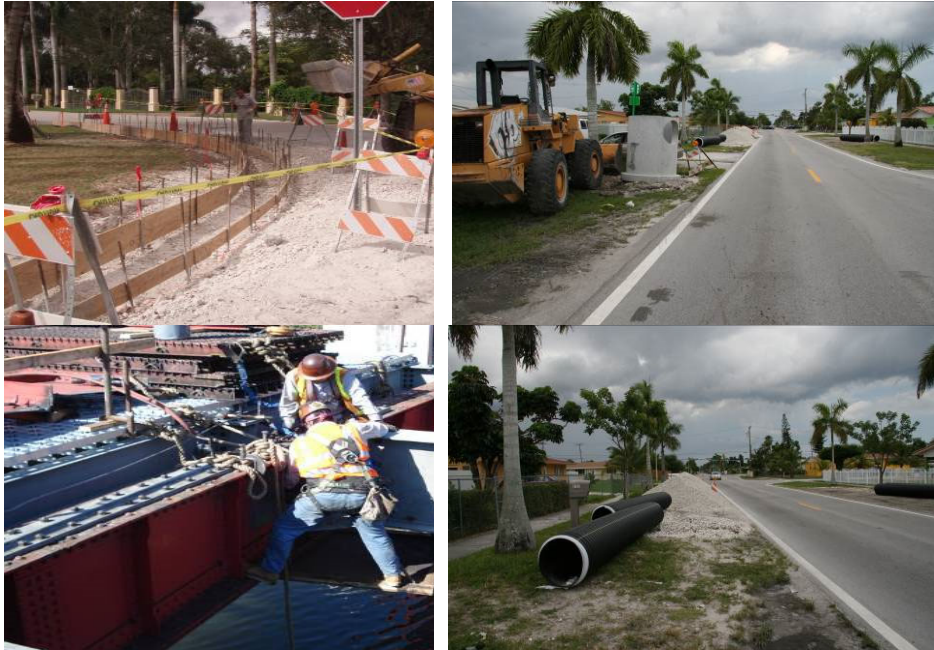


## ELECTRONIC DOCUMENTS DISCLAIMER

1. Electronic copies of the solicitation documents are made available on this website solely for the convenience of prospective bidders (whether as a prime contractor or sub-contractor) on the Project, and are not considered part of the Contract Documents. No representation or warranty is made, either expressed or implied, with regard to the accuracy or suitability of these electronic copies for any purpose whatsoever. In the event of discrepancies or conflicts between the County's originally published document(s) and any other version distributed or submitted by other parties, the County's original hard copy version shall prevail.
2. Miami-Dade County Department of Transportation and Public Works (DTPW) does not track or monitor downloads of Project documents from this website. Therefore, prospective bidders who choose to use this method of distribution shall also be responsible for monitoring the site and downloading any applicable addenda or supplemental information. DTPW will distribute hard copy addenda or supplemental information only to those persons or firms who we have purchased a hard copy of the original solicitation documents.
3. Miami-Dade County shall not be responsible for errors and omissions occurring in the transmission or downloading of any documents or specifications from this website. In the event of any discrepancy between information obtained from this website and the DTPW hard copy solicitation documents and specifications, the terms of the hard copy documents will prevail.
4. Miami-Dade County does not guarantee continuous, uninterrupted or secure access to this or other related websites. Operation of this website may be affected from time to time by numerous factors outside of our control. In the event that we are notified of any problems in a timely manner we will do our best to assist with those problems that fall within our control. For assistance, contact us at 305-375-2930. Solicitation documents are removed from this website as soon as possible after the due date.
5. DTPW does not accept facsimile or electronic bid responses of any kind. All bids must be submitted in writing, on the forms provided by the County, to the address designated in the bid package. It is the bidder's responsibility to ensure that their submittals are received at the designated location, complete and on time. Bids received after the due date will be rejected, even if the solicitation is still appearing on this site.
6. With regards to Miscellaneous Construction Contracts (MCC) 7040 Plan Request for Price Quotations:
  - a. Only bidders included on the Project's Bidders List, provided by the Internal Service Department, Procurement Management Division to the DTPW, can submit a bid.
  - b. Only timely bids received from bidders included in the Project's Bidders List will be considered.
7. These documents shall not be altered in any manner. Utilization or viewing of these electronic documents shall constitute implicit acknowledgement and acceptance of these provisions. Failure to comply with these provisions may result in rejection of your bid.



**Stormwater Pump Stations  
and  
Control Structures Improvements  
Volume 2 of 2**

Miami-Dade County  
Supplemental Solicitation  
and  
Contract Documents

**Small Business Enterprise-Construction Program (SBE-CONST.):**  
No Measure

**Community Workforce Program:**  
N/A

**DTPW Capital Improvements Engineer:**  
Elva Rosa Reyes

**RPQ Issue Date:**  
March 21, 2024

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## **SECTION 7: SPECIAL PROVISIONS**

## SPECIAL PROVISIONS

**SPECIAL PROVISIONS**  
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## 1. GENERAL REQUIREMENTS

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### 1.01 MISCELLANEOUS CONSTRUCTION CONTRACTS (MCC) PLAN. GENERAL TERMS AND CONDITIONS AND SPECIAL CONDITIONS

- A. Division 01 (General Requirements) of the DTPW Specifications amends the MCC Plan, and other provisions of the Contract Documents. All requirements of the MCC Plan, Resolution and amendments', or portions thereof, which are not specifically modified, deleted, or superseded by Division 01, remain in full effect. In the event a conflict between these two complementary portions of the Contract Documents occurs, Division 1 will prevail and Engineer will provide a clarification and final determination. These Special Provisions also amend, complement, modify or delete items from the DTPW Construction Specifications of these Solicitation and Contract Documents.

### 1.02 SCOPE OF WORK

- A. Work under this Contract includes furnishing of all supervision, labor, materials, tools, equipment and performing all operations required to construct the Work in accordance with the Contract Documents.

Scope of Work per Site:

#### 1. Arch Creek Phase 1 and 2 Pump Stations:

This task includes work on two (2) stormwater pump stations located at NE 18 Ave and NE143 St and NE 14 Ave and NE 144 St. Work includes the installation of three (3) telemetry sensors and integration into the existing SCADA system.

#### 2. Belen Phase 1 and 2 Pump Stations:

This task includes work on two (2) stormwater pump stations located at SW 127 Ave and SW 6 St and SW 120 Ave and SW 6 St. Work includes the installation of three (3) telemetry sensors and integration to the existing SCADA system, and installation of new louver windows with extraction capabilities in the pump control room at each pump station.

#### 3. Rucks Park Stormwater Pump Station:

This task includes work on one (1) stormwater pump station located at NE 4 Ave and NE 139 St. Work includes the installation of three (3) telemetry sensors and integration to existing SCADA system, installation of a new access door and new louver windows with extraction capabilities for the pump room, installation of a new louver door in the generator room, a new pump control panel, installation of a fixed swingable access door in the wet well trash interceptor, installation and automation of a new 60 inch sluice gate in the wet well with an actuator.

#### 4. Pump Station at SW 87th Avenue and SW 2nd Street:

This task includes work on one (1) stormwater pump station located at SW 87 Ave and SW 2 St. Work includes the installation of three (3) telemetry sensors and integration to existing

SCADA system, installation, and automation of a new 24-inch sluice gate in the wet well with actuator.

5. Ludlam Glades Water Control Structure:

This task includes work on the Ludlam Glades Water Control Canal Structure located at 6398 SW 80 Street. Work includes the replacement of one (1) actuator and converting the existing electric power source from 120V single phase to 240V three phase, coordination with FPL is required for all electric power connection. In addition, installation of three (3) telemetry sensors and integration to the existing SCADA system.

6. Sunswept Isles Water Control Structure:

This task includes work on the Sunswept Isles Water Control Canal Structure located at 2445 NE 207 Street. Work includes converting the existing electric power source from 120V single phase to 240V three phase, which includes the installation of underground electric power cables from the primary lines at approximately 900 Feet to the East along NW 207 St. In addition, the installation of three (3) telemetry sensors and integration into the existing SCADA system.

- B. If any changes are required due to conflict of design and or field conditions, the Engineer will make the final determination.
- C. The Contractor and all subcontractors, under this Contract, are prohibited from performing any work, other than specified in the Contract and/or directed by the Engineer, within the limits of the project site, without prior written notification to the Engineer. This includes any work for private or commercial entities.

1.03 LOCATION OF WORK

- A. The location of work to be performed under the terms of this Contract shall be as follows:
  - 1. Arch Creek Phase 1 and 2 Pump Stations at NE 18 Ave. and NE143 Street, and NE 14 Ave and NE 144 Street.
  - 2. Belen Phase 1 and 2 Pump Stations at SW 127th Ave and SW 6th Street, and SW 120th Ave and SW 6th Street.
  - 3. Rucks Park Stormwater Pump Station at NE 4th Ave and NE 139th Street.
  - 4. Pump Station at SW 87th Avenue and SW 2nd Street.
  - 5. Ludlam Glades Water Control Structure at 6398 SW 80 Street
  - 6. Sunswept Isles Water Control Structure at 2445 NE 207 Street.
- B. The exact location and limits of construction are as shown on the Plans accompanying these Contract Documents.

1.04 PLANS



- A. Engineering Drawings titled: "1. Arch Creek Phase 1 and 2 Pump Stations at NE 18 Ave. and NE143 Street, and NE 14 Ave and NE 144 Street; 2. Belen Phase 1 and 2 Pump Stations at SW 127th Ave and SW 6th Street, and SW 120th Ave and SW 6th Street; 3. Rucks Park Stormwater Pump Station at NE 4th Ave and NE 139th Street; 4. Pump Station at SW 87th Avenue and SW 2nd Street; 5. Ludlam Glades Water Control Structure at 6398 SW 80 Street; 6. Sunswept Isles Water Control Structure at 2445 NE 207 Street, (Project #20200043) prepared by Miami Dade County, Department of Transportation and Public Works, Right of Way Division, Stormwater Drainage Design Section are included with these Contract Documents. Additional standard details are available in the Miami-Dade County Public Works Manual and the latest edition of the Florida Department of Transportation's Design Standards for Design, Construction, Maintenance and Utility Operations on The State Highway System.
- B. The County through its Engineer shall have the right to modify the details and/or sketches, to supplement the sketches with additional plans and/or with additional information as work proceeds; all of which shall be considered as plans accompanying these Specifications herein generally referred to as the "Plans." In case of disagreement between the Plans and Specifications, the Engineer shall make a final determination as to which shall govern.

#### 1.05 TIME FOR COMPLETION

- A. This is a Work order driven Contract. The total Contract duration is 270 days. Perform each work order fully, entirely, and in accordance with the Contract Documents within the Contract Time specified in each Work Order. Time commences to run once the first Work Order is issued. Each work order is subject to the requirements of Subarticle 1.06, F, 4, Additional Requirements for work order contracts and Subarticle 1.06 J, Liquidated Damages of the General Requirements (Division 1). And as expanded under Article 1.12, Liquidated Damages, of the Supplementary Conditions.
- B. The effective date of the "Notice to Proceed" will be established during the Preconstruction Conference which is held shortly after the Award of Contract and which is attended by members of Department of Transportation and Public Works, the Contractor, representatives of utility companies, and others affected by the Work. The effective date shall be set as a date no later than 30 calendar days after the date of execution of the Contract Documents, unless a later date acceptable to both parties is agreed upon in writing.

#### 1.06 SCHEDULE OF VALUES

- A. A Schedule of Values is required for any Stipulated (Lump) sum contract, or for major lump sum items on Unit price contracts for which the Contractor requests progress payments as indicated under the General Requirements, Article 1.06, Subarticle D, of this Contract Documents.

## 2. GENERAL CONSTRUCTION

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### 2.01 FIELD OFFICE (REV. 11-9-15)

- A. A local field office is not required; however, the Contractor will be required to provide the Engineer with a local (Miami-Dade County) telephone or cellular number, where the Contractor may be contacted 24 hours a day, 7 days a week during the period for which the Contract is in force.

### 2.02 MOBILIZATION (ARTICLE 101)

- A. DTPW Construction Specification, Page 1, Article 101-B.2.b - "Payment will be made under...."; is deleted in its entirety and replaced with the following:
  - 1. No item for "Mobilization" has been provided in the Bid Form of the Proposal; however, the Contractor will be entitled to collect a Mobilization fee of \$500 per Work Order. This amount will be paid from a dedicated allowance established by the County.

### 2.03 MAINTENANCE OF TRAFFIC (ARTICLE 102)

- A. Delete DTPW Construction Specification, Page 8, Article 102-K.1 and replace it with the following:
  - 1. Method of Measurement.
    - a. Work under MOT will be compensated at, but not to exceed, 2 percent of each invoice from an appropriate dedicated allowance. The total compensation under this item shall not exceed 2 percent of the Contract Subtotal Amount. Payment shall be full compensation for all work and costs specified under this Section including furnishing, installing, operating, maintaining, and removing all required traffic control devices, signs, warning devices, barriers and other MOT devices or requirements not specifically covered for payment under the MOT items listed below. Such price and payment shall constitute full compensation for furnishing (including hardware, lights and posts if required), installing, relocating, maintaining, and removing of temporary traffic control devices.

### 2.04 TECHNICAL SPECIFICATIONS

- A. The contractor is responsible to comply with all the requirements and Technical Specifications under Appendix "B" to Special Provisions of the Contract Documents, Volume 2 of 2.

APPENDIX "A" TO SPECIAL PROVISIONS  
AUTHORIZATION AGREEMENT FOR AUTOMATIC DEPOSIT



# ACH AUTHORIZATION AGREEMENT FOR AUTOMATIC DIRECT DEPOSIT OF MIAMI-DADE COUNTY WARRANTS

We hereby authorize the Finance Department to initiate credit entries and, if necessary, a debit entry in order to reverse a credit entry made in error in accordance with NACHA rules.

**Original form** must be received before we can process your request for ACH deposits. Please refer to page 2 for instructions. Processing of the form is approximately 15 days from receipt of completed original form. This authority is to remain in effect until revoked in writing and received by the Finance Department. Account changes must be reported at a minimum **fifteen (15) days prior to actual change.**

### Section 1 (TO BE COMPLETED BY VENDOR) - ALL FIELDS ARE REQUIRED

TRANSACTION TYPE:                      New                       Change                       Terminate

**FEDERAL IDENTIFICATION NUMBER**

--	--	--	--	--	--	--	--	--	--

(AS PER CURRENT W-9) (FOR INTERNAL USE ONLY)

VENDOR NAME : \_\_\_\_\_

DBA (DOING BUSINESS AS) : \_\_\_\_\_

TELEPHONE NUMBER : \_\_\_\_\_

FISCAL OFFICER NAME AND TITLE : \_\_\_\_\_

FISCAL OFFICER'S EMAIL : \_\_\_\_\_

ACH NOTIFICATION EMAIL: \_\_\_\_\_

(This is the email where payment information will be sent)

**ROUTING NUMBER**

--	--	--	--	--	--	--	--	--	--

(FOR INTERNAL USE ONLY)

**VENDOR'S BANK ACCOUNT NUMBER**

--	--	--	--	--	--	--	--	--	--

TYPE OF ACCOUNT                      Checking                       Savings

AUTHORIZED SIGNATURE \_\_\_\_\_ DATE : \_\_\_\_\_

PRINTED NAME \_\_\_\_\_

A VOIDED CHECK OR REDACTED COPY OF A BANK STATEMENT FOR THE ACCOUNT LISTED ABOVE MUST BE PROVIDED. PLEASE REFER TO INSTRUCTIONS FOR OUR MAILING ADDRESS. SUBMISSION OF YOUR E-MAIL ADDRESS IS MANDATORY IN ORDER TO PARTICIPATE IN THIS PAYMENT OPTION.

### Section 2 (TO BE COMPLETED BY FINANCIAL INSTITUTION)

FINANCIAL INSTITUTION NAME: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

BANK OFFICIAL NAME (PRINTED) AND TITLE : \_\_\_\_\_

TELEPHONE NUMBER : \_\_\_\_\_ EMPLOYEE ID NO. : \_\_\_\_\_

EMAIL : \_\_\_\_\_

- I have verified that the account and routing number provided above is correct and corresponds to vendor noted above.
- I have also verified that the person signing is an authorized signer on the account specified.

SIGNATURE \_\_\_\_\_ DATE : \_\_\_\_\_

### Section 3 (TO BE COMPLETED BY MIAMI-DADE FINANCE DEPARTMENT)

Accounts Payable Verifications	Cash Management	Input/Output
Corp. Officer Name : _____ Verified by: _____ A/P Staff: _____	Routing # verified by : _____ Date: _____ Verified by : _____ Verification Date: _____	ACH Indicator updated by : _____ Date of Update : _____ Verified by : _____ Verification Date: _____
Corp. Officer Title : _____ Bank Officer: _____ Date: _____ A/P Supervisor: _____ Date: _____		



## ACH AUTHORIZATION AGREEMENT FOR AUTOMATIC DIRECT DEPOSIT OF MIAMI-DADE COUNTY WARRANTS

### INSTRUCTIONS

Please contact us at (305) 375-5111 or email at [FIN-ACHN@miamidade.gov](mailto:FIN-ACHN@miamidade.gov) if you have any questions or need assistance with this form.

You may obtain blank copies of this form at : [http://www.miamidade.gov/finance/library/ach\\_form.pdf](http://www.miamidade.gov/finance/library/ach_form.pdf)

At our Vendor Payment Inquiry (VPI) website you can obtain payment information as well as status of invoices, payment due date and other important information. You can reach the VPI site at :

<https://w85exp.miamidade.gov/VInvoice/login.do>

### Section 1

#### Transaction Type

New : If vendor is currently not on ACH deposits with Miami-Dade County.

Change : If vendor is currently on ACH deposits with Miami-Dade County and would like to make changes to their information ( example : change of financial institution, account number, etc.)

Terminate : If vendor is currently on ACH deposits with Miami-Dade County and would like to switch to either Check or AP Control disbursement type )

**Federal Identification Number** : Enter your Federal Employer Identification Number (FEIN) or Social Security Number (SSN) used to register you as a vendor with Miami-Dade County. Name and FEIN/SS must be exactly as provided on IRS Form W-9.

**Vendor Name** : Enter the name of your business or individual name used to register you as a vendor with Miami-Dade County.

**DBA (Doing Business As )** : If you have registered a DBA for your business or for you as an individual, please enter it here.

**Fiscal Officer Name, Title and E-Mail** : Name of Authorized Corporate officer, Title and E-Mail address to be contacted to. Corporate officer signing this form must be an authorized signatory in the corporate bank account listed on this form.

**ACH Notification E-Mail** : This is the E-Mail address where payment information will be sent to.

### Section 2

This section must be completed in full and legible manner by your banking institution in order to prevent delays in processing change to ACH.

Both acknowledgment statements must be checked off by Bank Official signing and dating the form.

### Section 3

This section will be completed by Miami-Dade County Finance Department.

#### ORIGINAL FORM AND VOIDED CHECK OR REDACTED STATEMENT MUST BE MAILED TO :

##### Accounts Payable Manager

**Miami-Dade County Finance Department**

**111 NW First Street, Suite 2620**

**Miami, Florida 33128**

#### Terms and Conditions

Completed form should not contain any changes (scratched off /white out) or altered information; otherwise, form will not be accepted.

Processing time is approximately fifteen (15) days from receipt of complete form and voided check or redacted Bank statement.

Providing account information does not authorize Miami-Dade County to access bank account activity.

ACH deposits can be made into **only** one (1) bank account. Payments can not be split between multiple accounts.

Notification E-mail providing payment information can be sent to one (1) single E-mail address **only**.

Proper verification will be conducted by Miami-Dade County Finance Department Staff, via a telephone call to confirm the information being provided is accurate.

This authorization shall remain in effect until terminated in writing with sufficient notice to Miami-Dade County Finance Department.

Miami-Dade County will not be responsible for any loss that may arise solely by reason of error, mistake or fraud regarding information provided on this ACH Authorization Agreement Form.

APPENDIX "B" TO SPECIAL PROVISIONS  
TECHNICAL SPECIFICATIONS

## TECHNICAL SPECIFICATIONS

ARCH CREEK PHASE 1 - PUMP STATION  
TECHNICAL SPECIFICATIONS



## SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated.
- C. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.
- D. The CONTRACTOR'S attention is directed to the requirement for proper coordination of the WORK of this Section with other trades sections.
- E. Equipment supports and foundations shall be in conformance with the requirements of Structural Specifications.

#### 1.2 REFERENCE STANDARDS

ANSI	American National Standards Institute
FBC	Florida Building Code 2020
NEC (NFPA 70)	National Electrical Code – 2017 Edition
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
NRTL	National Recognized Testing Laboratory

- A. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.
- B. Installation of electrical equipment and materials shall comply with state building standards, and applicable local codes and regulations, all as enforced by the Authority Having Jurisdiction (AHJ).
- C. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

#### 1.3 BASIS FOR WIRING DESIGNS

- A. The Contract Drawings and Specifications describe specific sizes of switches,

breakers, fuses, conduits, conductors, motor starters and other electrical equipment. These sizes are based on specific power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Wherever another trade provides power consuming equipment that differs from the Contract Documents, the wiring, conduits, starters, overcurrent devices, and other electrical devices that may be impacted shall be changed to proper sizes to match at no additional expense to the OWNER.

#### 1.4 SIGNAGE AND MARKINGS

##### A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

##### B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

##### C. Warning Signs

1. 600 Volts Nominal, or Less
  - a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.
2. Arc Flash Signage

#### 1.5 PERMITS AND INSPECTION

- A. Obtain permits and pay inspection fees according to the General Conditions.

#### 1.6 CONTRACTOR SUBMITTALS

##### A. General

1. Furnish submittals in accordance with Section 01 33 00 - Shop Drawings, product data, and samples.
2. Custom-prepare Shop Drawings.
3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.
4. Cross out options not proposed or delete from the Shop Drawings.

- B. Shop Drawings: Include the following as a minimum:

1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Shop drawings for grounding WORK not specifically indicated
3. Front, side, rear elevations, and top views with dimensional data
4. Location of conduit entrances and access plates
5. Component data
6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers
7. Types of materials and finish
8. Nameplates
9. Temperature limitations, as applicable
10. Voltage requirement, phase, and current, as applicable
11. Grounding requirements

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.
2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the ENGINEER a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.
2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Architectural Section for shop drawings requirements.
2. As-Built Drawings
  - a. A set of "Red-Lined" electrical drawings shall be carefully maintained at the job site. Actual conditions are to be put on the drawings in red on a daily basis so the Plans will continuously show locations and routings of cables, conduits, pull boxes, circuit numbers, and other information required by the ENGINEER. An

up-to-date copy of the "Red-Lined" Drawings shall be submitted to the OWNER by the CONTRACTOR once every two weeks. At the end of the Project, the CONTRACTOR shall turn over As-Built Drawings in AutoCAD format to the OWNER.

- b. Furnish the drawings to the ENGINEER in accordance with the requirements of Architectural Section for shop drawings requirements.
- c. Prepare As-Built Drawings of encased concealed and exposed raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

## 1.7 AREA DESIGNATIONS

### A. General

1. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections, unless indicated otherwise.

### B. Material Requirements

1. Construct NEMA 4X enclosures of Type 316 stainless steel, except in chlorine or hypochlorite areas or areas with ferric-based chemicals where non-metallic enclosures shall be provided.
2. Metallic NEMA 4X enclosures shall have a white, powder coated finish.
3. Construct NEMA 7 enclosures of cast aluminum where used with aluminum conduit.
4. Do not coat NEMA 7 and 9 enclosures.
5. Construct NEMA 1, 3R, and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

## 1.8 TESTS

- A. The CONTRACTOR shall be responsible for required factory and field as required by Engineer and other authorities having jurisdiction.
- B. Furnish necessary testing equipment.
- C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.
- D. Reporting
  1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
  2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.

3. Submit field test reports for review prior to Substantial Completion.
  - E. Remove and replace equipment or material that fails a test, or, if the ENGINEER approves, repair and retested for compliance.
  - F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.
- 1.9 DEMOLITION AND RELATED WORK
- A. General
    1. Perform electrical demolition WORK as indicated.
    2. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical Contract Drawings.
    3. Coordinate with all trades and building management regarding electrical de-energization, disconnection, and removal, and the overall sequence of construction.
  - B. Electrical Requirements for Removed Equipment
    1. Remove dedicated wiring and exposed conduits back to the source.
    2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring. Remove power wiring from the power source to the first pullbox or manhole remote from the panel, and abandon in place the remaining wiring.
    3. Remove remote-mounted starters, disconnect switches, circuit breakers, sensors, and transmitters. Breakers in Panels that are not replaced or re-used shall be abandoned in place, and nameplates replaced to read, "SPARE".
  - C. Where new lighting and receptacles are installed, remove old lighting, receptacles, switches, wiring, and conduits, and replace in their entirety.
  - D. Junction Boxes
    1. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips.
    2. Provide a junction box with a NEMA rating in accordance with the area in which it is located, and sized as required.
    3. Properly identify wires and terminals before disconnection.
  - E. Removed materials and equipment not indicated to be returned to the OWNER shall, upon removal, become the CONTRACTOR'S property and shall be disposed of off- site.
  - F. Remove and relocate material and equipment indicated to be relocated or reused, and reinstall with care in order to prevent damage.
  - G. Place materials indicated to be returned to the OWNER in boxes, with the contents

clearly marked, and store at a location determined by the OWNER.

#### H. Identification

1. Where panelboards are indicated to have components, assemblies, or circuits removed and reconnected, provide the affected panel compartments with new engraved nameplates worded as indicated and matching the existing, or modify the panelboard schedule to indicate the revised circuits. Replace the panelboard schedule in its entirety if the existing schedule is unreadable or otherwise unusable.
2. Pencil or magic marker markings directly on the panelboard will not be accepted.

### 1.10 CONSTRUCTION SEQUENCING

#### A. General

1. Because the continuance of building operation during the renovation is critical, the CONTRACTOR shall carefully examine the WORK to be provided in, on, or adjacent to existing equipment.
2. Schedule the WORK in phases, subject to OWNER's approval, to minimize disruption to normal operations.
3. Submit a written sequencing request, including the sequence and duration of activities to be performed.
4. In no case shall the CONTRACTOR begin any WORK phase without written authorization from the OWNER.

#### B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.
2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.
3. Repair coatings to match the existing.
4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the WORK.

#### C. Field Verifications

1. Visit the Site before submitting a bid to become better acquainted with the WORK of this Contract.
2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.

3. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL**

- A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.
- B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.
- C. Provide similar items in the WORK as products of the same manufacturer.
- D. Provide equipment and materials of industrial grade standard of construction.
- E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.
- F. On devices indicated to display dates, display the year as 4 digits.
- G. Temperature Ratings of Equipment Terminations
  1. Provide terminations and lugs rated for use with 75-degree C conductors.
  2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

### **2.2 MOUNTING HARDWARE**

- A. Miscellaneous Hardware
  1. Provide nuts, bolts, and washers constructed of stainless steel.
  2. Provide threaded rods for trapeze supports constructed from continuous threaded stainless steel, 3/8-inch diameter minimum.
  3. Struts
    - a. Provide struts for mounting of conduits and equipment of aluminum except where additional strength is needed, then use 316 stainless steel. Coat the back of aluminum struts with bitumastic coating where it comes in contact with concrete.
    - b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
    - c. Do not use aluminum strut for free-standing support frames. Use 316 stainless

steel except in chlorine, hypochlorite or ferric areas where FRP strut shall be used.

d. Strut Manufacturer, or Equal: **Unistrut; B-Line**

4. End Caps

a. Provide plastic protective end caps for all exposed metal strut ends.

b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860**

5. Anchors

a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

b. Wood plugs will not be accepted.

c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Hilti**.

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

##### **A. Incidentals**

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.

2. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

##### **B. Field Control of Location and Arrangement**

1. The Contract Drawings diagrammatically indicate the desired location and arrangement of loads, conduit runs, equipment, and other items.

2. Exact locations shall be determined by the CONTRACTOR in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.

3. Follow the locations on the Contract Drawings, however, as closely as possible.

##### **4. Conduits**

a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.

b. Provide exposed or encased routings as indicated, except conceal conduit in



finished areas unless indicated otherwise.

5. Placement

- a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.
- b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.
- c. Where exact locations are not indicated, such locations will be determined by the ENGINEER.
- d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.
- e. Slightly adjust luminaire locations based on actual field conditions in order to avoid obstructions and to minimize shadows, and update As-Built Drawings accordingly.

6. Circuits

- a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.
- b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).
- c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

7. Workmanship

- a. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer, and using workers skilled in the WORK.
- b. Coordinate installation in the field with other trades in order to avoid interferences.

8. Protection of Equipment and Materials

- a. Fully protect materials and equipment against damage from any cause.
- b. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.
- c. Keep moving parts clean and dry.

- d. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

### 3.2 CORE DRILLING

- A. Perform core drilling as required for the installation of raceways through concrete walls and floors.
- B. Base the locations of floor penetrations, as may be required, on field conditions.
- C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.
- D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities.
- E. Repair damage to walls, floors, encased conduits, wiring, and piping as part of the WORK.

### 3.3 CONCRETE HOUSEKEEPING PADS AND CURBS

- A. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.
- B. Extend housekeeping curbs to 4 inches above the finished floor or grade.

### 3.4 EQUIPMENT ANCHORING

- A. Floor-supported, wall, or ceiling-hung equipment and conductors shall be anchored in place by approved method in the area where the Project is located.
- B. Provide wall-mounted panels that weigh more than 500 pounds with fabricated steel support pedestals.
- C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.
- D. Provide transformers hung from 4-inch stud walls with auxiliary floor supports.
- E. Provide leveling channels anchored to the concrete pad for switchgear and pad-mounted transformer installations.
- F. Manufacturer's Recommendations
  - 1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract.
  - 2. Submit such recommendations as Shop Drawings as indicated.

### 3.5 CLEANING

- A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.
- B. Remove temporary tags, markers, stickers, and the like.
- C. Remove oil and grease spots with a non-flammable cleaning solvent, by carefully wiping and scraping cracks and corners.
- D. Apply touch-up paint to scratches on panels and cabinets.
- E. Vacuum-clean electrical cabinets and enclosures.
- F. Clean luminaires inside and out.
- G. Dispose cleaning debris and refuse off-Site.

**- END OF SECTION -**

## SECTION 26 05 19 - WIRE AND CABLE

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit Shop Drawings in accordance with Division 1 and 26 00 00 – ELECTRICAL WORK, GENERAL.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

#### 2.2 LOW VOLTAGE WIRE AND CABLE

##### A. Power and Lighting Wire

1. Wire rated for 600 volts in conduit for power and lighting circuits shall be type XHHW-2 rated 90 degrees C suitable for wet locations except where required otherwise by the plans.
2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drops on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
4. Wiring for 600 volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.

## B. Control Wire

1. Control wire in conduit shall be the same type as power and lighting wire indicated above.
2. Control wiring shall be #14 AWG, except for current transformer secondary conductors which shall be #12 AWG minimum.
3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable**, or equal.
4. All control wiring of 10 or more #14 shall be preassembled as manufactured by **Clifford of Vermont, Inc.**, Quik-Pull, meeting the following requirements:
  - a. #14 AWG stranded copper XHHW-2, 600 Volt
  - b. Each conductor numbered every 1½ Inches
  - c. Sequential footage tape.
  - d. Round compact units, spiral configuration
  - e. UL listed. Custom wire assembly
5. Assemblies are identified as QP-10, 20 to 100 maximum. Example: Where QP-20 is shown it supersedes the count if 16#14 are shown.
6. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3090A**, similar by **General Cable**, or equal.
7. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3091A**, similar by **General Cable**, or equal.

## 2.3 CABLE SPLICES AND TERMINATIONS

- A. Where cable lugs are required for power cable terminations, utilize copper, capped, one-hole and two-hole compression lugs – **3M** Scotchlok 30000 and 31100 Series, **Penn Union** HBBLU and BLU, **Burndy** Hylug, or equal. Utilize compression tools as recommended by the manufacturer. Open-ended lugs (where the end of the stranded cable is exposed) are not acceptable for power cable terminations. Pressure type, twist-on connectors (wire nuts) will not be acceptable.
- B. Pre-insulated ring lugs for control conductors shall be **Thomas & Betts, Burndy**, or equal.
- C. General purpose insulating tape shall be **Scotch No. 33, Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M**, or equal.

- D. Labels for coding 600 volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.
- E. No splices shall be permitted for low-voltage power cables.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

The CONTRACTOR shall provide, terminate and test all power, control, and instrumentation conductors.

The CONTRACTOR shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares.

### **3.2 INSTALLATION**

- A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.
- C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.
- D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

### **3.3 SPLICES AND TERMINATIONS**

#### **A. General**

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.
2. In general, there shall be no cable splices. Splices may be made only with the prior approval of the ENGINEER, and shall be performed in strict accordance with the cable and splice manufacturers' requirements. Splices will not be permitted for intra-building feeder or branch circuits.
3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug.
4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

#### **B. Control Wire and Cable**

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
2. In motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips. Where terminal strips require lugs, ring lugs shall be used. Fork-type lugs are not acceptable.
3. The CONTRACTOR shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR.
2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape.
3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR shall submit the proposed termination procedure as a Shop Drawing.

3.4 CABLE IDENTIFICATION. Also refer to Section 26 05 53 – ELECTRICAL IDENTIFICATION).

A. **General:** Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

B. **Identification Numbers:** The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on As-Built Drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control and Instrumentation Conductors" shall be defined as any conductor used for control, interlock, alarm, annunciator, or signal purposes.

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
2. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The

480/277 volt system conductors shall be color coded as follows: Phase A- Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs. Any phase changes necessary for proper rotation shall be made at the driven equipment and not in the local disconnect.

3. General purpose AC control cable shall be red. General purpose DC control cable shall be blue. DC power wiring shall be red for positive conductors (+) and black for negative conductors (-).
4. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
5. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

### 3.5 TESTING

- A. **Cable Assembly and Testing:** Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Division 1, prior to shipment of cable. The following field tests shall be the minimum requirements:
  1. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
  2. Field testing shall be done after cable is installed in the raceways.
  3. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.
  4. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.
- B. **Continuity Test:** Control cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

**- END OF SECTION -**



## SECTION 26 05 26 – GROUNDING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical grounding, complete and operable, as indicated in accordance with the Contract Documents.
- B. The requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL apply to this Section.
- C. Single Manufacturer
  - 1. 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.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Division 1 and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Equipment Grounding Circuit Conductors
  - 1. The conductors shall be the same type and insulation as the load circuit conductors.
  - 2. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.
  - 3. Metallic conduit systems shall have an equipment grounding wire as well as being equipment grounding conductors themselves.

### PART 3 -- EXECUTION

#### 3.1 GROUNDING

- A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.
- B. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.
- C. Route the conductors inside the raceway.

- D. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each panelboard.
- E. Individually bond the raceway to the ground bus in the secondary section.
- F. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.
- G. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.
- H. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.
- I. Low Voltage Grounded System (600V or less)
  - 1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.
  - 2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.
  - 3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.
  - 4. The termination of the shield drain wire shall be on its own terminal screw.
  - 5. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.
  - 6. Connect the ground bus via a green #12 conductor to the main ground bus for the panel.

### 3.2 TESTING

#### A. Fall-of-Potential Test

- 1. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
- 2. Main ground electrode system resistance to ground to be no greater than 3 ohms.

#### B. Two-Point Direct Method Test

1. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames and system neutral and derived neutral points.
  2. Equipment ground resistance not to exceed main ground system resistance by 0.25 ohms.
- C. Test several points of the system including: The neutral of every voltage level used in the system, enclosure of switchgears, motor control centers and panelboards and metal enclosure of outlet or fixture at remote location designated by the ENGINEER. Initial resistance to ground shall not be over 2.5 ohms for water pipe grounds and 15 ohms for made grounds.

**- END OF SECTION -**

## SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.
- B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.
  - 2. Submit dimensioned layout drawings of cable tray routings, including elevations.
  - 3. As-Built Drawings
    - a. Prepare as-built drawings of encased concealed and exposed raceways, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.
    - b. Furnish the drawings to the ENGINEER in accordance with the requirements of Division 1.

### PART 2 -- PRODUCTS

#### 2.1 METAL CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.
  - 2) Alflec Inc.
  - 3) Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4) Anamet Electrical, Inc.; Anaconda Metal Hose.

- 5) Electri-Flex Co.
  - 6) Manhattan/CDT/Cole-Flex.
  - 7) Maverick Tube Corporation.
  - 8) O-Z Gedney; a unit of General Signal.
  - 9) Wheatland Tube Company.
- c. Rigid Steel Conduit: ANSI C80.1.
  - d. Aluminum Rigid Conduit: ANSI C80.5.
  - e. IMC: ANSI C80.6.
  - f. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - 1) Comply with NEMA RN 1.
    - 2) Coating Thickness: 0.040 inch (1 mm), minimum.
  - g. EMT: ANSI C80.3.
  - h. FMC: Zinc-coated steel.
  - i. LFMC: Flexible steel conduit with PVC jacket.
  - j. 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.
    - 1) Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
    - 2) Fittings for EMT: Steel type.
    - 3) Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
  - k. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.

- 2) Anamet Electrical, Inc.; Anaconda Metal Hose.
- 3) Arnco Corporation.
- 4) CANTEX Inc.
- 5) CertainTeed Corp.; Pipe & Plastics Group.
- 6) Condux International, Inc.
- 7) ElecSYS, Inc.
- 8) Electri-Flex Co.
- 9) Lamson & Sessions; Carlon Electrical Products.
- 10) Manhattan/CDT/Cole-Flex.
- 11) RACO; a Hubbell Company.
- 12) Thomas & Betts Corporation.

- c. ENT: NEMA TC 13.
- d. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- e. LFNC: UL 1660.
- f. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- g. Fittings for LFNC: UL 514B.

### 2.3 METAL WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper B-Line, Inc.
  - 2) Hoffman.
  - 3) Square D; Schneider Electric.
- c. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R, unless otherwise indicated.
- d. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- e. Wireway Covers: Screw-cover type.
- f. Finish: Manufacturer's standard enamel finish.

## 2.4 NONMETALLIC WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Hoffman.
  - 2) Lamson & Sessions; Carlon Electrical Products.
- c. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- d. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- e. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.5 SURFACE RACEWAYS

- a. Surface Metal Raceways: Galvanized steel with snap-on covers. Prime coating, ready for field painting.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a) Thomas & Betts Corporation.
    - b) Walker Systems, Inc.; Wiremold Company (The).
    - c) Wiremold Company (The); Electrical Sales Division.
- b. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected manufacturer's standard colors.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a) Butler Manufacturing Company; Walker Division.
  - b) Enduro Systems, Inc.; Composite Products Division.
  - c) Hubbell Incorporated; Wiring Device-Kellems Division.
  - d) Lamson & Sessions; Carlon Electrical Products.
  - e) Panduit Corp.
  - f) Walker Systems, Inc.; Wiremold Company (The).
  - g) Wiremold Company (The); Electrical Sales Division.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2) EGS/Appleton Electric.
  - 3) Erickson Electrical Equipment Company.
  - 4) Hoffman.
  - 5) Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6) O-Z/Gedney; a unit of General Signal.
  - 7) RACO; a Hubbell Company.
  - 8) Robroy Industries, Inc.; Enclosure Division.
  - 9) Scott Fetzer Co.; Adalet Division.
  - 10) Spring City Electrical Manufacturing Company.
  - 11) Thomas & Betts Corporation.
  - 12) Walker Systems, Inc.; Wiremold Company (The).
  - 13) Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- c. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- d. Cast-Metal Outlet and Device Boxes: NEMA FB 1, [ferrous alloy] Type FD, with gasketed cover.
- e. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- f. Metal Floor Boxes: Cast metal , fully adjustable, rectangular.
- g. Nonmetallic Floor Boxes: Nonadjustable, round.
- h. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- i. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, [galvanized, cast iron] with gasketed cover.



- j. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  - 1) Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2) Nonmetallic Enclosures: Plastic

## EXECUTION

### 2.7 GENERAL

- A. Run wiring in raceway unless indicated otherwise.
- B. Install raceways between equipment as indicated.
- C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.
- D. Bends and Offsets
  - 1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.
  - 2. Provide factory elbows wherever possible.
- E. Combined Raceways
  - 1. Raceways other than those containing power conductors may be combined in strict accordance with the NEC and with prior written permission from the ENGINEER.
  - 2. In general, combine only raceways containing the same type (control, signal, and the like) and voltage of conductors/cables, or dedicated conduits from one source to one device/equipment, in accordance with the NEC.
  - 3. Permission from the ENGINEER shall not relieve the CONTRACTOR of responsibility to meet national, state and local requirements.
  - 4. Do not combine wiring for redundant systems into single raceways.
- F. Routing
  - 1. Where raceway routings are indicated, follow those routings to the extent possible.
  - 2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and provided in strict accordance with the NEC as well as customary installation practice.

3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.
  4. Adjust routings in order to avoid obstructions.
- G. Coordination
1. Coordinate between trades prior to installing the raceways.
  2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.
- H. Support wireways in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- I. Install exposed raceways parallel or perpendicular to structural beams.
- J. Install exposed raceways at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.
- K. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

## 2.8 CONDUIT

- A. Size
1. Provide exposed conduit of 3/4-inch minimum trade size.
  2. Provide encased conduit of one-inch minimum trade size.
- B. Install supports at distances required by the NEC.
- C. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.
- D. Penetrations
1. Provide conduit passing through walls or floors with plastic sleeves.
  2. Perform core drilling in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL.
  3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

- E. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.
- F. Coat threads with a conductive lubricant before assembly.
- G. Joints
  - 1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.
  - 2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.
  - 3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.
  - 4. Replace conduit with wrench marks.
- H. Slope
  - 1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.
  - 2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.
  - 3. Take extreme care in order to avoid pockets or depressions in the conduit.
- I. Installation of rigid conduit through a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.
- J. Connections
  - 1. Make connections to lay-in-type grid lighting fixtures by using flexible metal conduit not exceeding 4 feet in length.
  - 2. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.
  - 3. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.
- K. Empty Conduits
  - 1. Tag empty conduits at both ends to indicate the final destination.
  - 2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.
  - 3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

L. Identification of Conduits

1. Identify conduits at ends and at pulling points.
2. Identification shall be the unique conduit number assigned in the Contract Documents.
3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.
5. Provide conduit identification by a stamped or engraved non-corroding stainless steel metal tag attached to the conduit bushing.
6. Provide an engraved phenolic nameplate in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.
7. Markings with a pen or paint will not be accepted.

M. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.
2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the CONTRACTOR shall assign one following the numbering scheme used in the Contract Documents.
3. Provide box identification by a stamped or engraved stainless steel non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, and attached to the box or enclosure.
4. Markings with a pen or paint will not be accepted.

- N. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

**- END OF SECTION -**

## SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

##### A. Scope

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### B. Coordination

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### C. Related Sections

1. Section 26 00 00 – ELECTRICAL WORK, GENERAL.

#### 1.2 CONTRACTOR SUBMITTALS

##### A. Shop Drawings: Furnish submittals in accordance with Division 1.

1. Comply with the requirements below. Submit for approval of the following:
  - a. The complete description and enumeration of proposed electrical identification devices shall be shown on the Shop Drawings for the associated equipment or systems.

##### B. Product Data:

1. Manufacturer's cut sheet, specifications, dimensions and technical data for all products proposed to be furnished under this Section.
2. Any deviation shall be explicitly noted.

##### C. Samples:

1. Nameplates: Samples of nameplates shall be submitted and shall include both applied and unapplied wire and cable label samples. These samples shall be used as quality standards for the wire and cable labeling required by this Section. These samples shall be of material specified in this Section and shall include wire and cable designators meeting the requirements of this Section.

- D. Wiring diagrams annotated with wire numbers and terminal numbers shall be submitted prior to commissioning of associated equipment or systems.
- E. Project Record Documents:
  - 1. Submittals of Record Documents required by other Sections shall show final electrical identification and electrical identification devices.

## **PART 2 -- PRODUCTS**

### **2.1 MANUFACTURED UNITS**

#### **A. Engraved Identification Devices (Nameplates, and Legend):**

##### **1. Nameplates:**

- a. The following items shall be equipped with nameplates: All motors, motor starters, pushbutton stations, control panels, time switches, disconnect or relays in separate enclosures, transformers, receptacles, wall switches boxes and cabinets. All light switches and outlets shall carry a phenolic plate with the supply circuit panel I.D. and circuit number. Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.
- b. 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 motor nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and local control station nameplates for that machine. Nameplates shall be laminated phenolic plastic, white front and back with black core, with lettering etched through the outer covering; black engraved letters on white background. Lettering shall be 3/16 inch high at local control stations, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4 inch high, unless otherwise detailed on the Plans. Nameplates shall be securely fastened to the equipment with No. 4 Phillips, rough-head, cadmium- plated, steel self-tapping screws or nickel-plated brass bolts. For applications on NEMA 4X enclosures, nameplates shall be attached using an epoxy-based adhesive that is resistant to oil and moisture. Motor nameplates may be non-ferrous metal not less than 0.03 inch thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Engraved lettering shall be filled with contrasting enamel. Equipment nameplate schedule for all equipment shall be submitted with Shop Drawing submittal for Engineer's approval.
- c. All junction and splice boxes shall be labeled.

#### **B. Conduit Labels:**

##### **1. Products and Manufacturers:**

- a. **B-915 Series by Brady**, or approved equal.
  - b. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit diameters through five inches or pre-molded to conform to circumference of six-inch conduit.
  - c. Strap-on style for 6-inch conduit shall be attached with stainless steel springs.
  - d. Shall be blank for use with custom printed labels.
  - e. Labels shall be color coded as follows:
    - 1) Power Conduits (600V and less) – Orange
    - 2) Control/Instrumentation – Light Blue
    - 3) Telephone/Intercom – Yellow
    - 4) Data - White
- C. Custom Labels:
1. Shall have black lettering on yellow background
  2. Shall not contain abbreviations in legend
  3. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.
- D. Wire Identification:
1. All wire and cable shall be identified at each termination point and at each pull box, terminal box and manhole. Provide permanent, waterproof, non-metallic (paper unacceptable) tags indicating the circuit number in 3/16 inch letters. Circuit numbers shall be protected with clear shrinkable tubing.
  2. All 120 VAC and lower control circuits shall use vinyl, self-laminating, self-adhesive, wrap type labels that are heat, oil, water, and solvent resistant wire markers. Labels shall be by **Brady**, or approved equal (**Brady** XPS-187-1 and XPS-375-1, as applicable, based on wire size). Wire numbers shall be solid machine printed, and shall not be pieced from other single or double-digit tags.
  3. Where wire numbers change, the appropriate drawings shall include both wire numbers, clearly indicated, at the point of transition. Drawings shall also identify the insulation color for all wiring.
  4. Conductor Identification: Each conductor shall be identified by a 2-line identification. Line 1: X-Y, where X is a unique number and Y is the location of the termination in the cabinet you are looking at; Line 2: A-B, where A is a unique number (which should usually match the X in Line 1), and B is the location of the termination at the other end of the conductor. The termination locations are typically on terminal

- blocks with identifications such as "TB2-1". The CONTRACTOR shall coordinate with the OWNER regarding all conductor identifications prior to installation.
5. All terminals and terminal strips and posts shall be identified with terminal block markers.
  6. All wire labels shall be clearly visible and not hidden by wire duct or other components in the enclosures.
  7. PLC/DCS/RTU panel wire tag format and content shall be provided by the OWNER.

## 2.2 FABRICATION

### A. Engraved Identification Devices (Nameplates and Legend Plates):

1. All nameplate text shall remain preliminary and subject to change pending final review and acceptance of the nomenclature by the OWNER after commissioning. Temporary tags consisting of removable tape or other accepted material with the preliminary nomenclature legibly hand lettered shall be affixed to enclosures and cover plates to identify the enclosures and mounted components as required during assembly, factory testing, and start-up. Laminated plastic nameplates shall not be engraved until after commissioning of the associated system and release of final engraving information by the OWNER.

## PART 3 -- EXECUTION

### 3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the work is to be installed and notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Electrical identification shall be provided as shown, specified or required.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
  1. Temporary tags shall be provided at all locations until after start-up and release of final engraving information by OWNER.
  2. Unless otherwise specified, permanent nameplates shall be attached with a permanent adhesive and with stainless steel machine screws into drilled and tapped holes.
  3. A nameplate with 1-1/2 inch letters shall be provided to identify each console, cabinet, panel, or enclosure as shown or specified.
  4. Nameplates with 1/2 inch letters shall be provided to identify each junction and terminal box as shown or specified.



5. On switchgear, nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments.

a. A nameplate with 1-inch letters shall be provided giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.

b. The individual door for each compartment shall be identified with a nameplate giving them designation and circuit number as well as frame ampere size and appropriate trip rating.

C. Motor Control Centers:

1. A nameplate with 1-inch letters shall be provided giving motor control center designation.

2. The individual door for each unit compartment shall be identified with a nameplate identifying the controlled equipment, including the tag number indicated on the Contract Drawings.

D. Except conduit, all other electrical appurtenances including, but not limited to, lighting panels, convenience outlets, fixtures and lighting switches, shall be provided nameplates indicating the appropriate circuit breaker number(s).

E. Safety Sign and Voltage Markers:

1. Safety signs and voltage markers shall be provided on and around electrical equipment as specified and where shown.

2. Rigid safety signs shall be installed using stainless steel fasteners.

3. Surfaces shall be cleaned before application of pressure sensitive signs and markers.

4. Low voltage safety signs shall be mounted on all equipment doors providing access to uninsulated 480-volt conductors (including terminal devices).

5. Low voltage markers shall be installed on each terminal box, safety disconnect switch and panelboard installed, modified or relocated and containing 120/208-volt conductors.

F. Conduit Labels:

1. All conduits shall be provided with conduit labels unless otherwise specified.

2. Flexible conduit shall not be labeled.

3. Exposed single conduit runs of less than 25 feet between local disconnect switches and the equipment they operate shall not be labeled.
4. Conduit labels shall convey the following information:
  - a. Contract Number: Alphanumeric.
  - b. Conduit Number: Alphanumeric. Leftmost character shall be the uppercase letter "C", remaining characters shall be a unique combination for each conduit, as shown on the Drawings and in accordance with conforming submittals.
5. Conduit labels shall be installed at the following locations:
  - a. Where conduit enters or exits walls, ceilings, floors, or slabs.
  - b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
  - c. At intervals of not more than 50 feet along the length of the conduit.
6. Conduit labels shall be oriented so as to be readable, standing on the floor near the conduit.
7. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
8. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

G. Wire and Cable Identification:

1. Color-coding of insulated conductors and identification shall comply with Section 26 05 19 – WIRES AND CABLES.
2. Wire and Cable Labels shall be provided as follows:
  - a. New, re-routed, or revised wire or cable shall be labeled.
  - b. All insulated conductors shall be labeled.
  - c. Bare (non-insulated) conductors shall not be labeled unless otherwise shown or specified.
  - d. Wire and cable terminations shall be labeled.
3. Wire labels shall be applied between ½ and 1 inch of the completed termination.

4. Cable labels shall be applied between  $\frac{1}{2}$  and 1 inch of cable breakout into individual conductors.
  - a. Individual conductors in a cable shall be labeled after the breakout as specified for wires
5. Wire or cable exiting cabinets, consoles, panels, terminal boxes and enclosures shall be labeled.
  - a. Wires or cables shall be labeled within two inches of the entrance to the conduit.
6. Wire and cable installed in electrical manholes shall be labeled.
  - a. Wire and cable shall have wrap-around labels applied within one foot of exiting the manhole.
7. Wire and cable labels shall be installed when the wire or cable is pulled and prior to termination of the conductors. Installation of wire and cable labels after the conductors are terminated is not permitted.

**- END OF SECTION -**

## SECTION 262416 – PANELBOARDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including Conditions of the Contract and Division 1 of the Specifications, apply to the work in this Section.
- B. This Section is hereby made a part of all other sections of Division 260000 as fully as if repeated in each therein.

#### 1.2 SECTION INCLUDES

- A. Branch circuit panelboards.

#### 1.3 RELATED SECTIONS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260553 - Electrical Identification.

#### REFERENCES

- A. NECA – “Standard of Installation”.
- B. NEMA AB1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
- D. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- E. NEMA PB 1 - Panelboards.
- F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- H. NFPA 70 - National Electrical Code.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 260500.
- B. Product Data: Provide for panelboards, fusible switches, and circuit breakers.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch

arrangement and sizes.

- D. Manufacturers' Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- E. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- F. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, unless otherwise specified.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

## 1.7 COORDINATION

- A. Coordinate under provisions of Division 1.
- B. Field Measurements: Verify that field measurements are as shown on Drawings.
- C. Field Locations: Verify locations of panelboards prior to rough-in.

## 1.8 DELIVERY, STORAGE, PROTECTION, AND HANDLING

- A. Protect from moisture by using appropriate coverings. Store in dry interior locations.
- B. Do not install until building is closed in and suitable temperature conditions are controlled.
- C. Maintain suitable temperature and humidity conditions during and after installation of panelboards.

## 1.9 EXTRA MATERIALS

- A. Submit extra materials under provisions of Division 1 and Section 260500

Furnish five of each panelboard key.

## PART 2 PRODUCTS

### 2.1 PANELBOARDS

- A. Phase sequence and balance.
  - 1. Phase sequence: A-B-C, left to right.
  - 2. Load balance: Distribute loads for maximum 10 percent difference.
- B. Each panelboard, and associated over current protection devices shall be of the same manufacturer.
- C. Each panelboard lock shall be operable by the same key.
- D. Each panelboard shall have a door – in – door.

### 2.2 BRANCH CIRCUIT PANELBOARDS

- A. Branch Panelboard Manufacturers - 240Y/120V:
  - 1. GE A series
  - 2. Siemens S1
  - 3. Square D NQOD
- B. Branch CircuitBreaker Manufacturers:
  - 1. GE.
  - 2. Siemens.
  - 3. Square D.
- C. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard, 600 amp maximum bus.
- D. Panelboard Bus: 1000 amp per sq.in. Copper, ampere and voltage ratings as indicated. Provide copper ground bus in each panelboard. Provide insulated ground bus where identified. Provide 200% rated neutral where identified.
- E. Minimum Short Circuit Rating: Fully rated, 10,000 amperes rms symmetrical for 208 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated, or as required to be greater than the available short circuit current.
- F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Shunt trip where indicated, Class A ground fault interrupter circuit breakers where indicated. Quantity and ratings as indicated. Do not use tandem circuit breakers.
- G. Main Circuit Breakers: NEMA AB 1, bolt-on type non-interchangeable thermal magnetic trip unit, two or three pole as required, top or bottom mounted as required, with shunt trip as required, and suitable for the voltage and amperage of the panelboard.
- H. Enclosure: NEMA PB 1, Galvanized steel finished inside and outside with

manufacturer's standard gray enamel. Type 1, 3R, or 4X as suitable for the location, 6 inches deep, 20 inches wide, minimum, or as required to accommodate the number of outgoing conduits. Door-in-door construction.

- I. Cabinet Front: Steel, flush or surface cabinet front as indicated, with concealed trim clamps, concealed hinge, metal directory frame, and flush lock. Finish in manufacturer's standard gray enamel.
- J. Sub-feed or feed-through lugs as scheduled.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Install multiple pole circuit breakers below single pole circuit breakers.
- D. Height: 6 feet to top of panelboard unless otherwise indicated or as required for specific field conditions. Install panelboards taller than 6 feet with bottom not closer than 4 inches above floor, or provide concrete equipment base in accordance with 262416.
- E. Provide filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard under the provisions of Section 260553. Revise directory to reflect circuiting changes required to balance phase loads.
- G. Provide engraved plastic nameplates under the provisions of Section 260553.
- H. Ground and bond panelboard enclosure according to Section 260526

### **3.2 CLEANING**

- A. Clean installed work under the provisions of Division 1.
- B. Clean interior of cabinets and enclosures to remove dust, debris, and other material.
- C. Clean surfaces and touch up scratched or marred surfaces to match original finish.

**- END OF SECTION-**

## SECTION 26 50 00 - LIGHTING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide luminaires and accessories, complete and operable, in accordance with the Contract Documents.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes

- NFPA 70 National Electric Code – 2017 Edition

- NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)

- UL-595 UL-924 Standard for Safety Emergency Lighting and Power Equipment

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish the following product information in accordance with the requirements of Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.

- B. Furnish the following information:

- 1. Interior Luminaires

- a. catalog data sheets
    - b. luminaire finish and metal gauge
    - c. lens material, pattern, and thickness
    - d. candlepower distribution curves in 2 or more planes
    - e. lumen output chart
    - f. mounting or suspension details
    - g. lens material, pattern, and thickness
    - h. IES lighting classification and isolux diagram
    - i. fastening details to wall or pole

- 2. Lamps

- a. voltages
    - b. colors
    - c. approximate life (in hours)
    - d. approximate initial lumens
    - e. lamp type

- 3. Drivers

- a. type
    - b. wiring diagram
    - c. nominal watts and input watts
    - d. input voltage



4. Photocells
  - a. voltage and wiring diagram
  - b. capacity
  - c. contacts and time delay
  - d. operating levels
  - e. enclosure type and dimensions

1.4 A sample of each "equal" fixture proposed for use shall be submitted to the ENGINEER for review, if requested.

## **PART 2 -- PRODUCTS**

### **2.1 LUMINAIRES**

#### **A. General**

1. Additional WORK requirements are indicated in the Luminaire Schedule on the Drawings.

B. Provide a feed-through type or separate junction box.

C. Provide minimum 18 AWG wire leads.

D. Provide components that are accessible and replaceable without removing the luminaire from its mounting.

#### **E. Emergency Lighting**

##### **1. Power Pack**

- a. self-contained
- b. 120/277 V
- c. dual voltage
- d. selectable input transformer
- e. 6 V sealed nickel-cadmium, lead-acid or lead-calcium battery (see Luminaire Schedule)
- f. indicator switch in accordance with the requirements of UL 924

2. Lighted, push-to-test pushbutton and indicator

3. Capability of providing full illumination for 1-1/2 hours in emergency mode

4. Capability of full recharge in 24 hours, automatically initiated upon resumption of normal line voltage

5. Capability of protecting against excess charging and discharging

6. LED lighting heads, as indicated

7. Solid state charger

8. Normal and emergency LED indicating lights

9. Mounting stand

10. Provide NEMA-rated enclosures in accordance with the area classifications in which they are installed.

F. Exit Signs

1. Internally illuminated
2. Universal mounting type
3. Internal 6 v maintenance free nickel-cadmium battery
4. Battery charger
5. LED-type emergency and normal indicating lights
6. Press-to-test button
7. Directional arrows
8. Red letters on a white panel, or as indicated

- G. The schedule and details of lighting fixtures, appearing on the Plans, indicate the type, construction, appearance, quality and performance of the fixtures required. Any proposed deviation from the fixtures specified must equal or be superior to the item specified under these headings. Proposed substitute lighting fixtures will be judged on overall quality on construction and on the basis of laboratory tests by the Electrical Testing Laboratory or similar independent testing facility. The fixture manufacturer's products scheduled are considered acceptable. The CONTRACTOR shall furnish, upon request of the ENGINEER, a set of fabrication plans, a set of photometric curves and a physical sample for review of every specific type offered.

2.2 LAMPS

A. LED

1. As indicated on the luminaire schedule on the drawings.

**PART 3 -- EXECUTION**

3.1 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.
2. Provide necessary hangers, pendants, canopies, and other accessories.

3. Install the luminaire plumb and level.
4. Install each luminaire outlet box with a galvanized stud.
5. Mechanical and Electrical Equipment Rooms: In the Mechanical and Electrical Equipment rooms, lighting fixtures shall be installed on ceilings or walls after all piping ductwork and equipment therein are installed. Exact location and switching for such fixtures will be determined at the job site during the course of the work. Fixtures shall be located so as to give maximum illumination to items of equipment requiring servicing, and moving machinery. Any lighting fixtures that are blocked, inaccessible or improperly located shall be relocated at no extra cost.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.

C. Finished Areas

1. Install the luminaires symmetrically with tile pattern.
2. Locate with the centerline of tile or with centerline of the joint between adjacent tile runs.
3. Install recessed luminaires tight to the finished surface such that no spill light will show between the ceilings and the sealing rings.
4. When installing on combustible low-density cellulose fiberboard, provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use luminaires suitable for mounting on low-density ceilings.

5. Junction Boxes

- a. Flush and Recessed Luminaires: Locate a minimum of one foot from the luminaire.
- b. In concealed locations, install junction boxes to be accessible by the removal of the luminaire.

6. Wiring and Conduit

- a. Provide wiring of a suitable temperature rating as required by the luminaire.
- b. Provide liquid tight flexible metal conduit, except in ceiling spaces used as air plenums, where flexible steel conduit meeting NEC requirements shall be used.

7. Provide plaster frames when required by ceiling construction.

8. Independent Supports

- a. Provide each recessed troffer luminaire with 2 safety chains or 2 No. 12

soft- annealed galvanized steel wires of length needed to secure the luminaire to the building structure, independent of the ceiling structure.

- b. Ensure that the tensile strength of chain or wire, and the method of fastening to the structure, is adequate to support the weight of the luminaire.
- c. Fasten the chain or wire to each end of the luminaire.
- d. Chains shall not be the primary supporting means.

D. Unfinished Areas

1. Locate the luminaires to avoid conflicts with other building systems and blockage of the luminaire light output.
2. Luminaire Suspension
  - a. Provide 3/8-inch threaded stainless steel hanger rods.
  - b. Scissor-type hangers will not be accepted.
3. For attachments to steel beams, provide flanged beam clips and straight or angled hangers.

3.2 LAMPS

- A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.3 CLEAN-UP

- A. Remove labels and other markings, except the UL listing mark.
- B. Wipe the luminaires inside and out in order to remove construction dust.
- C. Clean the luminaire plastic lenses with an antistatic cleaner only.
- D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.
- E. Replace defective lamps at the Date of Substantial Completion.

**- END OF SECTION -**

ARCH CREEK PHASE 2 - PUMP STATION  
TECHNICAL SPECIFICATIONS

## SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated.
- C. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.
- D. The CONTRACTOR'S attention is directed to the requirement for proper coordination of the WORK of this Section with other trades sections.
- E. Equipment supports and foundations shall be in conformance with the requirements of Structural Specifications.

#### 1.2 REFERENCE STANDARDS

ANSI	American National Standards Institute
FBC	Florida Building Code 2020
NEC (NFPA 70)	National Electrical Code – 2017 Edition
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
NRTL	National Recognized Testing Laboratory

- A. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.
- B. Installation of electrical equipment and materials shall comply with state building standards, and applicable local codes and regulations, all as enforced by the Authority Having Jurisdiction (AHJ).
- C. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

#### 1.3 BASIS FOR WIRING DESIGNS

- A. The Contract Drawings and Specifications describe specific sizes of switches,

breakers, fuses, conduits, conductors, motor starters and other electrical equipment. These sizes are based on specific power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Wherever another trade provides power consuming equipment that differs from the Contract Documents, the wiring, conduits, starters, overcurrent devices, and other electrical devices that may be impacted shall be changed to proper sizes to match at no additional expense to the OWNER.

#### 1.4 SIGNAGE AND MARKINGS

##### A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

##### B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

##### C. Warning Signs

1. 600 Volts Nominal, or Less
  - a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.
2. Arc Flash Signage

#### 1.5 PERMITS AND INSPECTION

- A. Obtain permits and pay inspection fees according to the General Conditions.

#### 1.6 CONTRACTOR SUBMITTALS

##### A. General

1. Furnish submittals in accordance with Section 01 33 00 - Shop Drawings, product data, and samples.
2. Custom-prepare Shop Drawings.
3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.
4. Cross out options not proposed or delete from the Shop Drawings.

- B. Shop Drawings: Include the following as a minimum:

1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Shop drawings for grounding WORK not specifically indicated
3. Front, side, rear elevations, and top views with dimensional data
4. Location of conduit entrances and access plates
5. Component data
6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers
7. Types of materials and finish
8. Nameplates
9. Temperature limitations, as applicable
10. Voltage requirement, phase, and current, as applicable
11. Grounding requirements

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.
2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the ENGINEER a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.
2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Architectural Section for shop drawings requirements.
2. As-Built Drawings
  - a. A set of "Red-Lined" electrical drawings shall be carefully maintained at the job site. Actual conditions are to be put on the drawings in red on a daily basis so the Plans will continuously show locations and routings of cables, conduits, pull boxes, circuit numbers, and other information required by the ENGINEER. An



up-to-date copy of the "Red-Lined" Drawings shall be submitted to the OWNER by the CONTRACTOR once every two weeks. At the end of the Project, the CONTRACTOR shall turn over As-Built Drawings in AutoCAD format to the OWNER.

- b. Furnish the drawings to the ENGINEER in accordance with the requirements of Architectural Section for shop drawings requirements.
- c. Prepare As-Built Drawings of encased concealed and exposed raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

## 1.7 AREA DESIGNATIONS

### A. General

- 1. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections, unless indicated otherwise.

### B. Material Requirements

- 1. Construct NEMA 4X enclosures of Type 316 stainless steel, except in chlorine or hypochlorite areas or areas with ferric-based chemicals where non-metallic enclosures shall be provided.
- 2. Metallic NEMA 4X enclosures shall have a white, powder coated finish.
- 3. Construct NEMA 7 enclosures of cast aluminum where used with aluminum conduit.
- 4. Do not coat NEMA 7 and 9 enclosures.
- 5. Construct NEMA 1, 3R, and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

## 1.8 TESTS

- A. The CONTRACTOR shall be responsible for required factory and field as required by Engineer and other authorities having jurisdiction.
- B. Furnish necessary testing equipment.
- C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.
- D. Reporting
  - 1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
  - 2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.

3. Submit field test reports for review prior to Substantial Completion.
- E. Remove and replace equipment or material that fails a test, or, if the ENGINEER approves, repair and retested for compliance.
  - F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.
- 1.9 DEMOLITION AND RELATED WORK
- A. General
    1. Perform electrical demolition WORK as indicated.
    2. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical Contract Drawings.
    3. Coordinate with all trades and building management regarding electrical de-energization, disconnection, and removal, and the overall sequence of construction.
  - B. Electrical Requirements for Removed Equipment
    1. Remove dedicated wiring and exposed conduits back to the source.
    2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring. Remove power wiring from the power source to the first pullbox or manhole remote from the panel, and abandon in place the remaining wiring.
    3. Remove remote-mounted starters, disconnect switches, circuit breakers, sensors, and transmitters. Breakers in Panels that are not replaced or re-used shall be abandoned in place, and nameplates replaced to read, "SPARE".
  - C. Where new lighting and receptacles are installed, remove old lighting, receptacles, switches, wiring, and conduits, and replace in their entirety.
  - D. Junction Boxes
    1. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips.
    2. Provide a junction box with a NEMA rating in accordance with the area in which it is located, and sized as required.
    3. Properly identify wires and terminals before disconnection.
  - E. Removed materials and equipment not indicated to be returned to the OWNER shall, upon removal, become the CONTRACTOR'S property and shall be disposed of off- site.
  - F. Remove and relocate material and equipment indicated to be relocated or reused, and reinstall with care in order to prevent damage.
  - G. Place materials indicated to be returned to the OWNER in boxes, with the contents

clearly marked, and store at a location determined by the OWNER.

#### H. Identification

1. Where panelboards are indicated to have components, assemblies, or circuits removed and reconnected, provide the affected panel compartments with new engraved nameplates worded as indicated and matching the existing, or modify the panelboard schedule to indicate the revised circuits. Replace the panelboard schedule in its entirety if the existing schedule is unreadable or otherwise unusable.
2. Pencil or magic marker markings directly on the panelboard will not be accepted.

### 1.10 CONSTRUCTION SEQUENCING

#### A. General

1. Because the continuance of building operation during the renovation is critical, the CONTRACTOR shall carefully examine the WORK to be provided in, on, or adjacent to existing equipment.
2. Schedule the WORK in phases, subject to OWNER's approval, to minimize disruption to normal operations.
3. Submit a written sequencing request, including the sequence and duration of activities to be performed.
4. In no case shall the CONTRACTOR begin any WORK phase without written authorization from the OWNER.

#### B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.
2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.
3. Repair coatings to match the existing.
4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the WORK.

#### C. Field Verifications

1. Visit the Site before submitting a bid to become better acquainted with the WORK of this Contract.
2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.

3. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL**

- A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.
- B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.
- C. Provide similar items in the WORK as products of the same manufacturer.
- D. Provide equipment and materials of industrial grade standard of construction.
- E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.
- F. On devices indicated to display dates, display the year as 4 digits.
- G. Temperature Ratings of Equipment Terminations
  1. Provide terminations and lugs rated for use with 75-degree C conductors.
  2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

### **2.2 MOUNTING HARDWARE**

- A. Miscellaneous Hardware
  1. Provide nuts, bolts, and washers constructed of stainless steel.
  2. Provide threaded rods for trapeze supports constructed from continuous threaded stainless steel, 3/8-inch diameter minimum.
  3. Struts
    - a. Provide struts for mounting of conduits and equipment of aluminum except where additional strength is needed, then use 316 stainless steel. Coat the back of aluminum struts with bitumastic coating where it comes in contact with concrete.
    - b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
    - c. Do not use aluminum strut for free-standing support frames. Use 316 stainless

steel except in chlorine, hypochlorite or ferric areas where FRP strut shall be used.

d. Strut Manufacturer, or Equal: **Unistrut; B-Line**

4. End Caps

a. Provide plastic protective end caps for all exposed metal strut ends.

b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860**

5. Anchors

a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

b. Wood plugs will not be accepted.

c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Hilti**.

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

##### **A. Incidentals**

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.
2. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

##### **B. Field Control of Location and Arrangement**

1. The Contract Drawings diagrammatically indicate the desired location and arrangement of loads, conduit runs, equipment, and other items.
2. Exact locations shall be determined by the CONTRACTOR in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.
3. Follow the locations on the Contract Drawings, however, as closely as possible.
4. Conduits
  - a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.
  - b. Provide exposed or encased routings as indicated, except conceal conduit in

finished areas unless indicated otherwise.

5. Placement

- a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.
- b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.
- c. Where exact locations are not indicated, such locations will be determined by the ENGINEER.
- d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.
- e. Slightly adjust luminaire locations based on actual field conditions in order to avoid obstructions and to minimize shadows, and update As-Built Drawings accordingly.

6. Circuits

- a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.
- b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).
- c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

7. Workmanship

- a. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer, and using workers skilled in the WORK.
- b. Coordinate installation in the field with other trades in order to avoid interferences.

8. Protection of Equipment and Materials

- a. Fully protect materials and equipment against damage from any cause.
- b. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.
- c. Keep moving parts clean and dry.

- d. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

### 3.2 CORE DRILLING

- A. Perform core drilling as required for the installation of raceways through concrete walls and floors.
- B. Base the locations of floor penetrations, as may be required, on field conditions.
- C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.
- D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities.
- E. Repair damage to walls, floors, encased conduits, wiring, and piping as part of the WORK.

### 3.3 CONCRETE HOUSEKEEPING PADS AND CURBS

- A. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.
- B. Extend housekeeping curbs to 4 inches above the finished floor or grade.

### 3.4 EQUIPMENT ANCHORING

- A. Floor-supported, wall, or ceiling-hung equipment and conductors shall be anchored in place by approved method in the area where the Project is located.
- B. Provide wall-mounted panels that weigh more than 500 pounds with fabricated steel support pedestals.
- C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.
- D. Provide transformers hung from 4-inch stud walls with auxiliary floor supports.
- E. Provide leveling channels anchored to the concrete pad for switchgear and pad-mounted transformer installations.
- F. Manufacturer's Recommendations
  - 1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract.
  - 2. Submit such recommendations as Shop Drawings as indicated.

### 3.5 CLEANING

- A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.
- B. Remove temporary tags, markers, stickers, and the like.
- C. Remove oil and grease spots with a non-flammable cleaning solvent, by carefully wiping and scraping cracks and corners.
- D. Apply touch-up paint to scratches on panels and cabinets.
- E. Vacuum-clean electrical cabinets and enclosures.
- F. Clean luminaires inside and out.
- G. Dispose cleaning debris and refuse off-Site.

**- END OF SECTION -**



## SECTION 26 05 19 - WIRE AND CABLE

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit Shop Drawings in accordance with Division 1 and 26 00 00 – ELECTRICAL WORK, GENERAL.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

#### 2.2 LOW VOLTAGE WIRE AND CABLE

##### A. Power and Lighting Wire

1. Wire rated for 600 volts in conduit for power and lighting circuits shall be type XHHW-2 rated 90 degrees C suitable for wet locations except where required otherwise by the plans.
2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drops on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
4. Wiring for 600 volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.

## B. Control Wire

1. Control wire in conduit shall be the same type as power and lighting wire indicated above.
2. Control wiring shall be #14 AWG, except for current transformer secondary conductors which shall be #12 AWG minimum.
3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable**, or equal.
4. All control wiring of 10 or more #14 shall be preassembled as manufactured by **Clifford of Vermont, Inc.**, Quik-Pull, meeting the following requirements:
  - a. #14 AWG stranded copper XHHW-2, 600 Volt
  - b. Each conductor numbered every 1½ Inches
  - c. Sequential footage tape.
  - d. Round compact units, spiral configuration
  - e. UL listed. Custom wire assembly
5. Assemblies are identified as QP-10, 20 to 100 maximum. Example: Where QP-20 is shown it supersedes the count if 16#14 are shown.
6. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3090A**, similar by **General Cable**, or equal.
7. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3091A**, similar by **General Cable**, or equal.

## 2.3 CABLE SPLICES AND TERMINATIONS

- A. Where cable lugs are required for power cable terminations, utilize copper, capped, one-hole and two-hole compression lugs – **3M** Scotchlok 30000 and 31100 Series, **Penn Union** HBBLU and BLU, **Burndy** Hylug, or equal. Utilize compression tools as recommended by the manufacturer. Open-ended lugs (where the end of the stranded cable is exposed) are not acceptable for power cable terminations. Pressure type, twist-on connectors (wire nuts) will not be acceptable.
- B. Pre-insulated ring lugs for control conductors shall be **Thomas & Betts, Burndy**, or equal.
- C. General purpose insulating tape shall be **Scotch No. 33, Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M**, or equal.

- D. Labels for coding 600 volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.
- E. No splices shall be permitted for low-voltage power cables.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

The CONTRACTOR shall provide, terminate and test all power, control, and instrumentation conductors.

The CONTRACTOR shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares.

### **3.2 INSTALLATION**

- A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.
- C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.
- D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

### **3.3 SPLICES AND TERMINATIONS**

#### **A. General**

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.
2. In general, there shall be no cable splices. Splices may be made only with the prior approval of the ENGINEER, and shall be performed in strict accordance with the cable and splice manufacturers' requirements. Splices will not be permitted for intra-building feeder or branch circuits.
3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug.
4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

#### **B. Control Wire and Cable**

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
2. In motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips. Where terminal strips require lugs, ring lugs shall be used. Fork-type lugs are not acceptable.
3. The CONTRACTOR shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR.
2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape.
3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR shall submit the proposed termination procedure as a Shop Drawing.

3.4 CABLE IDENTIFICATION. Also refer to Section 26 05 53 – ELECTRICAL IDENTIFICATION).

A. **General:** Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

B. **Identification Numbers:** The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on As-Built Drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control and Instrumentation Conductors" shall be defined as any conductor used for control, interlock, alarm, annunciator, or signal purposes.

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
2. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The

480/277 volt system conductors shall be color coded as follows: Phase A- Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs. Any phase changes necessary for proper rotation shall be made at the driven equipment and not in the local disconnect.

3. General purpose AC control cable shall be red. General purpose DC control cable shall be blue. DC power wiring shall be red for positive conductors (+) and black for negative conductors (-).
4. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
5. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

### 3.5 TESTING

- A. **Cable Assembly and Testing:** Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Division 1, prior to shipment of cable. The following field tests shall be the minimum requirements:
  1. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
  2. Field testing shall be done after cable is installed in the raceways.
  3. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.
  4. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.
- B. **Continuity Test:** Control cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

**- END OF SECTION -**

## SECTION 26 05 26 – GROUNDING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical grounding, complete and operable, as indicated in accordance with the Contract Documents.
- B. The requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL apply to this Section.
- C. Single Manufacturer
  - 1. 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.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Division 1 and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Equipment Grounding Circuit Conductors
  - 1. The conductors shall be the same type and insulation as the load circuit conductors.
  - 2. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.
  - 3. Metallic conduit systems shall have an equipment grounding wire as well as being equipment grounding conductors themselves.

### PART 3 -- EXECUTION

#### 3.1 GROUNDING

- A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.
- B. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.
- C. Route the conductors inside the raceway.

- D. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each panelboard.
- E. Individually bond the raceway to the ground bus in the secondary section.
- F. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.
- G. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.
- H. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.
- I. Low Voltage Grounded System (600V or less)
  - 1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.
  - 2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.
  - 3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.
  - 4. The termination of the shield drain wire shall be on its own terminal screw.
  - 5. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.
  - 6. Connect the ground bus via a green #12 conductor to the main ground bus for the panel.

### 3.2 TESTING

#### A. Fall-of-Potential Test

- 1. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
- 2. Main ground electrode system resistance to ground to be no greater than 3 ohms.

#### B. Two-Point Direct Method Test

1. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames and system neutral and derived neutral points.
  2. Equipment ground resistance not to exceed main ground system resistance by 0.25 ohms.
- C. Test several points of the system including: The neutral of every voltage level used in the system, enclosure of switchgears, motor control centers and panelboards and metal enclosure of outlet or fixture at remote location designated by the ENGINEER. Initial resistance to ground shall not be over 2.5 ohms for water pipe grounds and 15 ohms for made grounds.

**- END OF SECTION -**



## SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.
- B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.
  - 2. Submit dimensioned layout drawings of cable tray routings, including elevations.
  - 3. As-Built Drawings
    - a. Prepare as-built drawings of encased concealed and exposed raceways, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.
    - b. Furnish the drawings to the ENGINEER in accordance with the requirements of Division 1.

### PART 2 -- PRODUCTS

#### 2.1 METAL CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.
  - 2) Alflec Inc.
  - 3) Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4) Anamet Electrical, Inc.; Anaconda Metal Hose.

- 5) Electri-Flex Co.
  - 6) Manhattan/CDT/Cole-Flex.
  - 7) Maverick Tube Corporation.
  - 8) O-Z Gedney; a unit of General Signal.
  - 9) Wheatland Tube Company.
- c. Rigid Steel Conduit: ANSI C80.1.
  - d. Aluminum Rigid Conduit: ANSI C80.5.
  - e. IMC: ANSI C80.6.
  - f. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - 1) Comply with NEMA RN 1.
    - 2) Coating Thickness: 0.040 inch (1 mm), minimum.
  - g. EMT: ANSI C80.3.
  - h. FMC: Zinc-coated steel.
  - i. LFMC: Flexible steel conduit with PVC jacket.
  - j. 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.
    - 1) Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
    - 2) Fittings for EMT: Steel type.
    - 3) Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
  - k. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.

- 2) Anamet Electrical, Inc.; Anaconda Metal Hose.
- 3) Arnco Corporation.
- 4) CANTEX Inc.
- 5) CertainTeed Corp.; Pipe & Plastics Group.
- 6) Condux International, Inc.
- 7) ElecSYS, Inc.
- 8) Electri-Flex Co.
- 9) Lamson & Sessions; Carlon Electrical Products.
- 10) Manhattan/CDT/Cole-Flex.
- 11) RACO; a Hubbell Company.
- 12) Thomas & Betts Corporation.

- c. ENT: NEMA TC 13.
- d. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- e. LFNC: UL 1660.
- f. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- g. Fittings for LFNC: UL 514B.

### 2.3 METAL WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper B-Line, Inc.
  - 2) Hoffman.
  - 3) Square D; Schneider Electric.
- c. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R, unless otherwise indicated.
- d. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- e. Wireway Covers: Screw-cover type.
- f. Finish: Manufacturer's standard enamel finish.

## 2.4 NONMETALLIC WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Hoffman.
  - 2) Lamson & Sessions; Carlon Electrical Products.
- c. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- d. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- e. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.5 SURFACE RACEWAYS

- a. Surface Metal Raceways: Galvanized steel with snap-on covers. Prime coating, ready for field painting.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a) Thomas & Betts Corporation.
    - b) Walker Systems, Inc.; Wiremold Company (The).
    - c) Wiremold Company (The); Electrical Sales Division.
- b. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected manufacturer's standard colors.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a) Butler Manufacturing Company; Walker Division.
  - b) Enduro Systems, Inc.; Composite Products Division.
  - c) Hubbell Incorporated; Wiring Device-Kellems Division.
  - d) Lamson & Sessions; Carlon Electrical Products.
  - e) Panduit Corp.
  - f) Walker Systems, Inc.; Wiremold Company (The).
  - g) Wiremold Company (The); Electrical Sales Division.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2) EGS/Appleton Electric.
  - 3) Erickson Electrical Equipment Company.
  - 4) Hoffman.
  - 5) Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6) O-Z/Gedney; a unit of General Signal.
  - 7) RACO; a Hubbell Company.
  - 8) Robroy Industries, Inc.; Enclosure Division.
  - 9) Scott Fetzer Co.; Adalet Division.
  - 10) Spring City Electrical Manufacturing Company.
  - 11) Thomas & Betts Corporation.
  - 12) Walker Systems, Inc.; Wiremold Company (The).
  - 13) Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- c. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- d. Cast-Metal Outlet and Device Boxes: NEMA FB 1, [ferrous alloy] Type FD, with gasketed cover.
- e. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- f. Metal Floor Boxes: Cast metal , fully adjustable, rectangular.
- g. Nonmetallic Floor Boxes: Nonadjustable, round.
- h. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- i. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, [galvanized, cast iron] with gasketed cover.

- j. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  - 1) Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2) Nonmetallic Enclosures: Plastic

## EXECUTION

### 2.7 GENERAL

- A. Run wiring in raceway unless indicated otherwise.
- B. Install raceways between equipment as indicated.
- C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.
- D. Bends and Offsets
  - 1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.
  - 2. Provide factory elbows wherever possible.
- E. Combined Raceways
  - 1. Raceways other than those containing power conductors may be combined in strict accordance with the NEC and with prior written permission from the ENGINEER.
  - 2. In general, combine only raceways containing the same type (control, signal, and the like) and voltage of conductors/cables, or dedicated conduits from one source to one device/equipment, in accordance with the NEC.
  - 3. Permission from the ENGINEER shall not relieve the CONTRACTOR of responsibility to meet national, state and local requirements.
  - 4. Do not combine wiring for redundant systems into single raceways.
- F. Routing
  - 1. Where raceway routings are indicated, follow those routings to the extent possible.
  - 2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and provided in strict accordance with the NEC as well as customary installation practice.

3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.
  4. Adjust routings in order to avoid obstructions.
- G. Coordination
1. Coordinate between trades prior to installing the raceways.
  2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.
- H. Support wireways in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- I. Install exposed raceways parallel or perpendicular to structural beams.
- J. Install exposed raceways at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.
- K. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

## 2.8 CONDUIT

- A. Size
1. Provide exposed conduit of 3/4-inch minimum trade size.
  2. Provide encased conduit of one-inch minimum trade size.
- B. Install supports at distances required by the NEC.
- C. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.
- D. Penetrations
1. Provide conduit passing through walls or floors with plastic sleeves.
  2. Perform core drilling in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL.
  3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

- E. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.
- F. Coat threads with a conductive lubricant before assembly.
- G. Joints
  - 1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.
  - 2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.
  - 3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.
  - 4. Replace conduit with wrench marks.
- H. Slope
  - 1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.
  - 2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.
  - 3. Take extreme care in order to avoid pockets or depressions in the conduit.
- I. Installation of rigid conduit through a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.
- J. Connections
  - 1. Make connections to lay-in-type grid lighting fixtures by using flexible metal conduit not exceeding 4 feet in length.
  - 2. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.
  - 3. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.
- K. Empty Conduits
  - 1. Tag empty conduits at both ends to indicate the final destination.
  - 2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.
  - 3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.



4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

L. Identification of Conduits

1. Identify conduits at ends and at pulling points.
2. Identification shall be the unique conduit number assigned in the Contract Documents.
3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.
5. Provide conduit identification by a stamped or engraved non-corroding stainless steel metal tag attached to the conduit bushing.
6. Provide an engraved phenolic nameplate in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.
7. Markings with a pen or paint will not be accepted.

M. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.
2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the CONTRACTOR shall assign one following the numbering scheme used in the Contract Documents.
3. Provide box identification by a stamped or engraved stainless steel non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, and attached to the box or enclosure.
4. Markings with a pen or paint will not be accepted.

- N. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

**- END OF SECTION -**

## SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

##### A. Scope

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### B. Coordination

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### C. Related Sections

1. Section 26 00 00 – ELECTRICAL WORK, GENERAL.

#### 1.2 CONTRACTOR SUBMITTALS

##### A. Shop Drawings: Furnish submittals in accordance with Division 1.

1. Comply with the requirements below. Submit for approval of the following:
  - a. The complete description and enumeration of proposed electrical identification devices shall be shown on the Shop Drawings for the associated equipment or systems.

##### B. Product Data:

1. Manufacturer's cut sheet, specifications, dimensions and technical data for all products proposed to be furnished under this Section.
2. Any deviation shall be explicitly noted.

##### C. Samples:

1. Nameplates: Samples of nameplates shall be submitted and shall include both applied and unapplied wire and cable label samples. These samples shall be used as quality standards for the wire and cable labeling required by this Section. These samples shall be of material specified in this Section and shall include wire and cable designators meeting the requirements of this Section.

- D. Wiring diagrams annotated with wire numbers and terminal numbers shall be submitted prior to commissioning of associated equipment or systems.
- E. Project Record Documents:
  - 1. Submittals of Record Documents required by other Sections shall show final electrical identification and electrical identification devices.

## **PART 2 -- PRODUCTS**

### **2.1 MANUFACTURED UNITS**

#### **A. Engraved Identification Devices (Nameplates, and Legend):**

##### **1. Nameplates:**

- a. The following items shall be equipped with nameplates: All motors, motor starters, pushbutton stations, control panels, time switches, disconnect or relays in separate enclosures, transformers, receptacles, wall switches boxes and cabinets. All light switches and outlets shall carry a phenolic plate with the supply circuit panel I.D. and circuit number. Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.
- b. 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 motor nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and local control station nameplates for that machine. Nameplates shall be laminated phenolic plastic, white front and back with black core, with lettering etched through the outer covering; black engraved letters on white background. Lettering shall be 3/16 inch high at local control stations, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4 inch high, unless otherwise detailed on the Plans. Nameplates shall be securely fastened to the equipment with No. 4 Phillips, rough-head, cadmium- plated, steel self-tapping screws or nickel-plated brass bolts. For applications on NEMA 4X enclosures, nameplates shall be attached using an epoxy-based adhesive that is resistant to oil and moisture. Motor nameplates may be non-ferrous metal not less than 0.03 inch thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Engraved lettering shall be filled with contrasting enamel. Equipment nameplate schedule for all equipment shall be submitted with Shop Drawing submittal for Engineer's approval.
- c. All junction and splice boxes shall be labeled.

#### **B. Conduit Labels:**

##### **1. Products and Manufacturers:**

- a. **B-915 Series by Brady**, or approved equal.
  - b. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit diameters through five inches or pre-molded to conform to circumference of six-inch conduit.
  - c. Strap-on style for 6-inch conduit shall be attached with stainless steel springs.
  - d. Shall be blank for use with custom printed labels.
  - e. Labels shall be color coded as follows:
    - 1) Power Conduits (600V and less) – Orange
    - 2) Control/Instrumentation – Light Blue
    - 3) Telephone/Intercom – Yellow
    - 4) Data - White
- C. Custom Labels:
1. Shall have black lettering on yellow background
  2. Shall not contain abbreviations in legend
  3. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.
- D. Wire Identification:
1. All wire and cable shall be identified at each termination point and at each pull box, terminal box and manhole. Provide permanent, waterproof, non-metallic (paper unacceptable) tags indicating the circuit number in 3/16 inch letters. Circuit numbers shall be protected with clear shrinkable tubing.
  2. All 120 VAC and lower control circuits shall use vinyl, self-laminating, self-adhesive, wrap type labels that are heat, oil, water, and solvent resistant wire markers. Labels shall be by **Brady**, or approved equal (**Brady** XPS-187-1 and XPS-375-1, as applicable, based on wire size). Wire numbers shall be solid machine printed, and shall not be pieced from other single or double-digit tags.
  3. Where wire numbers change, the appropriate drawings shall include both wire numbers, clearly indicated, at the point of transition. Drawings shall also identify the insulation color for all wiring.
  4. Conductor Identification: Each conductor shall be identified by a 2-line identification. Line 1: X-Y, where X is a unique number and Y is the location of the termination in the cabinet you are looking at; Line 2: A-B, where A is a unique number (which should usually match the X in Line 1), and B is the location of the termination at the other end of the conductor. The termination locations are typically on terminal

- blocks with identifications such as "TB2-1". The CONTRACTOR shall coordinate with the OWNER regarding all conductor identifications prior to installation.
5. All terminals and terminal strips and posts shall be identified with terminal block markers.
  6. All wire labels shall be clearly visible and not hidden by wire duct or other components in the enclosures.
  7. PLC/DCS/RTU panel wire tag format and content shall be provided by the OWNER.

## 2.2 FABRICATION

### A. Engraved Identification Devices (Nameplates and Legend Plates):

1. All nameplate text shall remain preliminary and subject to change pending final review and acceptance of the nomenclature by the OWNER after commissioning. Temporary tags consisting of removable tape or other accepted material with the preliminary nomenclature legibly hand lettered shall be affixed to enclosures and cover plates to identify the enclosures and mounted components as required during assembly, factory testing, and start-up. Laminated plastic nameplates shall not be engraved until after commissioning of the associated system and release of final engraving information by the OWNER.

## PART 3 -- EXECUTION

### 3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the work is to be installed and notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Electrical identification shall be provided as shown, specified or required.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
  1. Temporary tags shall be provided at all locations until after start-up and release of final engraving information by OWNER.
  2. Unless otherwise specified, permanent nameplates shall be attached with a permanent adhesive and with stainless steel machine screws into drilled and tapped holes.
  3. A nameplate with 1-1/2 inch letters shall be provided to identify each console, cabinet, panel, or enclosure as shown or specified.
  4. Nameplates with 1/2 inch letters shall be provided to identify each junction and terminal box as shown or specified.

5. On switchgear, nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments.

a. A nameplate with 1-inch letters shall be provided giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.

b. The individual door for each compartment shall be identified with a nameplate giving them designation and circuit number as well as frame ampere size and appropriate trip rating.

C. Motor Control Centers:

1. A nameplate with 1-inch letters shall be provided giving motor control center designation.

2. The individual door for each unit compartment shall be identified with a nameplate identifying the controlled equipment, including the tag number indicated on the Contract Drawings.

D. Except conduit, all other electrical appurtenances including, but not limited to, lighting panels, convenience outlets, fixtures and lighting switches, shall be provided nameplates indicating the appropriate circuit breaker number(s).

E. Safety Sign and Voltage Markers:

1. Safety signs and voltage markers shall be provided on and around electrical equipment as specified and where shown.

2. Rigid safety signs shall be installed using stainless steel fasteners.

3. Surfaces shall be cleaned before application of pressure sensitive signs and markers.

4. Low voltage safety signs shall be mounted on all equipment doors providing access to uninsulated 480-volt conductors (including terminal devices).

5. Low voltage markers shall be installed on each terminal box, safety disconnect switch and panelboard installed, modified or relocated and containing 120/208-volt conductors.

F. Conduit Labels:

1. All conduits shall be provided with conduit labels unless otherwise specified.

2. Flexible conduit shall not be labeled.

3. Exposed single conduit runs of less than 25 feet between local disconnect switches and the equipment they operate shall not be labeled.
4. Conduit labels shall convey the following information:
  - a. Contract Number: Alphanumeric.
  - b. Conduit Number: Alphanumeric. Leftmost character shall be the uppercase letter "C", remaining characters shall be a unique combination for each conduit, as shown on the Drawings and in accordance with conforming submittals.
5. Conduit labels shall be installed at the following locations:
  - a. Where conduit enters or exits walls, ceilings, floors, or slabs.
  - b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
  - c. At intervals of not more than 50 feet along the length of the conduit.
6. Conduit labels shall be oriented so as to be readable, standing on the floor near the conduit.
7. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
8. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

G. Wire and Cable Identification:

1. Color-coding of insulated conductors and identification shall comply with Section 26 05 19 – WIRES AND CABLES.
2. Wire and Cable Labels shall be provided as follows:
  - a. New, re-routed, or revised wire or cable shall be labeled.
  - b. All insulated conductors shall be labeled.
  - c. Bare (non-insulated) conductors shall not be labeled unless otherwise shown or specified.
  - d. Wire and cable terminations shall be labeled.
3. Wire labels shall be applied between ½ and 1 inch of the completed termination.

4. Cable labels shall be applied between  $\frac{1}{2}$  and 1 inch of cable breakout into individual conductors.
  - a. Individual conductors in a cable shall be labeled after the breakout as specified for wires
5. Wire or cable exiting cabinets, consoles, panels, terminal boxes and enclosures shall be labeled.
  - a. Wires or cables shall be labeled within two inches of the entrance to the conduit.
6. Wire and cable installed in electrical manholes shall be labeled.
  - a. Wire and cable shall have wrap-around labels applied within one foot of exiting the manhole.
7. Wire and cable labels shall be installed when the wire or cable is pulled and prior to termination of the conductors. Installation of wire and cable labels after the conductors are terminated is not permitted.

**- END OF SECTION -**



## SECTION 262416 – PANELBOARDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including Conditions of the Contract and Division 1 of the Specifications, apply to the work in this Section.
- B. This Section is hereby made a part of all other sections of Division 260000 as fully as if repeated in each therein.

#### 1.2 SECTION INCLUDES

- A. Branch circuit panelboards.

#### 1.3 RELATED SECTIONS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260553 - Electrical Identification.

#### REFERENCES

- A. NECA – “Standard of Installation”.
- B. NEMA AB1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
- D. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- E. NEMA PB 1 - Panelboards.
- F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- H. NFPA 70 - National Electrical Code.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 260500.
- B. Product Data: Provide for panelboards, fusible switches, and circuit breakers.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch

arrangement and sizes.

- D. Manufacturers' Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- E. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- F. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, unless otherwise specified.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

## 1.7 COORDINATION

- A. Coordinate under provisions of Division 1.
- B. Field Measurements: Verify that field measurements are as shown on Drawings.
- C. Field Locations: Verify locations of panelboards prior to rough-in.

## 1.8 DELIVERY, STORAGE, PROTECTION, AND HANDLING

- A. Protect from moisture by using appropriate coverings. Store in dry interior locations.
- B. Do not install until building is closed in and suitable temperature conditions are controlled.
- C. Maintain suitable temperature and humidity conditions during and after installation of panelboards.

## 1.9 EXTRA MATERIALS

- A. Submit extra materials under provisions of Division 1 and Section 260500

Furnish five of each panelboard key.

## PART 2 PRODUCTS

### 2.1 PANELBOARDS

- A. Phase sequence and balance.
  - 1. Phase sequence: A-B-C, left to right.
  - 2. Load balance: Distribute loads for maximum 10 percent difference.
- B. Each panelboard, and associated over current protection devices shall be of the same manufacturer.
- C. Each panelboard lock shall be operable by the same key.
- D. Each panelboard shall have a door – in – door.

### 2.2 BRANCH CIRCUIT PANELBOARDS

- A. Branch Panelboard Manufacturers - 240Y/120V:
  - 1. GE A series
  - 2. Siemens S1
  - 3. Square D NQOD
- B. Branch CircuitBreaker Manufacturers:
  - 1. GE.
  - 2. Siemens.
  - 3. Square D.
- C. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard, 600 amp maximum bus.
- D. Panelboard Bus: 1000 amp per sq.in. Copper, ampere and voltage ratings as indicated. Provide copper ground bus in each panelboard. Provide insulated ground bus where identified. Provide 200% rated neutral where identified.
- E. Minimum Short Circuit Rating: Fully rated, 10,000 amperes rms symmetrical for 208 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated, or as required to be greater than the available short circuit current.
- F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Shunt trip where indicated, Class A ground fault interrupter circuit breakers where indicated. Quantity and ratings as indicated. Do not use tandem circuit breakers.
- G. Main Circuit Breakers: NEMA AB 1, bolt-on type non-interchangeable thermal magnetic trip unit, two or three pole as required, top or bottom mounted as required, with shunt trip as required, and suitable for the voltage and amperage of the panelboard.
- H. Enclosure: NEMA PB 1, Galvanized steel finished inside and outside with

manufacturer's standard gray enamel. Type 1, 3R, or 4X as suitable for the location, 6 inches deep, 20 inches wide, minimum, or as required to accommodate the number of outgoing conduits. Door-in-door construction.

- I. Cabinet Front: Steel, flush or surface cabinet front as indicated, with concealed trim clamps, concealed hinge, metal directory frame, and flush lock. Finish in manufacturer's standard gray enamel.
- J. Sub-feed or feed-through lugs as scheduled.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Install multiple pole circuit breakers below single pole circuit breakers.
- D. Height: 6 feet to top of panelboard unless otherwise indicated or as required for specific field conditions. Install panelboards taller than 6 feet with bottom not closer than 4 inches above floor, or provide concrete equipment base in accordance with 262416.
- E. Provide filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard under the provisions of Section 260553. Revise directory to reflect circuiting changes required to balance phase loads.
- G. Provide engraved plastic nameplates under the provisions of Section 260553.
- H. Ground and bond panelboard enclosure according to Section 260526

### **3.2 CLEANING**

- A. Clean installed work under the provisions of Division 1.
- B. Clean interior of cabinets and enclosures to remove dust, debris, and other material.
- C. Clean surfaces and touch up scratched or marred surfaces to match original finish.

**- END OF SECTION-**

## SECTION 26 50 00 - LIGHTING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide luminaires and accessories, complete and operable, in accordance with the Contract Documents.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes

- NFPA 70 National Electric Code – 2017 Edition

- NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)

- UL-595 UL-924 Standard for Safety Emergency Lighting and Power Equipment

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish the following product information in accordance with the requirements of Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.

- B. Furnish the following information:

- 1. Interior Luminaires

- a. catalog data sheets
    - b. luminaire finish and metal gauge
    - c. lens material, pattern, and thickness
    - d. candlepower distribution curves in 2 or more planes
    - e. lumen output chart
    - f. mounting or suspension details
    - g. lens material, pattern, and thickness
    - h. IES lighting classification and isolux diagram
    - i. fastening details to wall or pole

- 2. Lamps

- a. voltages
    - b. colors
    - c. approximate life (in hours)
    - d. approximate initial lumens
    - e. lamp type

- 3. Drivers

- a. type
    - b. wiring diagram
    - c. nominal watts and input watts
    - d. input voltage

4. Photocells
  - a. voltage and wiring diagram
  - b. capacity
  - c. contacts and time delay
  - d. operating levels
  - e. enclosure type and dimensions

1.4 A sample of each "equal" fixture proposed for use shall be submitted to the ENGINEER for review, if requested.

## **PART 2 -- PRODUCTS**

### **2.1 LUMINAIRES**

#### **A. General**

1. Additional WORK requirements are indicated in the Luminaire Schedule on the Drawings.

B. Provide a feed-through type or separate junction box.

C. Provide minimum 18 AWG wire leads.

D. Provide components that are accessible and replaceable without removing the luminaire from its mounting.

#### **E. Emergency Lighting**

##### **1. Power Pack**

- a. self-contained
- b. 120/277 V
- c. dual voltage
- d. selectable input transformer
- e. 6 V sealed nickel-cadmium, lead-acid or lead-calcium battery (see Luminaire Schedule)
- f. indicator switch in accordance with the requirements of UL 924

2. Lighted, push-to-test pushbutton and indicator

3. Capability of providing full illumination for 1-1/2 hours in emergency mode

4. Capability of full recharge in 24 hours, automatically initiated upon resumption of normal line voltage

5. Capability of protecting against excess charging and discharging

6. LED lighting heads, as indicated

7. Solid state charger

8. Normal and emergency LED indicating lights

9. Mounting stand

10. Provide NEMA-rated enclosures in accordance with the area classifications in which they are installed.

F. Exit Signs

1. Internally illuminated
2. Universal mounting type
3. Internal 6 v maintenance free nickel-cadmium battery
4. Battery charger
5. LED-type emergency and normal indicating lights
6. Press-to-test button
7. Directional arrows
8. Red letters on a white panel, or as indicated

- G. The schedule and details of lighting fixtures, appearing on the Plans, indicate the type, construction, appearance, quality and performance of the fixtures required. Any proposed deviation from the fixtures specified must equal or be superior to the item specified under these headings. Proposed substitute lighting fixtures will be judged on overall quality on construction and on the basis of laboratory tests by the Electrical Testing Laboratory or similar independent testing facility. The fixture manufacturer's products scheduled are considered acceptable. The CONTRACTOR shall furnish, upon request of the ENGINEER, a set of fabrication plans, a set of photometric curves and a physical sample for review of every specific type offered.

2.2 LAMPS

A. LED

1. As indicated on the luminaire schedule on the drawings.

**PART 3 -- EXECUTION**

3.1 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.
2. Provide necessary hangers, pendants, canopies, and other accessories.

3. Install the luminaire plumb and level.
4. Install each luminaire outlet box with a galvanized stud.
5. Mechanical and Electrical Equipment Rooms: In the Mechanical and Electrical Equipment rooms, lighting fixtures shall be installed on ceilings or walls after all piping ductwork and equipment therein are installed. Exact location and switching for such fixtures will be determined at the job site during the course of the work. Fixtures shall be located so as to give maximum illumination to items of equipment requiring servicing, and moving machinery. Any lighting fixtures that are blocked, inaccessible or improperly located shall be relocated at no extra cost.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.

C. Finished Areas

1. Install the luminaires symmetrically with tile pattern.
2. Locate with the centerline of tile or with centerline of the joint between adjacent tile runs.
3. Install recessed luminaires tight to the finished surface such that no spill light will show between the ceilings and the sealing rings.
4. When installing on combustible low-density cellulose fiberboard, provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use luminaires suitable for mounting on low-density ceilings.

5. Junction Boxes

- a. Flush and Recessed Luminaires: Locate a minimum of one foot from the luminaire.
- b. In concealed locations, install junction boxes to be accessible by the removal of the luminaire.

6. Wiring and Conduit

- a. Provide wiring of a suitable temperature rating as required by the luminaire.
- b. Provide liquid tight flexible metal conduit, except in ceiling spaces used as air plenums, where flexible steel conduit meeting NEC requirements shall be used.

7. Provide plaster frames when required by ceiling construction.

8. Independent Supports

- a. Provide each recessed troffer luminaire with 2 safety chains or 2 No. 12



soft- annealed galvanized steel wires of length needed to secure the luminaire to the building structure, independent of the ceiling structure.

- b. Ensure that the tensile strength of chain or wire, and the method of fastening to the structure, is adequate to support the weight of the luminaire.
- c. Fasten the chain or wire to each end of the luminaire.
- d. Chains shall not be the primary supporting means.

D. Unfinished Areas

1. Locate the luminaires to avoid conflicts with other building systems and blockage of the luminaire light output.
2. Luminaire Suspension
  - a. Provide 3/8-inch threaded stainless steel hanger rods.
  - b. Scissor-type hangers will not be accepted.
3. For attachments to steel beams, provide flanged beam clips and straight or angled hangers.

3.2 LAMPS

- A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.3 CLEAN-UP

- A. Remove labels and other markings, except the UL listing mark.
- B. Wipe the luminaires inside and out in order to remove construction dust.
- C. Clean the luminaire plastic lenses with an antistatic cleaner only.
- D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.
- E. Replace defective lamps at the Date of Substantial Completion.

**- END OF SECTION -**

BELEN PHASE 1 - PUMP STATION  
TECHNICAL SPECIFICATIONS

## SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated.
- C. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.
- D. The CONTRACTOR'S attention is directed to the requirement for proper coordination of the WORK of this Section with other trades sections.
- E. Equipment supports and foundations shall be in conformance with the requirements of Structural Specifications.

#### 1.2 REFERENCE STANDARDS

ANSI	American National Standards Institute
FBC	Florida Building Code 2020
NEC (NFPA 70)	National Electrical Code – 2017 Edition
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
NRTL	National Recognized Testing Laboratory

- A. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.
- B. Installation of electrical equipment and materials shall comply with state building standards, and applicable local codes and regulations, all as enforced by the Authority Having Jurisdiction (AHJ).
- C. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

#### 1.3 BASIS FOR WIRING DESIGNS

- A. The Contract Drawings and Specifications describe specific sizes of switches,

breakers, fuses, conduits, conductors, motor starters and other electrical equipment. These sizes are based on specific power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Wherever another trade provides power consuming equipment that differs from the Contract Documents, the wiring, conduits, starters, overcurrent devices, and other electrical devices that may be impacted shall be changed to proper sizes to match at no additional expense to the OWNER.

#### 1.4 SIGNAGE AND MARKINGS

##### A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

##### B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

##### C. Warning Signs

1. 600 Volts Nominal, or Less
  - a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.
2. Arc Flash Signage

#### 1.5 PERMITS AND INSPECTION

- A. Obtain permits and pay inspection fees according to the General Conditions.

#### 1.6 CONTRACTOR SUBMITTALS

##### A. General

1. Furnish submittals in accordance with Section 01 33 00 - Shop Drawings, product data, and samples.
2. Custom-prepare Shop Drawings.
3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.
4. Cross out options not proposed or delete from the Shop Drawings.

- B. Shop Drawings: Include the following as a minimum:

1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Shop drawings for grounding WORK not specifically indicated
3. Front, side, rear elevations, and top views with dimensional data
4. Location of conduit entrances and access plates
5. Component data
6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers
7. Types of materials and finish
8. Nameplates
9. Temperature limitations, as applicable
10. Voltage requirement, phase, and current, as applicable
11. Grounding requirements

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.
2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the ENGINEER a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.
2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Architectural Section for shop drawings requirements.
2. As-Built Drawings
  - a. A set of "Red-Lined" electrical drawings shall be carefully maintained at the job site. Actual conditions are to be put on the drawings in red on a daily basis so the Plans will continuously show locations and routings of cables, conduits, pull boxes, circuit numbers, and other information required by the ENGINEER. An

up-to-date copy of the "Red-Lined" Drawings shall be submitted to the OWNER by the CONTRACTOR once every two weeks. At the end of the Project, the CONTRACTOR shall turn over As-Built Drawings in AutoCAD format to the OWNER.

- b. Furnish the drawings to the ENGINEER in accordance with the requirements of Architectural Section for shop drawings requirements.
- c. Prepare As-Built Drawings of encased concealed and exposed raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

## 1.7 AREA DESIGNATIONS

### A. General

- 1. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections, unless indicated otherwise.

### B. Material Requirements

- 1. Construct NEMA 4X enclosures of Type 316 stainless steel, except in chlorine or hypochlorite areas or areas with ferric-based chemicals where non-metallic enclosures shall be provided.
- 2. Metallic NEMA 4X enclosures shall have a white, powder coated finish.
- 3. Construct NEMA 7 enclosures of cast aluminum where used with aluminum conduit.
- 4. Do not coat NEMA 7 and 9 enclosures.
- 5. Construct NEMA 1, 3R, and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

## 1.8 TESTS

- A. The CONTRACTOR shall be responsible for required factory and field as required by Engineer and other authorities having jurisdiction.
- B. Furnish necessary testing equipment.
- C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.
- D. Reporting
  - 1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
  - 2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.

3. Submit field test reports for review prior to Substantial Completion.
- E. Remove and replace equipment or material that fails a test, or, if the ENGINEER approves, repair and retested for compliance.
  - F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.
- 1.9 DEMOLITION AND RELATED WORK
- A. General
    1. Perform electrical demolition WORK as indicated.
    2. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical Contract Drawings.
    3. Coordinate with all trades and building management regarding electrical de-energization, disconnection, and removal, and the overall sequence of construction.
  - B. Electrical Requirements for Removed Equipment
    1. Remove dedicated wiring and exposed conduits back to the source.
    2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring. Remove power wiring from the power source to the first pullbox or manhole remote from the panel, and abandon in place the remaining wiring.
    3. Remove remote-mounted starters, disconnect switches, circuit breakers, sensors, and transmitters. Breakers in Panels that are not replaced or re-used shall be abandoned in place, and nameplates replaced to read, "SPARE".
  - C. Where new lighting and receptacles are installed, remove old lighting, receptacles, switches, wiring, and conduits, and replace in their entirety.
  - D. Junction Boxes
    1. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips.
    2. Provide a junction box with a NEMA rating in accordance with the area in which it is located, and sized as required.
    3. Properly identify wires and terminals before disconnection.
  - E. Removed materials and equipment not indicated to be returned to the OWNER shall, upon removal, become the CONTRACTOR'S property and shall be disposed of off- site.
  - F. Remove and relocate material and equipment indicated to be relocated or reused, and reinstall with care in order to prevent damage.
  - G. Place materials indicated to be returned to the OWNER in boxes, with the contents

clearly marked, and store at a location determined by the OWNER.

#### H. Identification

1. Where panelboards are indicated to have components, assemblies, or circuits removed and reconnected, provide the affected panel compartments with new engraved nameplates worded as indicated and matching the existing, or modify the panelboard schedule to indicate the revised circuits. Replace the panelboard schedule in its entirety if the existing schedule is unreadable or otherwise unusable.
2. Pencil or magic marker markings directly on the panelboard will not be accepted.

### 1.10 CONSTRUCTION SEQUENCING

#### A. General

1. Because the continuance of building operation during the renovation is critical, the CONTRACTOR shall carefully examine the WORK to be provided in, on, or adjacent to existing equipment.
2. Schedule the WORK in phases, subject to OWNER's approval, to minimize disruption to normal operations.
3. Submit a written sequencing request, including the sequence and duration of activities to be performed.
4. In no case shall the CONTRACTOR begin any WORK phase without written authorization from the OWNER.

#### B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.
2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.
3. Repair coatings to match the existing.
4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the WORK.

#### C. Field Verifications

1. Visit the Site before submitting a bid to become better acquainted with the WORK of this Contract.
2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.



3. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL**

- A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.
- B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.
- C. Provide similar items in the WORK as products of the same manufacturer.
- D. Provide equipment and materials of industrial grade standard of construction.
- E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.
- F. On devices indicated to display dates, display the year as 4 digits.
- G. Temperature Ratings of Equipment Terminations
  1. Provide terminations and lugs rated for use with 75-degree C conductors.
  2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

### **2.2 MOUNTING HARDWARE**

- A. Miscellaneous Hardware
  1. Provide nuts, bolts, and washers constructed of stainless steel.
  2. Provide threaded rods for trapeze supports constructed from continuous threaded stainless steel, 3/8-inch diameter minimum.
  3. Struts
    - a. Provide struts for mounting of conduits and equipment of aluminum except where additional strength is needed, then use 316 stainless steel. Coat the back of aluminum struts with bitumastic coating where it comes in contact with concrete.
    - b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
    - c. Do not use aluminum strut for free-standing support frames. Use 316 stainless

steel except in chlorine, hypochlorite or ferric areas where FRP strut shall be used.

d. Strut Manufacturer, or Equal: **Unistrut; B-Line**

4. End Caps

a. Provide plastic protective end caps for all exposed metal strut ends.

b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860**

5. Anchors

a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

b. Wood plugs will not be accepted.

c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Hilti**.

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

##### **A. Incidentals**

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.
2. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

##### **B. Field Control of Location and Arrangement**

1. The Contract Drawings diagrammatically indicate the desired location and arrangement of loads, conduit runs, equipment, and other items.
2. Exact locations shall be determined by the CONTRACTOR in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.
3. Follow the locations on the Contract Drawings, however, as closely as possible.
4. Conduits
  - a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.
  - b. Provide exposed or encased routings as indicated, except conceal conduit in

finished areas unless indicated otherwise.

5. Placement

- a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.
- b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.
- c. Where exact locations are not indicated, such locations will be determined by the ENGINEER.
- d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.
- e. Slightly adjust luminaire locations based on actual field conditions in order to avoid obstructions and to minimize shadows, and update As-Built Drawings accordingly.

6. Circuits

- a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.
- b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).
- c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

7. Workmanship

- a. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer, and using workers skilled in the WORK.
- b. Coordinate installation in the field with other trades in order to avoid interferences.

8. Protection of Equipment and Materials

- a. Fully protect materials and equipment against damage from any cause.
- b. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.
- c. Keep moving parts clean and dry.

- d. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

### 3.2 CORE DRILLING

- A. Perform core drilling as required for the installation of raceways through concrete walls and floors.
- B. Base the locations of floor penetrations, as may be required, on field conditions.
- C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.
- D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities.
- E. Repair damage to walls, floors, encased conduits, wiring, and piping as part of the WORK.

### 3.3 CONCRETE HOUSEKEEPING PADS AND CURBS

- A. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.
- B. Extend housekeeping curbs to 4 inches above the finished floor or grade.

### 3.4 EQUIPMENT ANCHORING

- A. Floor-supported, wall, or ceiling-hung equipment and conductors shall be anchored in place by approved method in the area where the Project is located.
- B. Provide wall-mounted panels that weigh more than 500 pounds with fabricated steel support pedestals.
- C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.
- D. Provide transformers hung from 4-inch stud walls with auxiliary floor supports.
- E. Provide leveling channels anchored to the concrete pad for switchgear and pad-mounted transformer installations.
- F. Manufacturer's Recommendations
  - 1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract.
  - 2. Submit such recommendations as Shop Drawings as indicated.

### 3.5 CLEANING

- A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.
- B. Remove temporary tags, markers, stickers, and the like.
- C. Remove oil and grease spots with a non-flammable cleaning solvent, by carefully wiping and scraping cracks and corners.
- D. Apply touch-up paint to scratches on panels and cabinets.
- E. Vacuum-clean electrical cabinets and enclosures.
- F. Clean luminaires inside and out.
- G. Dispose cleaning debris and refuse off-Site.

**- END OF SECTION -**

## SECTION 26 05 19 - WIRE AND CABLE

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit Shop Drawings in accordance with Division 1 and 26 00 00 – ELECTRICAL WORK, GENERAL.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

#### 2.2 LOW VOLTAGE WIRE AND CABLE

##### A. Power and Lighting Wire

1. Wire rated for 600 volts in conduit for power and lighting circuits shall be type XHHW-2 rated 90 degrees C suitable for wet locations except where required otherwise by the plans.
2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drops on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
4. Wiring for 600 volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.

## B. Control Wire

1. Control wire in conduit shall be the same type as power and lighting wire indicated above.
2. Control wiring shall be #14 AWG, except for current transformer secondary conductors which shall be #12 AWG minimum.
3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable**, or equal.
4. All control wiring of 10 or more #14 shall be preassembled as manufactured by **Clifford of Vermont, Inc.**, Quik-Pull, meeting the following requirements:
  - a. #14 AWG stranded copper XHHW-2, 600 Volt
  - b. Each conductor numbered every 1½ Inches
  - c. Sequential footage tape.
  - d. Round compact units, spiral configuration
  - e. UL listed. Custom wire assembly
5. Assemblies are identified as QP-10, 20 to 100 maximum. Example: Where QP-20 is shown it supersedes the count if 16#14 are shown.
6. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3090A**, similar by **General Cable**, or equal.
7. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3091A**, similar by **General Cable**, or equal.

## 2.3 CABLE SPLICES AND TERMINATIONS

- A. Where cable lugs are required for power cable terminations, utilize copper, capped, one-hole and two-hole compression lugs – **3M** Scotchlok 30000 and 31100 Series, **Penn Union** HBBLU and BLU, **Burndy** Hylug, or equal. Utilize compression tools as recommended by the manufacturer. Open-ended lugs (where the end of the stranded cable is exposed) are not acceptable for power cable terminations. Pressure type, twist-on connectors (wire nuts) will not be acceptable.
- B. Pre-insulated ring lugs for control conductors shall be **Thomas & Betts, Burndy**, or equal.
- C. General purpose insulating tape shall be **Scotch No. 33, Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M**, or equal.

- D. Labels for coding 600 volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.
- E. No splices shall be permitted for low-voltage power cables.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

The CONTRACTOR shall provide, terminate and test all power, control, and instrumentation conductors.

The CONTRACTOR shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares.

### **3.2 INSTALLATION**

- A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.
- C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.
- D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

### **3.3 SPLICES AND TERMINATIONS**

#### **A. General**

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.
2. In general, there shall be no cable splices. Splices may be made only with the prior approval of the ENGINEER, and shall be performed in strict accordance with the cable and splice manufacturers' requirements. Splices will not be permitted for intra-building feeder or branch circuits.
3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug.
4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

#### **B. Control Wire and Cable**



1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
2. In motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips. Where terminal strips require lugs, ring lugs shall be used. Fork-type lugs are not acceptable.
3. The CONTRACTOR shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR.
2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape.
3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR shall submit the proposed termination procedure as a Shop Drawing.

3.4 CABLE IDENTIFICATION. Also refer to Section 26 05 53 – ELECTRICAL IDENTIFICATION).

A. **General:** Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

B. **Identification Numbers:** The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on As-Built Drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control and Instrumentation Conductors" shall be defined as any conductor used for control, interlock, alarm, annunciator, or signal purposes.

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
2. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The

480/277 volt system conductors shall be color coded as follows: Phase A- Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs. Any phase changes necessary for proper rotation shall be made at the driven equipment and not in the local disconnect.

3. General purpose AC control cable shall be red. General purpose DC control cable shall be blue. DC power wiring shall be red for positive conductors (+) and black for negative conductors (-).
4. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
5. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

### 3.5 TESTING

- A. **Cable Assembly and Testing:** Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Division 1, prior to shipment of cable. The following field tests shall be the minimum requirements:
  1. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
  2. Field testing shall be done after cable is installed in the raceways.
  3. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.
  4. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.
- B. **Continuity Test:** Control cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

**- END OF SECTION -**

## SECTION 26 05 26 – GROUNDING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical grounding, complete and operable, as indicated in accordance with the Contract Documents.
- B. The requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL apply to this Section.
- C. Single Manufacturer
  - 1. 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.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Division 1 and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Equipment Grounding Circuit Conductors
  - 1. The conductors shall be the same type and insulation as the load circuit conductors.
  - 2. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.
  - 3. Metallic conduit systems shall have an equipment grounding wire as well as being equipment grounding conductors themselves.

### PART 3 -- EXECUTION

#### 3.1 GROUNDING

- A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.
- B. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.
- C. Route the conductors inside the raceway.

- D. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each panelboard.
- E. Individually bond the raceway to the ground bus in the secondary section.
- F. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.
- G. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.
- H. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.
- I. Low Voltage Grounded System (600V or less)
  - 1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.
  - 2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.
  - 3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.
  - 4. The termination of the shield drain wire shall be on its own terminal screw.
  - 5. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.
  - 6. Connect the ground bus via a green #12 conductor to the main ground bus for the panel.

### 3.2 TESTING

#### A. Fall-of-Potential Test

- 1. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
- 2. Main ground electrode system resistance to ground to be no greater than 3 ohms.

#### B. Two-Point Direct Method Test

1. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames and system neutral and derived neutral points.
  2. Equipment ground resistance not to exceed main ground system resistance by 0.25 ohms.
- C. Test several points of the system including: The neutral of every voltage level used in the system, enclosure of switchgears, motor control centers and panelboards and metal enclosure of outlet or fixture at remote location designated by the ENGINEER. Initial resistance to ground shall not be over 2.5 ohms for water pipe grounds and 15 ohms for made grounds.

**- END OF SECTION -**

## SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.
- B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.
  - 2. Submit dimensioned layout drawings of cable tray routings, including elevations.
  - 3. As-Built Drawings
    - a. Prepare as-built drawings of encased concealed and exposed raceways, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.
    - b. Furnish the drawings to the ENGINEER in accordance with the requirements of Division 1.

### PART 2 -- PRODUCTS

#### 2.1 METAL CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.
  - 2) Alflec Inc.
  - 3) Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4) Anamet Electrical, Inc.; Anaconda Metal Hose.

- 5) Electri-Flex Co.
  - 6) Manhattan/CDT/Cole-Flex.
  - 7) Maverick Tube Corporation.
  - 8) O-Z Gedney; a unit of General Signal.
  - 9) Wheatland Tube Company.
- c. Rigid Steel Conduit: ANSI C80.1.
  - d. Aluminum Rigid Conduit: ANSI C80.5.
  - e. IMC: ANSI C80.6.
  - f. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - 1) Comply with NEMA RN 1.
    - 2) Coating Thickness: 0.040 inch (1 mm), minimum.
  - g. EMT: ANSI C80.3.
  - h. FMC: Zinc-coated steel.
  - i. LFMC: Flexible steel conduit with PVC jacket.
  - j. 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.
    - 1) Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
    - 2) Fittings for EMT: Steel type.
    - 3) Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
  - k. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.

- 2) Anamet Electrical, Inc.; Anaconda Metal Hose.
- 3) Arnco Corporation.
- 4) CANTEX Inc.
- 5) CertainTeed Corp.; Pipe & Plastics Group.
- 6) Condux International, Inc.
- 7) ElecSYS, Inc.
- 8) Electri-Flex Co.
- 9) Lamson & Sessions; Carlon Electrical Products.
- 10) Manhattan/CDT/Cole-Flex.
- 11) RACO; a Hubbell Company.
- 12) Thomas & Betts Corporation.

- c. ENT: NEMA TC 13.
- d. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- e. LFNC: UL 1660.
- f. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- g. Fittings for LFNC: UL 514B.

## 2.3 METAL WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper B-Line, Inc.
  - 2) Hoffman.
  - 3) Square D; Schneider Electric.
- c. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R, unless otherwise indicated.
- d. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- e. Wireway Covers: Screw-cover type.
- f. Finish: Manufacturer's standard enamel finish.



## 2.4 NONMETALLIC WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Hoffman.
  - 2) Lamson & Sessions; Carlon Electrical Products.
- c. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- d. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- e. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.5 SURFACE RACEWAYS

- a. Surface Metal Raceways: Galvanized steel with snap-on covers. Prime coating, ready for field painting.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a) Thomas & Betts Corporation.
    - b) Walker Systems, Inc.; Wiremold Company (The).
    - c) Wiremold Company (The); Electrical Sales Division.
- b. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected manufacturer's standard colors.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a) Butler Manufacturing Company; Walker Division.
  - b) Enduro Systems, Inc.; Composite Products Division.
  - c) Hubbell Incorporated; Wiring Device-Kellems Division.
  - d) Lamson & Sessions; Carlon Electrical Products.
  - e) Panduit Corp.
  - f) Walker Systems, Inc.; Wiremold Company (The).
  - g) Wiremold Company (The); Electrical Sales Division.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2) EGS/Appleton Electric.
  - 3) Erickson Electrical Equipment Company.
  - 4) Hoffman.
  - 5) Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6) O-Z/Gedney; a unit of General Signal.
  - 7) RACO; a Hubbell Company.
  - 8) Robroy Industries, Inc.; Enclosure Division.
  - 9) Scott Fetzer Co.; Adalet Division.
  - 10) Spring City Electrical Manufacturing Company.
  - 11) Thomas & Betts Corporation.
  - 12) Walker Systems, Inc.; Wiremold Company (The).
  - 13) Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- c. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- d. Cast-Metal Outlet and Device Boxes: NEMA FB 1, [ferrous alloy] Type FD, with gasketed cover.
- e. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- f. Metal Floor Boxes: Cast metal , fully adjustable, rectangular.
- g. Nonmetallic Floor Boxes: Nonadjustable, round.
- h. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- i. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, [galvanized, cast iron] with gasketed cover.

- j. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  - 1) Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2) Nonmetallic Enclosures: Plastic

## EXECUTION

### 2.7 GENERAL

- A. Run wiring in raceway unless indicated otherwise.
- B. Install raceways between equipment as indicated.
- C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.
- D. Bends and Offsets
  - 1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.
  - 2. Provide factory elbows wherever possible.
- E. Combined Raceways
  - 1. Raceways other than those containing power conductors may be combined in strict accordance with the NEC and with prior written permission from the ENGINEER.
  - 2. In general, combine only raceways containing the same type (control, signal, and the like) and voltage of conductors/cables, or dedicated conduits from one source to one device/equipment, in accordance with the NEC.
  - 3. Permission from the ENGINEER shall not relieve the CONTRACTOR of responsibility to meet national, state and local requirements.
  - 4. Do not combine wiring for redundant systems into single raceways.
- F. Routing
  - 1. Where raceway routings are indicated, follow those routings to the extent possible.
  - 2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and provided in strict accordance with the NEC as well as customary installation practice.

3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.
  4. Adjust routings in order to avoid obstructions.
- G. Coordination
1. Coordinate between trades prior to installing the raceways.
  2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.
- H. Support wireways in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- I. Install exposed raceways parallel or perpendicular to structural beams.
- J. Install exposed raceways at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.
- K. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

## 2.8 CONDUIT

- A. Size
1. Provide exposed conduit of 3/4-inch minimum trade size.
  2. Provide encased conduit of one-inch minimum trade size.
- B. Install supports at distances required by the NEC.
- C. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.
- D. Penetrations
1. Provide conduit passing through walls or floors with plastic sleeves.
  2. Perform core drilling in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL.
  3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

- E. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.
- F. Coat threads with a conductive lubricant before assembly.
- G. Joints
  - 1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.
  - 2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.
  - 3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.
  - 4. Replace conduit with wrench marks.
- H. Slope
  - 1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.
  - 2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.
  - 3. Take extreme care in order to avoid pockets or depressions in the conduit.
- I. Installation of rigid conduit through a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.
- J. Connections
  - 1. Make connections to lay-in-type grid lighting fixtures by using flexible metal conduit not exceeding 4 feet in length.
  - 2. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.
  - 3. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.
- K. Empty Conduits
  - 1. Tag empty conduits at both ends to indicate the final destination.
  - 2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.
  - 3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

L. Identification of Conduits

1. Identify conduits at ends and at pulling points.
2. Identification shall be the unique conduit number assigned in the Contract Documents.
3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.
5. Provide conduit identification by a stamped or engraved non-corroding stainless steel metal tag attached to the conduit bushing.
6. Provide an engraved phenolic nameplate in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.
7. Markings with a pen or paint will not be accepted.

M. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.
2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the CONTRACTOR shall assign one following the numbering scheme used in the Contract Documents.
3. Provide box identification by a stamped or engraved stainless steel non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, and attached to the box or enclosure.
4. Markings with a pen or paint will not be accepted.

- N. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

**- END OF SECTION -**

## SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

##### A. Scope

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### B. Coordination

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### C. Related Sections

1. Section 26 00 00 – ELECTRICAL WORK, GENERAL.

#### 1.2 CONTRACTOR SUBMITTALS

##### A. Shop Drawings: Furnish submittals in accordance with Division 1.

1. Comply with the requirements below. Submit for approval of the following:
  - a. The complete description and enumeration of proposed electrical identification devices shall be shown on the Shop Drawings for the associated equipment or systems.

##### B. Product Data:

1. Manufacturer's cut sheet, specifications, dimensions and technical data for all products proposed to be furnished under this Section.
2. Any deviation shall be explicitly noted.

##### C. Samples:

1. Nameplates: Samples of nameplates shall be submitted and shall include both applied and unapplied wire and cable label samples. These samples shall be used as quality standards for the wire and cable labeling required by this Section. These samples shall be of material specified in this Section and shall include wire and cable designators meeting the requirements of this Section.

- D. Wiring diagrams annotated with wire numbers and terminal numbers shall be submitted prior to commissioning of associated equipment or systems.
- E. Project Record Documents:
  - 1. Submittals of Record Documents required by other Sections shall show final electrical identification and electrical identification devices.

## **PART 2 -- PRODUCTS**

### **2.1 MANUFACTURED UNITS**

#### **A. Engraved Identification Devices (Nameplates, and Legend):**

##### **1. Nameplates:**

- a. The following items shall be equipped with nameplates: All motors, motor starters, pushbutton stations, control panels, time switches, disconnect or relays in separate enclosures, transformers, receptacles, wall switches boxes and cabinets. All light switches and outlets shall carry a phenolic plate with the supply circuit panel I.D. and circuit number. Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.
- b. 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 motor nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and local control station nameplates for that machine. Nameplates shall be laminated phenolic plastic, white front and back with black core, with lettering etched through the outer covering; black engraved letters on white background. Lettering shall be 3/16 inch high at local control stations, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4 inch high, unless otherwise detailed on the Plans. Nameplates shall be securely fastened to the equipment with No. 4 Phillips, rough-head, cadmium- plated, steel self-tapping screws or nickel-plated brass bolts. For applications on NEMA 4X enclosures, nameplates shall be attached using an epoxy-based adhesive that is resistant to oil and moisture. Motor nameplates may be non-ferrous metal not less than 0.03 inch thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Engraved lettering shall be filled with contrasting enamel. Equipment nameplate schedule for all equipment shall be submitted with Shop Drawing submittal for Engineer's approval.
- c. All junction and splice boxes shall be labeled.

#### **B. Conduit Labels:**

##### **1. Products and Manufacturers:**



- a. **B-915 Series by Brady**, or approved equal.
  - b. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit diameters through five inches or pre-molded to conform to circumference of six-inch conduit.
  - c. Strap-on style for 6-inch conduit shall be attached with stainless steel springs.
  - d. Shall be blank for use with custom printed labels.
  - e. Labels shall be color coded as follows:
    - 1) Power Conduits (600V and less) – Orange
    - 2) Control/Instrumentation – Light Blue
    - 3) Telephone/Intercom – Yellow
    - 4) Data - White
- C. Custom Labels:
1. Shall have black lettering on yellow background
  2. Shall not contain abbreviations in legend
  3. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.
- D. Wire Identification:
1. All wire and cable shall be identified at each termination point and at each pull box, terminal box and manhole. Provide permanent, waterproof, non-metallic (paper unacceptable) tags indicating the circuit number in 3/16 inch letters. Circuit numbers shall be protected with clear shrinkable tubing.
  2. All 120 VAC and lower control circuits shall use vinyl, self-laminating, self-adhesive, wrap type labels that are heat, oil, water, and solvent resistant wire markers. Labels shall be by **Brady**, or approved equal (**Brady** XPS-187-1 and XPS-375-1, as applicable, based on wire size). Wire numbers shall be solid machine printed, and shall not be pieced from other single or double-digit tags.
  3. Where wire numbers change, the appropriate drawings shall include both wire numbers, clearly indicated, at the point of transition. Drawings shall also identify the insulation color for all wiring.
  4. Conductor Identification: Each conductor shall be identified by a 2-line identification. Line 1: X-Y, where X is a unique number and Y is the location of the termination in the cabinet you are looking at; Line 2: A-B, where A is a unique number (which should usually match the X in Line 1), and B is the location of the termination at the other end of the conductor. The termination locations are typically on terminal

- blocks with identifications such as "TB2-1". The CONTRACTOR shall coordinate with the OWNER regarding all conductor identifications prior to installation.
5. All terminals and terminal strips and posts shall be identified with terminal block markers.
  6. All wire labels shall be clearly visible and not hidden by wire duct or other components in the enclosures.
  7. PLC/DCS/RTU panel wire tag format and content shall be provided by the OWNER.

## 2.2 FABRICATION

### A. Engraved Identification Devices (Nameplates and Legend Plates):

1. All nameplate text shall remain preliminary and subject to change pending final review and acceptance of the nomenclature by the OWNER after commissioning. Temporary tags consisting of removable tape or other accepted material with the preliminary nomenclature legibly hand lettered shall be affixed to enclosures and cover plates to identify the enclosures and mounted components as required during assembly, factory testing, and start-up. Laminated plastic nameplates shall not be engraved until after commissioning of the associated system and release of final engraving information by the OWNER.

## PART 3 -- EXECUTION

### 3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the work is to be installed and notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Electrical identification shall be provided as shown, specified or required.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
  1. Temporary tags shall be provided at all locations until after start-up and release of final engraving information by OWNER.
  2. Unless otherwise specified, permanent nameplates shall be attached with a permanent adhesive and with stainless steel machine screws into drilled and tapped holes.
  3. A nameplate with 1-1/2 inch letters shall be provided to identify each console, cabinet, panel, or enclosure as shown or specified.
  4. Nameplates with 1/2 inch letters shall be provided to identify each junction and terminal box as shown or specified.

5. On switchgear, nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments.

a. A nameplate with 1-inch letters shall be provided giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.

b. The individual door for each compartment shall be identified with a nameplate giving them designation and circuit number as well as frame ampere size and appropriate trip rating.

C. Motor Control Centers:

1. A nameplate with 1-inch letters shall be provided giving motor control center designation.

2. The individual door for each unit compartment shall be identified with a nameplate identifying the controlled equipment, including the tag number indicated on the Contract Drawings.

D. Except conduit, all other electrical appurtenances including, but not limited to, lighting panels, convenience outlets, fixtures and lighting switches, shall be provided nameplates indicating the appropriate circuit breaker number(s).

E. Safety Sign and Voltage Markers:

1. Safety signs and voltage markers shall be provided on and around electrical equipment as specified and where shown.

2. Rigid safety signs shall be installed using stainless steel fasteners.

3. Surfaces shall be cleaned before application of pressure sensitive signs and markers.

4. Low voltage safety signs shall be mounted on all equipment doors providing access to uninsulated 480-volt conductors (including terminal devices).

5. Low voltage markers shall be installed on each terminal box, safety disconnect switch and panelboard installed, modified or relocated and containing 120/208-volt conductors.

F. Conduit Labels:

1. All conduits shall be provided with conduit labels unless otherwise specified.

2. Flexible conduit shall not be labeled.

3. Exposed single conduit runs of less than 25 feet between local disconnect switches and the equipment they operate shall not be labeled.
4. Conduit labels shall convey the following information:
  - a. Contract Number: Alphanumeric.
  - b. Conduit Number: Alphanumeric. Leftmost character shall be the uppercase letter "C", remaining characters shall be a unique combination for each conduit, as shown on the Drawings and in accordance with conforming submittals.
5. Conduit labels shall be installed at the following locations:
  - a. Where conduit enters or exits walls, ceilings, floors, or slabs.
  - b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
  - c. At intervals of not more than 50 feet along the length of the conduit.
6. Conduit labels shall be oriented so as to be readable, standing on the floor near the conduit.
7. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
8. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

G. Wire and Cable Identification:

1. Color-coding of insulated conductors and identification shall comply with Section 26 05 19 – WIRES AND CABLES.
2. Wire and Cable Labels shall be provided as follows:
  - a. New, re-routed, or revised wire or cable shall be labeled.
  - b. All insulated conductors shall be labeled.
  - c. Bare (non-insulated) conductors shall not be labeled unless otherwise shown or specified.
  - d. Wire and cable terminations shall be labeled.
3. Wire labels shall be applied between ½ and 1 inch of the completed termination.

4. Cable labels shall be applied between  $\frac{1}{2}$  and 1 inch of cable breakout into individual conductors.
  - a. Individual conductors in a cable shall be labeled after the breakout as specified for wires
5. Wire or cable exiting cabinets, consoles, panels, terminal boxes and enclosures shall be labeled.
  - a. Wires or cables shall be labeled within two inches of the entrance to the conduit.
6. Wire and cable installed in electrical manholes shall be labeled.
  - a. Wire and cable shall have wrap-around labels applied within one foot of exiting the manhole.
7. Wire and cable labels shall be installed when the wire or cable is pulled and prior to termination of the conductors. Installation of wire and cable labels after the conductors are terminated is not permitted.

**- END OF SECTION -**

## SECTION 262416 – PANELBOARDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including Conditions of the Contract and Division 1 of the Specifications, apply to the work in this Section.
- B. This Section is hereby made a part of all other sections of Division 260000 as fully as if repeated in each therein.

#### 1.2 SECTION INCLUDES

- A. Branch circuit panelboards.

#### 1.3 RELATED SECTIONS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260553 - Electrical Identification.

#### REFERENCES

- A. NECA – “Standard of Installation”.
- B. NEMA AB1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
- D. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- E. NEMA PB 1 - Panelboards.
- F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- H. NFPA 70 - National Electrical Code.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 260500.
- B. Product Data: Provide for panelboards, fusible switches, and circuit breakers.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch

arrangement and sizes.

- D. Manufacturers' Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- E. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- F. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, unless otherwise specified.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

## 1.7 COORDINATION

- A. Coordinate under provisions of Division 1.
- B. Field Measurements: Verify that field measurements are as shown on Drawings.
- C. Field Locations: Verify locations of panelboards prior to rough-in.

## 1.8 DELIVERY, STORAGE, PROTECTION, AND HANDLING

- A. Protect from moisture by using appropriate coverings. Store in dry interior locations.
- B. Do not install until building is closed in and suitable temperature conditions are controlled.
- C. Maintain suitable temperature and humidity conditions during and after installation of panelboards.

## 1.9 EXTRA MATERIALS

- A. Submit extra materials under provisions of Division 1 and Section 260500

Furnish five of each panelboard key.

## PART 2 PRODUCTS

### 2.1 PANELBOARDS

- A. Phase sequence and balance.
  - 1. Phase sequence: A-B-C, left to right.
  - 2. Load balance: Distribute loads for maximum 10 percent difference.
- B. Each panelboard, and associated over current protection devices shall be of the same manufacturer.
- C. Each panelboard lock shall be operable by the same key.
- D. Each panelboard shall have a door – in – door.

### 2.2 BRANCH CIRCUIT PANELBOARDS

- A. Branch Panelboard Manufacturers - 240Y/120V:
  - 1. GE A series
  - 2. Siemens S1
  - 3. Square D NQOD
- B. Branch CircuitBreaker Manufacturers:
  - 1. GE.
  - 2. Siemens.
  - 3. Square D.
- C. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard, 600 amp maximum bus.
- D. Panelboard Bus: 1000 amp per sq.in. Copper, ampere and voltage ratings as indicated. Provide copper ground bus in each panelboard. Provide insulated ground bus where identified. Provide 200% rated neutral where identified.
- E. Minimum Short Circuit Rating: Fully rated, 10,000 amperes rms symmetrical for 208 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated, or as required to be greater than the available short circuit current.
- F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Shunt trip where indicated, Class A ground fault interrupter circuit breakers where indicated. Quantity and ratings as indicated. Do not use tandem circuit breakers.
- G. Main Circuit Breakers: NEMA AB 1, bolt-on type non-interchangeable thermal magnetic trip unit, two or three pole as required, top or bottom mounted as required, with shunt trip as required, and suitable for the voltage and amperage of the panelboard.
- H. Enclosure: NEMA PB 1, Galvanized steel finished inside and outside with



manufacturer's standard gray enamel. Type 1, 3R, or 4X as suitable for the location, 6 inches deep, 20 inches wide, minimum, or as required to accommodate the number of outgoing conduits. Door-in-door construction.

- I. Cabinet Front: Steel, flush or surface cabinet front as indicated, with concealed trim clamps, concealed hinge, metal directory frame, and flush lock. Finish in manufacturer's standard gray enamel.
- J. Sub-feed or feed-through lugs as scheduled.

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Install multiple pole circuit breakers below single pole circuit breakers.
- D. Height: 6 feet to top of panelboard unless otherwise indicated or as required for specific field conditions. Install panelboards taller than 6 feet with bottom not closer than 4 inches above floor, or provide concrete equipment base in accordance with 262416.
- E. Provide filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard under the provisions of Section 260553. Revise directory to reflect circuiting changes required to balance phase loads.
- G. Provide engraved plastic nameplates under the provisions of Section 260553.
- H. Ground and bond panelboard enclosure according to Section 260526

#### **3.2 CLEANING**

- A. Clean installed work under the provisions of Division 1.
- B. Clean interior of cabinets and enclosures to remove dust, debris, and other material.
- C. Clean surfaces and touch up scratched or marred surfaces to match original finish.

**- END OF SECTION-**

## SECTION 26 50 00 - LIGHTING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide luminaires and accessories, complete and operable, in accordance with the Contract Documents.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes

- NFPA 70 National Electric Code – 2017 Edition

- NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)

- UL-595 UL-924 Standard for Safety Emergency Lighting and Power Equipment

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish the following product information in accordance with the requirements of Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.

- B. Furnish the following information:

- 1. Interior Luminaires

- a. catalog data sheets
    - b. luminaire finish and metal gauge
    - c. lens material, pattern, and thickness
    - d. candlepower distribution curves in 2 or more planes
    - e. lumen output chart
    - f. mounting or suspension details
    - g. lens material, pattern, and thickness
    - h. IES lighting classification and isolux diagram
    - i. fastening details to wall or pole

- 2. Lamps

- a. voltages
    - b. colors
    - c. approximate life (in hours)
    - d. approximate initial lumens
    - e. lamp type

- 3. Drivers

- a. type
    - b. wiring diagram
    - c. nominal watts and input watts
    - d. input voltage

4. Photocells
  - a. voltage and wiring diagram
  - b. capacity
  - c. contacts and time delay
  - d. operating levels
  - e. enclosure type and dimensions

1.4 A sample of each "equal" fixture proposed for use shall be submitted to the ENGINEER for review, if requested.

## **PART 2 -- PRODUCTS**

### **2.1 LUMINAIRES**

#### **A. General**

1. Additional WORK requirements are indicated in the Luminaire Schedule on the Drawings.

B. Provide a feed-through type or separate junction box.

C. Provide minimum 18 AWG wire leads.

D. Provide components that are accessible and replaceable without removing the luminaire from its mounting.

#### **E. Emergency Lighting**

##### **1. Power Pack**

- a. self-contained
- b. 120/277 V
- c. dual voltage
- d. selectable input transformer
- e. 6 V sealed nickel-cadmium, lead-acid or lead-calcium battery (see Luminaire Schedule)
- f. indicator switch in accordance with the requirements of UL 924

2. Lighted, push-to-test pushbutton and indicator

3. Capability of providing full illumination for 1-1/2 hours in emergency mode

4. Capability of full recharge in 24 hours, automatically initiated upon resumption of normal line voltage

5. Capability of protecting against excess charging and discharging

6. LED lighting heads, as indicated

7. Solid state charger

8. Normal and emergency LED indicating lights

9. Mounting stand

10. Provide NEMA-rated enclosures in accordance with the area classifications in which they are installed.

F. Exit Signs

1. Internally illuminated
2. Universal mounting type
3. Internal 6 v maintenance free nickel-cadmium battery
4. Battery charger
5. LED-type emergency and normal indicating lights
6. Press-to-test button
7. Directional arrows
8. Red letters on a white panel, or as indicated

- G. The schedule and details of lighting fixtures, appearing on the Plans, indicate the type, construction, appearance, quality and performance of the fixtures required. Any proposed deviation from the fixtures specified must equal or be superior to the item specified under these headings. Proposed substitute lighting fixtures will be judged on overall quality on construction and on the basis of laboratory tests by the Electrical Testing Laboratory or similar independent testing facility. The fixture manufacturer's products scheduled are considered acceptable. The CONTRACTOR shall furnish, upon request of the ENGINEER, a set of fabrication plans, a set of photometric curves and a physical sample for review of every specific type offered.

2.2 LAMPS

A. LED

1. As indicated on the luminaire schedule on the drawings.

**PART 3 -- EXECUTION**

3.1 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.
2. Provide necessary hangers, pendants, canopies, and other accessories.

3. Install the luminaire plumb and level.
4. Install each luminaire outlet box with a galvanized stud.
5. Mechanical and Electrical Equipment Rooms: In the Mechanical and Electrical Equipment rooms, lighting fixtures shall be installed on ceilings or walls after all piping ductwork and equipment therein are installed. Exact location and switching for such fixtures will be determined at the job site during the course of the work. Fixtures shall be located so as to give maximum illumination to items of equipment requiring servicing, and moving machinery. Any lighting fixtures that are blocked, inaccessible or improperly located shall be relocated at no extra cost.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.

C. Finished Areas

1. Install the luminaires symmetrically with tile pattern.
2. Locate with the centerline of tile or with centerline of the joint between adjacent tile runs.
3. Install recessed luminaires tight to the finished surface such that no spill light will show between the ceilings and the sealing rings.
4. When installing on combustible low-density cellulose fiberboard, provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use luminaires suitable for mounting on low-density ceilings.

5. Junction Boxes

- a. Flush and Recessed Luminaires: Locate a minimum of one foot from the luminaire.
- b. In concealed locations, install junction boxes to be accessible by the removal of the luminaire.

6. Wiring and Conduit

- a. Provide wiring of a suitable temperature rating as required by the luminaire.
- b. Provide liquid tight flexible metal conduit, except in ceiling spaces used as air plenums, where flexible steel conduit meeting NEC requirements shall be used.

7. Provide plaster frames when required by ceiling construction.

8. Independent Supports

- a. Provide each recessed troffer luminaire with 2 safety chains or 2 No. 12

soft- annealed galvanized steel wires of length needed to secure the luminaire to the building structure, independent of the ceiling structure.

- b. Ensure that the tensile strength of chain or wire, and the method of fastening to the structure, is adequate to support the weight of the luminaire.
- c. Fasten the chain or wire to each end of the luminaire.
- d. Chains shall not be the primary supporting means.

D. Unfinished Areas

1. Locate the luminaires to avoid conflicts with other building systems and blockage of the luminaire light output.
2. Luminaire Suspension
  - a. Provide 3/8-inch threaded stainless steel hanger rods.
  - b. Scissor-type hangers will not be accepted.
3. For attachments to steel beams, provide flanged beam clips and straight or angled hangers.

3.2 LAMPS

- A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.3 CLEAN-UP

- A. Remove labels and other markings, except the UL listing mark.
- B. Wipe the luminaires inside and out in order to remove construction dust.
- C. Clean the luminaire plastic lenses with an antistatic cleaner only.
- D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.
- E. Replace defective lamps at the Date of Substantial Completion.

**- END OF SECTION -**

BELEN PHASE 2 - PUMP STATION  
TECHNICAL SPECIFICATIONS

## SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated.
- C. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.
- D. The CONTRACTOR'S attention is directed to the requirement for proper coordination of the WORK of this Section with other trades sections.
- E. Equipment supports and foundations shall be in conformance with the requirements of Structural Specifications.

#### 1.2 REFERENCE STANDARDS

ANSI	American National Standards Institute
FBC	Florida Building Code 2020
NEC (NFPA 70)	National Electrical Code – 2017 Edition
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
NRTL	National Recognized Testing Laboratory

- A. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.
- B. Installation of electrical equipment and materials shall comply with state building standards, and applicable local codes and regulations, all as enforced by the Authority Having Jurisdiction (AHJ).
- C. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

#### 1.3 BASIS FOR WIRING DESIGNS

- A. The Contract Drawings and Specifications describe specific sizes of switches,



breakers, fuses, conduits, conductors, motor starters and other electrical equipment. These sizes are based on specific power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Wherever another trade provides power consuming equipment that differs from the Contract Documents, the wiring, conduits, starters, overcurrent devices, and other electrical devices that may be impacted shall be changed to proper sizes to match at no additional expense to the OWNER.

#### 1.4 SIGNAGE AND MARKINGS

##### A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

##### B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

##### C. Warning Signs

1. 600 Volts Nominal, or Less
  - a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.
2. Arc Flash Signage

#### 1.5 PERMITS AND INSPECTION

- A. Obtain permits and pay inspection fees according to the General Conditions.

#### 1.6 CONTRACTOR SUBMITTALS

##### A. General

1. Furnish submittals in accordance with Section 01 33 00 - Shop Drawings, product data, and samples.
2. Custom-prepare Shop Drawings.
3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.
4. Cross out options not proposed or delete from the Shop Drawings.

- B. Shop Drawings: Include the following as a minimum:

1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Shop drawings for grounding WORK not specifically indicated
3. Front, side, rear elevations, and top views with dimensional data
4. Location of conduit entrances and access plates
5. Component data
6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers
7. Types of materials and finish
8. Nameplates
9. Temperature limitations, as applicable
10. Voltage requirement, phase, and current, as applicable
11. Grounding requirements

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.
2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the ENGINEER a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.
2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Architectural Section for shop drawings requirements.
2. As-Built Drawings
  - a. A set of "Red-Lined" electrical drawings shall be carefully maintained at the job site. Actual conditions are to be put on the drawings in red on a daily basis so the Plans will continuously show locations and routings of cables, conduits, pull boxes, circuit numbers, and other information required by the ENGINEER. An

up-to-date copy of the "Red-Lined" Drawings shall be submitted to the OWNER by the CONTRACTOR once every two weeks. At the end of the Project, the CONTRACTOR shall turn over As-Built Drawings in AutoCAD format to the OWNER.

- b. Furnish the drawings to the ENGINEER in accordance with the requirements of Architectural Section for shop drawings requirements.
- c. Prepare As-Built Drawings of encased concealed and exposed raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

## 1.7 AREA DESIGNATIONS

### A. General

- 1. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections, unless indicated otherwise.

### B. Material Requirements

- 1. Construct NEMA 4X enclosures of Type 316 stainless steel, except in chlorine or hypochlorite areas or areas with ferric-based chemicals where non-metallic enclosures shall be provided.
- 2. Metallic NEMA 4X enclosures shall have a white, powder coated finish.
- 3. Construct NEMA 7 enclosures of cast aluminum where used with aluminum conduit.
- 4. Do not coat NEMA 7 and 9 enclosures.
- 5. Construct NEMA 1, 3R, and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

## 1.8 TESTS

- A. The CONTRACTOR shall be responsible for required factory and field as required by Engineer and other authorities having jurisdiction.
- B. Furnish necessary testing equipment.
- C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.
- D. Reporting
  - 1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
  - 2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.

3. Submit field test reports for review prior to Substantial Completion.
- E. Remove and replace equipment or material that fails a test, or, if the ENGINEER approves, repair and retested for compliance.
  - F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.
- 1.9 DEMOLITION AND RELATED WORK
- A. General
    1. Perform electrical demolition WORK as indicated.
    2. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical Contract Drawings.
    3. Coordinate with all trades and building management regarding electrical de-energization, disconnection, and removal, and the overall sequence of construction.
  - B. Electrical Requirements for Removed Equipment
    1. Remove dedicated wiring and exposed conduits back to the source.
    2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring. Remove power wiring from the power source to the first pullbox or manhole remote from the panel, and abandon in place the remaining wiring.
    3. Remove remote-mounted starters, disconnect switches, circuit breakers, sensors, and transmitters. Breakers in Panels that are not replaced or re-used shall be abandoned in place, and nameplates replaced to read, "SPARE".
  - C. Where new lighting and receptacles are installed, remove old lighting, receptacles, switches, wiring, and conduits, and replace in their entirety.
  - D. Junction Boxes
    1. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips.
    2. Provide a junction box with a NEMA rating in accordance with the area in which it is located, and sized as required.
    3. Properly identify wires and terminals before disconnection.
  - E. Removed materials and equipment not indicated to be returned to the OWNER shall, upon removal, become the CONTRACTOR'S property and shall be disposed of off- site.
  - F. Remove and relocate material and equipment indicated to be relocated or reused, and reinstall with care in order to prevent damage.
  - G. Place materials indicated to be returned to the OWNER in boxes, with the contents

clearly marked, and store at a location determined by the OWNER.

#### H. Identification

1. Where panelboards are indicated to have components, assemblies, or circuits removed and reconnected, provide the affected panel compartments with new engraved nameplates worded as indicated and matching the existing, or modify the panelboard schedule to indicate the revised circuits. Replace the panelboard schedule in its entirety if the existing schedule is unreadable or otherwise unusable.
2. Pencil or magic marker markings directly on the panelboard will not be accepted.

### 1.10 CONSTRUCTION SEQUENCING

#### A. General

1. Because the continuance of building operation during the renovation is critical, the CONTRACTOR shall carefully examine the WORK to be provided in, on, or adjacent to existing equipment.
2. Schedule the WORK in phases, subject to OWNER's approval, to minimize disruption to normal operations.
3. Submit a written sequencing request, including the sequence and duration of activities to be performed.
4. In no case shall the CONTRACTOR begin any WORK phase without written authorization from the OWNER.

#### B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.
2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.
3. Repair coatings to match the existing.
4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the WORK.

#### C. Field Verifications

1. Visit the Site before submitting a bid to become better acquainted with the WORK of this Contract.
2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.

3. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL**

- A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.
- B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.
- C. Provide similar items in the WORK as products of the same manufacturer.
- D. Provide equipment and materials of industrial grade standard of construction.
- E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.
- F. On devices indicated to display dates, display the year as 4 digits.
- G. Temperature Ratings of Equipment Terminations
  1. Provide terminations and lugs rated for use with 75-degree C conductors.
  2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

### **2.2 MOUNTING HARDWARE**

- A. Miscellaneous Hardware
  1. Provide nuts, bolts, and washers constructed of stainless steel.
  2. Provide threaded rods for trapeze supports constructed from continuous threaded stainless steel, 3/8-inch diameter minimum.
  3. Struts
    - a. Provide struts for mounting of conduits and equipment of aluminum except where additional strength is needed, then use 316 stainless steel. Coat the back of aluminum struts with bitumastic coating where it comes in contact with concrete.
    - b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
    - c. Do not use aluminum strut for free-standing support frames. Use 316 stainless

steel except in chlorine, hypochlorite or ferric areas where FRP strut shall be used.

d. Strut Manufacturer, or Equal: **Unistrut; B-Line**

4. End Caps

a. Provide plastic protective end caps for all exposed metal strut ends.

b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860**

5. Anchors

a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

b. Wood plugs will not be accepted.

c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Hilti**.

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

##### **A. Incidentals**

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.
2. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

##### **B. Field Control of Location and Arrangement**

1. The Contract Drawings diagrammatically indicate the desired location and arrangement of loads, conduit runs, equipment, and other items.
2. Exact locations shall be determined by the CONTRACTOR in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.
3. Follow the locations on the Contract Drawings, however, as closely as possible.
4. Conduits
  - a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.
  - b. Provide exposed or encased routings as indicated, except conceal conduit in

finished areas unless indicated otherwise.

5. Placement

- a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.
- b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.
- c. Where exact locations are not indicated, such locations will be determined by the ENGINEER.
- d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.
- e. Slightly adjust luminaire locations based on actual field conditions in order to avoid obstructions and to minimize shadows, and update As-Built Drawings accordingly.

6. Circuits

- a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.
- b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).
- c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

7. Workmanship

- a. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer, and using workers skilled in the WORK.
- b. Coordinate installation in the field with other trades in order to avoid interferences.

8. Protection of Equipment and Materials

- a. Fully protect materials and equipment against damage from any cause.
- b. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.
- c. Keep moving parts clean and dry.



- d. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

### 3.2 CORE DRILLING

- A. Perform core drilling as required for the installation of raceways through concrete walls and floors.
- B. Base the locations of floor penetrations, as may be required, on field conditions.
- C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.
- D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities.
- E. Repair damage to walls, floors, encased conduits, wiring, and piping as part of the WORK.

### 3.3 CONCRETE HOUSEKEEPING PADS AND CURBS

- A. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.
- B. Extend housekeeping curbs to 4 inches above the finished floor or grade.

### 3.4 EQUIPMENT ANCHORING

- A. Floor-supported, wall, or ceiling-hung equipment and conductors shall be anchored in place by approved method in the area where the Project is located.
- B. Provide wall-mounted panels that weigh more than 500 pounds with fabricated steel support pedestals.
- C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.
- D. Provide transformers hung from 4-inch stud walls with auxiliary floor supports.
- E. Provide leveling channels anchored to the concrete pad for switchgear and pad-mounted transformer installations.
- F. Manufacturer's Recommendations
  - 1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract.
  - 2. Submit such recommendations as Shop Drawings as indicated.

### 3.5 CLEANING

- A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.
- B. Remove temporary tags, markers, stickers, and the like.
- C. Remove oil and grease spots with a non-flammable cleaning solvent, by carefully wiping and scraping cracks and corners.
- D. Apply touch-up paint to scratches on panels and cabinets.
- E. Vacuum-clean electrical cabinets and enclosures.
- F. Clean luminaires inside and out.
- G. Dispose cleaning debris and refuse off-Site.

**- END OF SECTION -**

## SECTION 26 05 19 - WIRE AND CABLE

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit Shop Drawings in accordance with Division 1 and 26 00 00 – ELECTRICAL WORK, GENERAL.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

#### 2.2 LOW VOLTAGE WIRE AND CABLE

##### A. Power and Lighting Wire

1. Wire rated for 600 volts in conduit for power and lighting circuits shall be type XHHW-2 rated 90 degrees C suitable for wet locations except where required otherwise by the plans.
2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drops on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
4. Wiring for 600 volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.

## B. Control Wire

1. Control wire in conduit shall be the same type as power and lighting wire indicated above.
2. Control wiring shall be #14 AWG, except for current transformer secondary conductors which shall be #12 AWG minimum.
3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable**, or equal.
4. All control wiring of 10 or more #14 shall be preassembled as manufactured by **Clifford of Vermont, Inc.**, Quik-Pull, meeting the following requirements:
  - a. #14 AWG stranded copper XHHW-2, 600 Volt
  - b. Each conductor numbered every 1½ Inches
  - c. Sequential footage tape.
  - d. Round compact units, spiral configuration
  - e. UL listed. Custom wire assembly
5. Assemblies are identified as QP-10, 20 to 100 maximum. Example: Where QP-20 is shown it supersedes the count if 16#14 are shown.
6. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3090A**, similar by **General Cable**, or equal.
7. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3091A**, similar by **General Cable**, or equal.

## 2.3 CABLE SPLICES AND TERMINATIONS

- A. Where cable lugs are required for power cable terminations, utilize copper, capped, one-hole and two-hole compression lugs – **3M** Scotchlok 30000 and 31100 Series, **Penn Union** HBBLU and BLU, **Burndy** Hylug, or equal. Utilize compression tools as recommended by the manufacturer. Open-ended lugs (where the end of the stranded cable is exposed) are not acceptable for power cable terminations. Pressure type, twist-on connectors (wire nuts) will not be acceptable.
- B. Pre-insulated ring lugs for control conductors shall be **Thomas & Betts, Burndy**, or equal.
- C. General purpose insulating tape shall be **Scotch No. 33, Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M**, or equal.

- D. Labels for coding 600 volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.
- E. No splices shall be permitted for low-voltage power cables.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

The CONTRACTOR shall provide, terminate and test all power, control, and instrumentation conductors.

The CONTRACTOR shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares.

### **3.2 INSTALLATION**

- A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.
- C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.
- D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

### **3.3 SPLICES AND TERMINATIONS**

#### **A. General**

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.
2. In general, there shall be no cable splices. Splices may be made only with the prior approval of the ENGINEER, and shall be performed in strict accordance with the cable and splice manufacturers' requirements. Splices will not be permitted for intra-building feeder or branch circuits.
3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug.
4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

#### **B. Control Wire and Cable**

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
2. In motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips. Where terminal strips require lugs, ring lugs shall be used. Fork-type lugs are not acceptable.
3. The CONTRACTOR shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR.
2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape.
3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR shall submit the proposed termination procedure as a Shop Drawing.

3.4 CABLE IDENTIFICATION. Also refer to Section 26 05 53 – ELECTRICAL IDENTIFICATION).

A. **General:** Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

B. **Identification Numbers:** The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on As-Built Drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control and Instrumentation Conductors" shall be defined as any conductor used for control, interlock, alarm, annunciator, or signal purposes.

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
2. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The

480/277 volt system conductors shall be color coded as follows: Phase A- Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs. Any phase changes necessary for proper rotation shall be made at the driven equipment and not in the local disconnect.

3. General purpose AC control cable shall be red. General purpose DC control cable shall be blue. DC power wiring shall be red for positive conductors (+) and black for negative conductors (-).
4. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
5. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

### 3.5 TESTING

- A. **Cable Assembly and Testing:** Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Division 1, prior to shipment of cable. The following field tests shall be the minimum requirements:
  1. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
  2. Field testing shall be done after cable is installed in the raceways.
  3. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.
  4. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.
- B. **Continuity Test:** Control cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

**- END OF SECTION -**

## SECTION 26 05 26 – GROUNDING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical grounding, complete and operable, as indicated in accordance with the Contract Documents.
- B. The requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL apply to this Section.
- C. Single Manufacturer
  - 1. 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.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Division 1 and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Equipment Grounding Circuit Conductors
  - 1. The conductors shall be the same type and insulation as the load circuit conductors.
  - 2. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.
  - 3. Metallic conduit systems shall have an equipment grounding wire as well as being equipment grounding conductors themselves.

### PART 3 -- EXECUTION

#### 3.1 GROUNDING

- A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.
- B. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.
- C. Route the conductors inside the raceway.



- D. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each panelboard.
- E. Individually bond the raceway to the ground bus in the secondary section.
- F. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.
- G. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.
- H. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.
- I. Low Voltage Grounded System (600V or less)
  - 1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.
  - 2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.
  - 3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.
  - 4. The termination of the shield drain wire shall be on its own terminal screw.
  - 5. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.
  - 6. Connect the ground bus via a green #12 conductor to the main ground bus for the panel.

### 3.2 TESTING

#### A. Fall-of-Potential Test

- 1. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
- 2. Main ground electrode system resistance to ground to be no greater than 3 ohms.

#### B. Two-Point Direct Method Test

1. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames and system neutral and derived neutral points.
  2. Equipment ground resistance not to exceed main ground system resistance by 0.25 ohms.
- C. Test several points of the system including: The neutral of every voltage level used in the system, enclosure of switchgears, motor control centers and panelboards and metal enclosure of outlet or fixture at remote location designated by the ENGINEER. Initial resistance to ground shall not be over 2.5 ohms for water pipe grounds and 15 ohms for made grounds.

**- END OF SECTION -**

## SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.
- B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.
  - 2. Submit dimensioned layout drawings of cable tray routings, including elevations.
  - 3. As-Built Drawings
    - a. Prepare as-built drawings of encased concealed and exposed raceways, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.
    - b. Furnish the drawings to the ENGINEER in accordance with the requirements of Division 1.

### PART 2 -- PRODUCTS

#### 2.1 METAL CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.
  - 2) Alflec Inc.
  - 3) Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4) Anamet Electrical, Inc.; Anaconda Metal Hose.

- 5) Electri-Flex Co.
  - 6) Manhattan/CDT/Cole-Flex.
  - 7) Maverick Tube Corporation.
  - 8) O-Z Gedney; a unit of General Signal.
  - 9) Wheatland Tube Company.
- c. Rigid Steel Conduit: ANSI C80.1.
  - d. Aluminum Rigid Conduit: ANSI C80.5.
  - e. IMC: ANSI C80.6.
  - f. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - 1) Comply with NEMA RN 1.
    - 2) Coating Thickness: 0.040 inch (1 mm), minimum.
  - g. EMT: ANSI C80.3.
  - h. FMC: Zinc-coated steel.
  - i. LFMC: Flexible steel conduit with PVC jacket.
  - j. 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.
    - 1) Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
    - 2) Fittings for EMT: Steel type.
    - 3) Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
  - k. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.

- 2) Anamet Electrical, Inc.; Anaconda Metal Hose.
- 3) Arnco Corporation.
- 4) CANTEX Inc.
- 5) CertainTeed Corp.; Pipe & Plastics Group.
- 6) Condux International, Inc.
- 7) ElecSYS, Inc.
- 8) Electri-Flex Co.
- 9) Lamson & Sessions; Carlon Electrical Products.
- 10) Manhattan/CDT/Cole-Flex.
- 11) RACO; a Hubbell Company.
- 12) Thomas & Betts Corporation.

- c. ENT: NEMA TC 13.
- d. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- e. LFNC: UL 1660.
- f. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- g. Fittings for LFNC: UL 514B.

### 2.3 METAL WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper B-Line, Inc.
  - 2) Hoffman.
  - 3) Square D; Schneider Electric.
- c. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R, unless otherwise indicated.
- d. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- e. Wireway Covers: Screw-cover type.
- f. Finish: Manufacturer's standard enamel finish.

## 2.4 NONMETALLIC WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Hoffman.
  - 2) Lamson & Sessions; Carlon Electrical Products.
- c. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- d. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- e. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.5 SURFACE RACEWAYS

- a. Surface Metal Raceways: Galvanized steel with snap-on covers. Prime coating, ready for field painting.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a) Thomas & Betts Corporation.
    - b) Walker Systems, Inc.; Wiremold Company (The).
    - c) Wiremold Company (The); Electrical Sales Division.
- b. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected manufacturer's standard colors.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a) Butler Manufacturing Company; Walker Division.
  - b) Enduro Systems, Inc.; Composite Products Division.
  - c) Hubbell Incorporated; Wiring Device-Kellems Division.
  - d) Lamson & Sessions; Carlon Electrical Products.
  - e) Panduit Corp.
  - f) Walker Systems, Inc.; Wiremold Company (The).
  - g) Wiremold Company (The); Electrical Sales Division.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2) EGS/Appleton Electric.
  - 3) Erickson Electrical Equipment Company.
  - 4) Hoffman.
  - 5) Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6) O-Z/Gedney; a unit of General Signal.
  - 7) RACO; a Hubbell Company.
  - 8) Robroy Industries, Inc.; Enclosure Division.
  - 9) Scott Fetzer Co.; Adalet Division.
  - 10) Spring City Electrical Manufacturing Company.
  - 11) Thomas & Betts Corporation.
  - 12) Walker Systems, Inc.; Wiremold Company (The).
  - 13) Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- c. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- d. Cast-Metal Outlet and Device Boxes: NEMA FB 1, [ferrous alloy] Type FD, with gasketed cover.
- e. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- f. Metal Floor Boxes: Cast metal , fully adjustable, rectangular.
- g. Nonmetallic Floor Boxes: Nonadjustable, round.
- h. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- i. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, [galvanized, cast iron] with gasketed cover.

- j. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  - 1) Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2) Nonmetallic Enclosures: Plastic

## EXECUTION

### 2.7 GENERAL

- A. Run wiring in raceway unless indicated otherwise.
- B. Install raceways between equipment as indicated.
- C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.
- D. Bends and Offsets
  - 1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.
  - 2. Provide factory elbows wherever possible.
- E. Combined Raceways
  - 1. Raceways other than those containing power conductors may be combined in strict accordance with the NEC and with prior written permission from the ENGINEER.
  - 2. In general, combine only raceways containing the same type (control, signal, and the like) and voltage of conductors/cables, or dedicated conduits from one source to one device/equipment, in accordance with the NEC.
  - 3. Permission from the ENGINEER shall not relieve the CONTRACTOR of responsibility to meet national, state and local requirements.
  - 4. Do not combine wiring for redundant systems into single raceways.
- F. Routing
  - 1. Where raceway routings are indicated, follow those routings to the extent possible.
  - 2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and provided in strict accordance with the NEC as well as customary installation practice.



3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.
  4. Adjust routings in order to avoid obstructions.
- G. Coordination
1. Coordinate between trades prior to installing the raceways.
  2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.
- H. Support wireways in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- I. Install exposed raceways parallel or perpendicular to structural beams.
- J. Install exposed raceways at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.
- K. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

## 2.8 CONDUIT

- A. Size
1. Provide exposed conduit of 3/4-inch minimum trade size.
  2. Provide encased conduit of one-inch minimum trade size.
- B. Install supports at distances required by the NEC.
- C. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.
- D. Penetrations
1. Provide conduit passing through walls or floors with plastic sleeves.
  2. Perform core drilling in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL.
  3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

- E. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.
- F. Coat threads with a conductive lubricant before assembly.
- G. Joints
  - 1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.
  - 2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.
  - 3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.
  - 4. Replace conduit with wrench marks.
- H. Slope
  - 1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.
  - 2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.
  - 3. Take extreme care in order to avoid pockets or depressions in the conduit.
- I. Installation of rigid conduit through a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.
- J. Connections
  - 1. Make connections to lay-in-type grid lighting fixtures by using flexible metal conduit not exceeding 4 feet in length.
  - 2. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.
  - 3. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.
- K. Empty Conduits
  - 1. Tag empty conduits at both ends to indicate the final destination.
  - 2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.
  - 3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

L. Identification of Conduits

1. Identify conduits at ends and at pulling points.
2. Identification shall be the unique conduit number assigned in the Contract Documents.
3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.
5. Provide conduit identification by a stamped or engraved non-corroding stainless steel metal tag attached to the conduit bushing.
6. Provide an engraved phenolic nameplate in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.
7. Markings with a pen or paint will not be accepted.

M. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.
2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the CONTRACTOR shall assign one following the numbering scheme used in the Contract Documents.
3. Provide box identification by a stamped or engraved stainless steel non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, and attached to the box or enclosure.
4. Markings with a pen or paint will not be accepted.

- N. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

**- END OF SECTION -**

## SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

##### A. Scope

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### B. Coordination

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### C. Related Sections

1. Section 26 00 00 – ELECTRICAL WORK, GENERAL.

#### 1.2 CONTRACTOR SUBMITTALS

##### A. Shop Drawings: Furnish submittals in accordance with Division 1.

1. Comply with the requirements below. Submit for approval of the following:
  - a. The complete description and enumeration of proposed electrical identification devices shall be shown on the Shop Drawings for the associated equipment or systems.

##### B. Product Data:

1. Manufacturer's cut sheet, specifications, dimensions and technical data for all products proposed to be furnished under this Section.
2. Any deviation shall be explicitly noted.

##### C. Samples:

1. Nameplates: Samples of nameplates shall be submitted and shall include both applied and unapplied wire and cable label samples. These samples shall be used as quality standards for the wire and cable labeling required by this Section. These samples shall be of material specified in this Section and shall include wire and cable designators meeting the requirements of this Section.

- D. Wiring diagrams annotated with wire numbers and terminal numbers shall be submitted prior to commissioning of associated equipment or systems.
- E. Project Record Documents:
  - 1. Submittals of Record Documents required by other Sections shall show final electrical identification and electrical identification devices.

## **PART 2 -- PRODUCTS**

### **2.1 MANUFACTURED UNITS**

#### **A. Engraved Identification Devices (Nameplates, and Legend):**

##### **1. Nameplates:**

- a. The following items shall be equipped with nameplates: All motors, motor starters, pushbutton stations, control panels, time switches, disconnect or relays in separate enclosures, transformers, receptacles, wall switches boxes and cabinets. All light switches and outlets shall carry a phenolic plate with the supply circuit panel I.D. and circuit number. Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.
- b. 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 motor nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and local control station nameplates for that machine. Nameplates shall be laminated phenolic plastic, white front and back with black core, with lettering etched through the outer covering; black engraved letters on white background. Lettering shall be 3/16 inch high at local control stations, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4 inch high, unless otherwise detailed on the Plans. Nameplates shall be securely fastened to the equipment with No. 4 Phillips, rough-head, cadmium- plated, steel self-tapping screws or nickel-plated brass bolts. For applications on NEMA 4X enclosures, nameplates shall be attached using an epoxy-based adhesive that is resistant to oil and moisture. Motor nameplates may be non-ferrous metal not less than 0.03 inch thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Engraved lettering shall be filled with contrasting enamel. Equipment nameplate schedule for all equipment shall be submitted with Shop Drawing submittal for Engineer's approval.
- c. All junction and splice boxes shall be labeled.

#### **B. Conduit Labels:**

##### **1. Products and Manufacturers:**

- a. **B-915 Series by Brady**, or approved equal.
  - b. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit diameters through five inches or pre-molded to conform to circumference of six-inch conduit.
  - c. Strap-on style for 6-inch conduit shall be attached with stainless steel springs.
  - d. Shall be blank for use with custom printed labels.
  - e. Labels shall be color coded as follows:
    - 1) Power Conduits (600V and less) – Orange
    - 2) Control/Instrumentation – Light Blue
    - 3) Telephone/Intercom – Yellow
    - 4) Data - White
- C. Custom Labels:
1. Shall have black lettering on yellow background
  2. Shall not contain abbreviations in legend
  3. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.
- D. Wire Identification:
1. All wire and cable shall be identified at each termination point and at each pull box, terminal box and manhole. Provide permanent, waterproof, non-metallic (paper unacceptable) tags indicating the circuit number in 3/16 inch letters. Circuit numbers shall be protected with clear shrinkable tubing.
  2. All 120 VAC and lower control circuits shall use vinyl, self-laminating, self-adhesive, wrap type labels that are heat, oil, water, and solvent resistant wire markers. Labels shall be by **Brady**, or approved equal (**Brady** XPS-187-1 and XPS-375-1, as applicable, based on wire size). Wire numbers shall be solid machine printed, and shall not be pieced from other single or double-digit tags.
  3. Where wire numbers change, the appropriate drawings shall include both wire numbers, clearly indicated, at the point of transition. Drawings shall also identify the insulation color for all wiring.
  4. Conductor Identification: Each conductor shall be identified by a 2-line identification. Line 1: X-Y, where X is a unique number and Y is the location of the termination in the cabinet you are looking at; Line 2: A-B, where A is a unique number (which should usually match the X in Line 1), and B is the location of the termination at the other end of the conductor. The termination locations are typically on terminal

- blocks with identifications such as "TB2-1". The CONTRACTOR shall coordinate with the OWNER regarding all conductor identifications prior to installation.
- 5. All terminals and terminal strips and posts shall be identified with terminal block markers.
- 6. All wire labels shall be clearly visible and not hidden by wire duct or other components in the enclosures.
- 7. PLC/DCS/RTU panel wire tag format and content shall be provided by the OWNER.

## 2.2 FABRICATION

### A. Engraved Identification Devices (Nameplates and Legend Plates):

1. All nameplate text shall remain preliminary and subject to change pending final review and acceptance of the nomenclature by the OWNER after commissioning. Temporary tags consisting of removable tape or other accepted material with the preliminary nomenclature legibly hand lettered shall be affixed to enclosures and cover plates to identify the enclosures and mounted components as required during assembly, factory testing, and start-up. Laminated plastic nameplates shall not be engraved until after commissioning of the associated system and release of final engraving information by the OWNER.

## PART 3 -- EXECUTION

### 3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the work is to be installed and notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Electrical identification shall be provided as shown, specified or required.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
  1. Temporary tags shall be provided at all locations until after start-up and release of final engraving information by OWNER.
  2. Unless otherwise specified, permanent nameplates shall be attached with a permanent adhesive and with stainless steel machine screws into drilled and tapped holes.
  3. A nameplate with 1-1/2 inch letters shall be provided to identify each console, cabinet, panel, or enclosure as shown or specified.
  4. Nameplates with 1/2 inch letters shall be provided to identify each junction and terminal box as shown or specified.

5. On switchgear, nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments.
  - a. A nameplate with 1-inch letters shall be provided giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.
  - b. The individual door for each compartment shall be identified with a nameplate giving them designation and circuit number as well as frame ampere size and appropriate trip rating.

C. Motor Control Centers:

1. A nameplate with 1-inch letters shall be provided giving motor control center designation.
2. The individual door for each unit compartment shall be identified with a nameplate identifying the controlled equipment, including the tag number indicated on the Contract Drawings.

D. Except conduit, all other electrical appurtenances including, but not limited to, lighting panels, convenience outlets, fixtures and lighting switches, shall be provided nameplates indicating the appropriate circuit breaker number(s).

E. Safety Sign and Voltage Markers:

1. Safety signs and voltage markers shall be provided on and around electrical equipment as specified and where shown.
2. Rigid safety signs shall be installed using stainless steel fasteners.
3. Surfaces shall be cleaned before application of pressure sensitive signs and markers.
4. Low voltage safety signs shall be mounted on all equipment doors providing access to uninsulated 480-volt conductors (including terminal devices).
5. Low voltage markers shall be installed on each terminal box, safety disconnect switch and panelboard installed, modified or relocated and containing 120/208-volt conductors.

F. Conduit Labels:

1. All conduits shall be provided with conduit labels unless otherwise specified.
2. Flexible conduit shall not be labeled.



3. Exposed single conduit runs of less than 25 feet between local disconnect switches and the equipment they operate shall not be labeled.
4. Conduit labels shall convey the following information:
  - a. Contract Number: Alphanumeric.
  - b. Conduit Number: Alphanumeric. Leftmost character shall be the uppercase letter "C", remaining characters shall be a unique combination for each conduit, as shown on the Drawings and in accordance with conforming submittals.
5. Conduit labels shall be installed at the following locations:
  - a. Where conduit enters or exits walls, ceilings, floors, or slabs.
  - b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
  - c. At intervals of not more than 50 feet along the length of the conduit.
6. Conduit labels shall be oriented so as to be readable, standing on the floor near the conduit.
7. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
8. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

G. Wire and Cable Identification:

1. Color-coding of insulated conductors and identification shall comply with Section 26 05 19 – WIRES AND CABLES.
2. Wire and Cable Labels shall be provided as follows:
  - a. New, re-routed, or revised wire or cable shall be labeled.
  - b. All insulated conductors shall be labeled.
  - c. Bare (non-insulated) conductors shall not be labeled unless otherwise shown or specified.
  - d. Wire and cable terminations shall be labeled.
3. Wire labels shall be applied between ½ and 1 inch of the completed termination.

4. Cable labels shall be applied between  $\frac{1}{2}$  and 1 inch of cable breakout into individual conductors.
  - a. Individual conductors in a cable shall be labeled after the breakout as specified for wires
5. Wire or cable exiting cabinets, consoles, panels, terminal boxes and enclosures shall be labeled.
  - a. Wires or cables shall be labeled within two inches of the entrance to the conduit.
6. Wire and cable installed in electrical manholes shall be labeled.
  - a. Wire and cable shall have wrap-around labels applied within one foot of exiting the manhole.
7. Wire and cable labels shall be installed when the wire or cable is pulled and prior to termination of the conductors. Installation of wire and cable labels after the conductors are terminated is not permitted.

**- END OF SECTION -**

## SECTION 262416 – PANELBOARDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including Conditions of the Contract and Division 1 of the Specifications, apply to the work in this Section.
- B. This Section is hereby made a part of all other sections of Division 260000 as fully as if repeated in each therein.

#### 1.2 SECTION INCLUDES

- A. Branch circuit panelboards.

#### 1.3 RELATED SECTIONS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260553 - Electrical Identification.

#### REFERENCES

- A. NECA – “Standard of Installation”.
- B. NEMA AB1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
- D. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- E. NEMA PB 1 - Panelboards.
- F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- H. NFPA 70 - National Electrical Code.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 260500.
- B. Product Data: Provide for panelboards, fusible switches, and circuit breakers.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch

arrangement and sizes.

- D. Manufacturers' Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- E. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- F. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, unless otherwise specified.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

## 1.7 COORDINATION

- A. Coordinate under provisions of Division 1.
- B. Field Measurements: Verify that field measurements are as shown on Drawings.
- C. Field Locations: Verify locations of panelboards prior to rough-in.

## 1.8 DELIVERY, STORAGE, PROTECTION, AND HANDLING

- A. Protect from moisture by using appropriate coverings. Store in dry interior locations.
- B. Do not install until building is closed in and suitable temperature conditions are controlled.
- C. Maintain suitable temperature and humidity conditions during and after installation of panelboards.

## 1.9 EXTRA MATERIALS

- A. Submit extra materials under provisions of Division 1 and Section 260500

Furnish five of each panelboard key.

## PART 2 PRODUCTS

### 2.1 PANELBOARDS

- A. Phase sequence and balance.
  - 1. Phase sequence: A-B-C, left to right.
  - 2. Load balance: Distribute loads for maximum 10 percent difference.
- B. Each panelboard, and associated over current protection devices shall be of the same manufacturer.
- C. Each panelboard lock shall be operable by the same key.
- D. Each panelboard shall have a door – in – door.

### 2.2 BRANCH CIRCUIT PANELBOARDS

- A. Branch Panelboard Manufacturers - 240Y/120V:
  - 1. GE A series
  - 2. Siemens S1
  - 3. Square D NQOD
- B. Branch CircuitBreaker Manufacturers:
  - 1. GE.
  - 2. Siemens.
  - 3. Square D.
- C. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard, 600 amp maximum bus.
- D. Panelboard Bus: 1000 amp per sq.in. Copper, ampere and voltage ratings as indicated. Provide copper ground bus in each panelboard. Provide insulated ground bus where identified. Provide 200% rated neutral where identified.
- E. Minimum Short Circuit Rating: Fully rated, 10,000 amperes rms symmetrical for 208 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated, or as required to be greater than the available short circuit current.
- F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Shunt trip where indicated, Class A ground fault interrupter circuit breakers where indicated. Quantity and ratings as indicated. Do not use tandem circuit breakers.
- G. Main Circuit Breakers: NEMA AB 1, bolt-on type non-interchangeable thermal magnetic trip unit, two or three pole as required, top or bottom mounted as required, with shunt trip as required, and suitable for the voltage and amperage of the panelboard.
- H. Enclosure: NEMA PB 1, Galvanized steel finished inside and outside with

manufacturer's standard gray enamel. Type 1, 3R, or 4X as suitable for the location, 6 inches deep, 20 inches wide, minimum, or as required to accommodate the number of outgoing conduits. Door-in-door construction.

- I. Cabinet Front: Steel, flush or surface cabinet front as indicated, with concealed trim clamps, concealed hinge, metal directory frame, and flush lock. Finish in manufacturer's standard gray enamel.
- J. Sub-feed or feed-through lugs as scheduled.

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Install multiple pole circuit breakers below single pole circuit breakers.
- D. Height: 6 feet to top of panelboard unless otherwise indicated or as required for specific field conditions. Install panelboards taller than 6 feet with bottom not closer than 4 inches above floor, or provide concrete equipment base in accordance with 262416.
- E. Provide filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard under the provisions of Section 260553. Revise directory to reflect circuiting changes required to balance phase loads.
- G. Provide engraved plastic nameplates under the provisions of Section 260553.
- H. Ground and bond panelboard enclosure according to Section 260526

#### **3.2 CLEANING**

- A. Clean installed work under the provisions of Division 1.
- B. Clean interior of cabinets and enclosures to remove dust, debris, and other material.
- C. Clean surfaces and touch up scratched or marred surfaces to match original finish.

**- END OF SECTION-**

## SECTION 26 50 00 - LIGHTING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide luminaires and accessories, complete and operable, in accordance with the Contract Documents.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes

- NFPA 70 National Electric Code – 2017 Edition

- NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)

- UL-595 UL-924 Standard for Safety Emergency Lighting and Power Equipment

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish the following product information in accordance with the requirements of Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.

- B. Furnish the following information:

- 1. Interior Luminaires

- a. catalog data sheets
    - b. luminaire finish and metal gauge
    - c. lens material, pattern, and thickness
    - d. candlepower distribution curves in 2 or more planes
    - e. lumen output chart
    - f. mounting or suspension details
    - g. lens material, pattern, and thickness
    - h. IES lighting classification and isolux diagram
    - i. fastening details to wall or pole

- 2. Lamps

- a. voltages
    - b. colors
    - c. approximate life (in hours)
    - d. approximate initial lumens
    - e. lamp type

- 3. Drivers

- a. type
    - b. wiring diagram
    - c. nominal watts and input watts
    - d. input voltage

4. Photocells
  - a. voltage and wiring diagram
  - b. capacity
  - c. contacts and time delay
  - d. operating levels
  - e. enclosure type and dimensions

1.4 A sample of each "equal" fixture proposed for use shall be submitted to the ENGINEER for review, if requested.

## **PART 2 -- PRODUCTS**

### **2.1 LUMINAIRES**

#### **A. General**

1. Additional WORK requirements are indicated in the Luminaire Schedule on the Drawings.

B. Provide a feed-through type or separate junction box.

C. Provide minimum 18 AWG wire leads.

D. Provide components that are accessible and replaceable without removing the luminaire from its mounting.

#### **E. Emergency Lighting**

##### **1. Power Pack**

- a. self-contained
- b. 120/277 V
- c. dual voltage
- d. selectable input transformer
- e. 6 V sealed nickel-cadmium, lead-acid or lead-calcium battery (see Luminaire Schedule)
- f. indicator switch in accordance with the requirements of UL 924

2. Lighted, push-to-test pushbutton and indicator

3. Capability of providing full illumination for 1-1/2 hours in emergency mode

4. Capability of full recharge in 24 hours, automatically initiated upon resumption of normal line voltage

5. Capability of protecting against excess charging and discharging

6. LED lighting heads, as indicated

7. Solid state charger

8. Normal and emergency LED indicating lights

9. Mounting stand



10. Provide NEMA-rated enclosures in accordance with the area classifications in which they are installed.

F. Exit Signs

1. Internally illuminated
2. Universal mounting type
3. Internal 6 v maintenance free nickel-cadmium battery
4. Battery charger
5. LED-type emergency and normal indicating lights
6. Press-to-test button
7. Directional arrows
8. Red letters on a white panel, or as indicated

- G. The schedule and details of lighting fixtures, appearing on the Plans, indicate the type, construction, appearance, quality and performance of the fixtures required. Any proposed deviation from the fixtures specified must equal or be superior to the item specified under these headings. Proposed substitute lighting fixtures will be judged on overall quality on construction and on the basis of laboratory tests by the Electrical Testing Laboratory or similar independent testing facility. The fixture manufacturer's products scheduled are considered acceptable. The CONTRACTOR shall furnish, upon request of the ENGINEER, a set of fabrication plans, a set of photometric curves and a physical sample for review of every specific type offered.

2.2 LAMPS

A. LED

1. As indicated on the luminaire schedule on the drawings.

**PART 3 -- EXECUTION**

3.1 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.
2. Provide necessary hangers, pendants, canopies, and other accessories.

3. Install the luminaire plumb and level.
4. Install each luminaire outlet box with a galvanized stud.
5. Mechanical and Electrical Equipment Rooms: In the Mechanical and Electrical Equipment rooms, lighting fixtures shall be installed on ceilings or walls after all piping ductwork and equipment therein are installed. Exact location and switching for such fixtures will be determined at the job site during the course of the work. Fixtures shall be located so as to give maximum illumination to items of equipment requiring servicing, and moving machinery. Any lighting fixtures that are blocked, inaccessible or improperly located shall be relocated at no extra cost.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.

C. Finished Areas

1. Install the luminaires symmetrically with tile pattern.
2. Locate with the centerline of tile or with centerline of the joint between adjacent tile runs.
3. Install recessed luminaires tight to the finished surface such that no spill light will show between the ceilings and the sealing rings.
4. When installing on combustible low-density cellulose fiberboard, provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use luminaires suitable for mounting on low-density ceilings.

5. Junction Boxes

- a. Flush and Recessed Luminaires: Locate a minimum of one foot from the luminaire.
- b. In concealed locations, install junction boxes to be accessible by the removal of the luminaire.

6. Wiring and Conduit

- a. Provide wiring of a suitable temperature rating as required by the luminaire.
- b. Provide liquid tight flexible metal conduit, except in ceiling spaces used as air plenums, where flexible steel conduit meeting NEC requirements shall be used.

7. Provide plaster frames when required by ceiling construction.

8. Independent Supports

- a. Provide each recessed troffer luminaire with 2 safety chains or 2 No. 12

soft- annealed galvanized steel wires of length needed to secure the luminaire to the building structure, independent of the ceiling structure.

- b. Ensure that the tensile strength of chain or wire, and the method of fastening to the structure, is adequate to support the weight of the luminaire.
- c. Fasten the chain or wire to each end of the luminaire.
- d. Chains shall not be the primary supporting means.

D. Unfinished Areas

1. Locate the luminaires to avoid conflicts with other building systems and blockage of the luminaire light output.
2. Luminaire Suspension
  - a. Provide 3/8-inch threaded stainless steel hanger rods.
  - b. Scissor-type hangers will not be accepted.
3. For attachments to steel beams, provide flanged beam clips and straight or angled hangers.

3.2 LAMPS

- A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.3 CLEAN-UP

- A. Remove labels and other markings, except the UL listing mark.
- B. Wipe the luminaires inside and out in order to remove construction dust.
- C. Clean the luminaire plastic lenses with an antistatic cleaner only.
- D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.
- E. Replace defective lamps at the Date of Substantial Completion.

**- END OF SECTION -**

LUDLAM GLADES – CONTROL STRUCTURE  
TECHNICAL SPECIFICATIONS

ARCH CREEK 1

## SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated.
- C. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.
- D. The CONTRACTOR'S attention is directed to the requirement for proper coordination of the WORK of this Section with other trades sections.
- E. Equipment supports and foundations shall be in conformance with the requirements of Structural Specifications.

#### 1.2 REFERENCE STANDARDS

ANSI	American National Standards Institute
FBC	Florida Building Code 2020
NEC (NFPA 70)	National Electrical Code – 2017 Edition
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
NRTL	National Recognized Testing Laboratory

- A. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.
- B. Installation of electrical equipment and materials shall comply with state building standards, and applicable local codes and regulations, all as enforced by the Authority Having Jurisdiction (AHJ).
- C. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

#### 1.3 BASIS FOR WIRING DESIGNS

- A. The Contract Drawings and Specifications describe specific sizes of switches,

breakers, fuses, conduits, conductors, motor starters and other electrical equipment. These sizes are based on specific power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Wherever another trade provides power consuming equipment that differs from the Contract Documents, the wiring, conduits, starters, overcurrent devices, and other electrical devices that may be impacted shall be changed to proper sizes to match at no additional expense to the OWNER.

#### 1.4 SIGNAGE AND MARKINGS

##### A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

##### B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

##### C. Warning Signs

1. 600 Volts Nominal, or Less
  - a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.
2. Arc Flash Signage

#### 1.5 PERMITS AND INSPECTION

- A. Obtain permits and pay inspection fees according to the General Conditions.

#### 1.6 CONTRACTOR SUBMITTALS

##### A. General

1. Furnish submittals in accordance with Section 01 33 00 - Shop Drawings, product data, and samples.
2. Custom-prepare Shop Drawings.
3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.
4. Cross out options not proposed or delete from the Shop Drawings.

- B. Shop Drawings: Include the following as a minimum:

1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Shop drawings for grounding WORK not specifically indicated
3. Front, side, rear elevations, and top views with dimensional data
4. Location of conduit entrances and access plates
5. Component data
6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers
7. Types of materials and finish
8. Nameplates
9. Temperature limitations, as applicable
10. Voltage requirement, phase, and current, as applicable
11. Grounding requirements

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.
2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the ENGINEER a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.
2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Architectural Section for shop drawings requirements.
2. As-Built Drawings
  - a. A set of "Red-Lined" electrical drawings shall be carefully maintained at the job site. Actual conditions are to be put on the drawings in red on a daily basis so the Plans will continuously show locations and routings of cables, conduits, pull boxes, circuit numbers, and other information required by the ENGINEER. An

up-to-date copy of the "Red-Lined" Drawings shall be submitted to the OWNER by the CONTRACTOR once every two weeks. At the end of the Project, the CONTRACTOR shall turn over As-Built Drawings in AutoCAD format to the OWNER.

- b. Furnish the drawings to the ENGINEER in accordance with the requirements of Architectural Section for shop drawings requirements.
- c. Prepare As-Built Drawings of encased concealed and exposed raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

## 1.7 AREA DESIGNATIONS

### A. General

1. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections, unless indicated otherwise.

### B. Material Requirements

1. Construct NEMA 4X enclosures of Type 316 stainless steel, except in chlorine or hypochlorite areas or areas with ferric-based chemicals where non-metallic enclosures shall be provided.
2. Metallic NEMA 4X enclosures shall have a white, powder coated finish.
3. Construct NEMA 7 enclosures of cast aluminum where used with aluminum conduit.
4. Do not coat NEMA 7 and 9 enclosures.
5. Construct NEMA 1, 3R, and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

## 1.8 TESTS

- A. The CONTRACTOR shall be responsible for required factory and field as required by Engineer and other authorities having jurisdiction.
- B. Furnish necessary testing equipment.
- C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.
- D. Reporting
  1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
  2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.



3. Submit field test reports for review prior to Substantial Completion.
- E. Remove and replace equipment or material that fails a test, or, if the ENGINEER approves, repair and retested for compliance.
  - F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.
- 1.9 DEMOLITION AND RELATED WORK
- A. General
    1. Perform electrical demolition WORK as indicated.
    2. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical Contract Drawings.
    3. Coordinate with all trades and building management regarding electrical de-energization, disconnection, and removal, and the overall sequence of construction.
  - B. Electrical Requirements for Removed Equipment
    1. Remove dedicated wiring and exposed conduits back to the source.
    2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring. Remove power wiring from the power source to the first pullbox or manhole remote from the panel, and abandon in place the remaining wiring.
    3. Remove remote-mounted starters, disconnect switches, circuit breakers, sensors, and transmitters. Breakers in Panels that are not replaced or re-used shall be abandoned in place, and nameplates replaced to read, "SPARE".
  - C. Where new lighting and receptacles are installed, remove old lighting, receptacles, switches, wiring, and conduits, and replace in their entirety.
  - D. Junction Boxes
    1. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips.
    2. Provide a junction box with a NEMA rating in accordance with the area in which it is located, and sized as required.
    3. Properly identify wires and terminals before disconnection.
  - E. Removed materials and equipment not indicated to be returned to the OWNER shall, upon removal, become the CONTRACTOR'S property and shall be disposed of off- site.
  - F. Remove and relocate material and equipment indicated to be relocated or reused, and reinstall with care in order to prevent damage.
  - G. Place materials indicated to be returned to the OWNER in boxes, with the contents

clearly marked, and store at a location determined by the OWNER.

#### H. Identification

1. Where panelboards are indicated to have components, assemblies, or circuits removed and reconnected, provide the affected panel compartments with new engraved nameplates worded as indicated and matching the existing, or modify the panelboard schedule to indicate the revised circuits. Replace the panelboard schedule in its entirety if the existing schedule is unreadable or otherwise unusable.
2. Pencil or magic marker markings directly on the panelboard will not be accepted.

### 1.10 CONSTRUCTION SEQUENCING

#### A. General

1. Because the continuance of building operation during the renovation is critical, the CONTRACTOR shall carefully examine the WORK to be provided in, on, or adjacent to existing equipment.
2. Schedule the WORK in phases, subject to OWNER's approval, to minimize disruption to normal operations.
3. Submit a written sequencing request, including the sequence and duration of activities to be performed.
4. In no case shall the CONTRACTOR begin any WORK phase without written authorization from the OWNER.

#### B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.
2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.
3. Repair coatings to match the existing.
4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the WORK.

#### C. Field Verifications

1. Visit the Site before submitting a bid to become better acquainted with the WORK of this Contract.
2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.

3. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL**

- A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.
- B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.
- C. Provide similar items in the WORK as products of the same manufacturer.
- D. Provide equipment and materials of industrial grade standard of construction.
- E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.
- F. On devices indicated to display dates, display the year as 4 digits.
- G. Temperature Ratings of Equipment Terminations
  1. Provide terminations and lugs rated for use with 75-degree C conductors.
  2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

### **2.2 MOUNTING HARDWARE**

- A. Miscellaneous Hardware
  1. Provide nuts, bolts, and washers constructed of stainless steel.
  2. Provide threaded rods for trapeze supports constructed from continuous threaded stainless steel, 3/8-inch diameter minimum.
  3. Struts
    - a. Provide struts for mounting of conduits and equipment of aluminum except where additional strength is needed, then use 316 stainless steel. Coat the back of aluminum struts with bitumastic coating where it comes in contact with concrete.
    - b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
    - c. Do not use aluminum strut for free-standing support frames. Use 316 stainless

steel except in chlorine, hypochlorite or ferric areas where FRP strut shall be used.

d. Strut Manufacturer, or Equal: **Unistrut; B-Line**

4. End Caps

a. Provide plastic protective end caps for all exposed metal strut ends.

b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860**

5. Anchors

a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

b. Wood plugs will not be accepted.

c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Hilti**.

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

##### **A. Incidentals**

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.
2. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

##### **B. Field Control of Location and Arrangement**

1. The Contract Drawings diagrammatically indicate the desired location and arrangement of loads, conduit runs, equipment, and other items.
2. Exact locations shall be determined by the CONTRACTOR in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.
3. Follow the locations on the Contract Drawings, however, as closely as possible.
4. Conduits
  - a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.
  - b. Provide exposed or encased routings as indicated, except conceal conduit in

finished areas unless indicated otherwise.

5. Placement

- a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.
- b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.
- c. Where exact locations are not indicated, such locations will be determined by the ENGINEER.
- d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.
- e. Slightly adjust luminaire locations based on actual field conditions in order to avoid obstructions and to minimize shadows, and update As-Built Drawings accordingly.

6. Circuits

- a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.
- b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).
- c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

7. Workmanship

- a. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer, and using workers skilled in the WORK.
- b. Coordinate installation in the field with other trades in order to avoid interferences.

8. Protection of Equipment and Materials

- a. Fully protect materials and equipment against damage from any cause.
- b. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.
- c. Keep moving parts clean and dry.

- d. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

### 3.2 CORE DRILLING

- A. Perform core drilling as required for the installation of raceways through concrete walls and floors.
- B. Base the locations of floor penetrations, as may be required, on field conditions.
- C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.
- D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities.
- E. Repair damage to walls, floors, encased conduits, wiring, and piping as part of the WORK.

### 3.3 CONCRETE HOUSEKEEPING PADS AND CURBS

- A. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.
- B. Extend housekeeping curbs to 4 inches above the finished floor or grade.

### 3.4 EQUIPMENT ANCHORING

- A. Floor-supported, wall, or ceiling-hung equipment and conductors shall be anchored in place by approved method in the area where the Project is located.
- B. Provide wall-mounted panels that weigh more than 500 pounds with fabricated steel support pedestals.
- C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.
- D. Provide transformers hung from 4-inch stud walls with auxiliary floor supports.
- E. Provide leveling channels anchored to the concrete pad for switchgear and pad-mounted transformer installations.
- F. Manufacturer's Recommendations
  - 1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract.
  - 2. Submit such recommendations as Shop Drawings as indicated.

### 3.5 CLEANING

- A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.
- B. Remove temporary tags, markers, stickers, and the like.
- C. Remove oil and grease spots with a non-flammable cleaning solvent, by carefully wiping and scraping cracks and corners.
- D. Apply touch-up paint to scratches on panels and cabinets.
- E. Vacuum-clean electrical cabinets and enclosures.
- F. Clean luminaires inside and out.
- G. Dispose cleaning debris and refuse off-Site.

**- END OF SECTION -**

## SECTION 26 05 19 - WIRE AND CABLE

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit Shop Drawings in accordance with Division 1 and 26 00 00 – ELECTRICAL WORK, GENERAL.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

#### 2.2 LOW VOLTAGE WIRE AND CABLE

- A. Power and Lighting Wire

1. Wire rated for 600 volts in conduit for power and lighting circuits shall be type XHHW-2 rated 90 degrees C suitable for wet locations except where required otherwise by the plans.
2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drops on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
4. Wiring for 600 volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.



## B. Control Wire

1. Control wire in conduit shall be the same type as power and lighting wire indicated above.
2. Control wiring shall be #14 AWG, except for current transformer secondary conductors which shall be #12 AWG minimum.
3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable**, or equal.
4. All control wiring of 10 or more #14 shall be preassembled as manufactured by **Clifford of Vermont, Inc.**, Quik-Pull, meeting the following requirements:
  - a. #14 AWG stranded copper XHHW-2, 600 Volt
  - b. Each conductor numbered every 1½ Inches
  - c. Sequential footage tape.
  - d. Round compact units, spiral configuration
  - e. UL listed. Custom wire assembly
5. Assemblies are identified as QP-10, 20 to 100 maximum. Example: Where QP-20 is shown it supersedes the count if 16#14 are shown.
6. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3090A**, similar by **General Cable**, or equal.
7. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3091A**, similar by **General Cable**, or equal.

## 2.3 CABLE SPLICES AND TERMINATIONS

- A. Where cable lugs are required for power cable terminations, utilize copper, capped, one-hole and two-hole compression lugs – **3M** Scotchlok 30000 and 31100 Series, **Penn Union** HBBLU and BLU, **Burndy** Hylug, or equal. Utilize compression tools as recommended by the manufacturer. Open-ended lugs (where the end of the stranded cable is exposed) are not acceptable for power cable terminations. Pressure type, twist-on connectors (wire nuts) will not be acceptable.
- B. Pre-insulated ring lugs for control conductors shall be **Thomas & Betts, Burndy**, or equal.
- C. General purpose insulating tape shall be **Scotch No. 33, Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M**, or equal.

- D. Labels for coding 600 volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.
- E. No splices shall be permitted for low-voltage power cables.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

The CONTRACTOR shall provide, terminate and test all power, control, and instrumentation conductors.

The CONTRACTOR shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares.

### **3.2 INSTALLATION**

- A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.
- C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.
- D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

### **3.3 SPLICES AND TERMINATIONS**

#### **A. General**

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.
2. In general, there shall be no cable splices. Splices may be made only with the prior approval of the ENGINEER, and shall be performed in strict accordance with the cable and splice manufacturers' requirements. Splices will not be permitted for intra-building feeder or branch circuits.
3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug.
4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

#### **B. Control Wire and Cable**

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
2. In motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips. Where terminal strips require lugs, ring lugs shall be used. Fork-type lugs are not acceptable.
3. The CONTRACTOR shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR.
2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape.
3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR shall submit the proposed termination procedure as a Shop Drawing.

3.4 CABLE IDENTIFICATION. Also refer to Section 26 05 53 – ELECTRICAL IDENTIFICATION).

A. **General:** Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

B. **Identification Numbers:** The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on As-Built Drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control and Instrumentation Conductors" shall be defined as any conductor used for control, interlock, alarm, annunciator, or signal purposes.

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
2. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The

480/277 volt system conductors shall be color coded as follows: Phase A- Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs. Any phase changes necessary for proper rotation shall be made at the driven equipment and not in the local disconnect.

3. General purpose AC control cable shall be red. General purpose DC control cable shall be blue. DC power wiring shall be red for positive conductors (+) and black for negative conductors (-).
4. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
5. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

### 3.5 TESTING

- A. **Cable Assembly and Testing:** Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Division 1, prior to shipment of cable. The following field tests shall be the minimum requirements:
  1. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
  2. Field testing shall be done after cable is installed in the raceways.
  3. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.
  4. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.
- B. **Continuity Test:** Control cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

**- END OF SECTION -**

## SECTION 26 05 26 – GROUNDING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical grounding, complete and operable, as indicated in accordance with the Contract Documents.
- B. The requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL apply to this Section.
- C. Single Manufacturer
  - 1. 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.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Division 1 and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Equipment Grounding Circuit Conductors
  - 1. The conductors shall be the same type and insulation as the load circuit conductors.
  - 2. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.
  - 3. Metallic conduit systems shall have an equipment grounding wire as well as being equipment grounding conductors themselves.

### PART 3 -- EXECUTION

#### 3.1 GROUNDING

- A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.
- B. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.
- C. Route the conductors inside the raceway.

- D. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each panelboard.
- E. Individually bond the raceway to the ground bus in the secondary section.
- F. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.
- G. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.
- H. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.
- I. Low Voltage Grounded System (600V or less)
  - 1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.
  - 2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.
  - 3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.
  - 4. The termination of the shield drain wire shall be on its own terminal screw.
  - 5. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.
  - 6. Connect the ground bus via a green #12 conductor to the main ground bus for the panel.

### 3.2 TESTING

#### A. Fall-of-Potential Test

- 1. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
- 2. Main ground electrode system resistance to ground to be no greater than 3 ohms.

#### B. Two-Point Direct Method Test

1. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames and system neutral and derived neutral points.
  2. Equipment ground resistance not to exceed main ground system resistance by 0.25 ohms.
- C. Test several points of the system including: The neutral of every voltage level used in the system, enclosure of switchgears, motor control centers and panelboards and metal enclosure of outlet or fixture at remote location designated by the ENGINEER. Initial resistance to ground shall not be over 2.5 ohms for water pipe grounds and 15 ohms for made grounds.

**- END OF SECTION -**

## SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.
- B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.
  - 2. Submit dimensioned layout drawings of cable tray routings, including elevations.
  - 3. As-Built Drawings
    - a. Prepare as-built drawings of encased concealed and exposed raceways, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.
    - b. Furnish the drawings to the ENGINEER in accordance with the requirements of Division 1.

### PART 2 -- PRODUCTS

#### 2.1 METAL CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.
  - 2) Alflec Inc.
  - 3) Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4) Anamet Electrical, Inc.; Anaconda Metal Hose.



- 5) Electri-Flex Co.
  - 6) Manhattan/CDT/Cole-Flex.
  - 7) Maverick Tube Corporation.
  - 8) O-Z Gedney; a unit of General Signal.
  - 9) Wheatland Tube Company.
- c. Rigid Steel Conduit: ANSI C80.1.
  - d. Aluminum Rigid Conduit: ANSI C80.5.
  - e. IMC: ANSI C80.6.
  - f. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - 1) Comply with NEMA RN 1.
    - 2) Coating Thickness: 0.040 inch (1 mm), minimum.
  - g. EMT: ANSI C80.3.
  - h. FMC: Zinc-coated steel.
  - i. LFMC: Flexible steel conduit with PVC jacket.
  - j. 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.
    - 1) Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
    - 2) Fittings for EMT: Steel type.
    - 3) Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
  - k. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.

- 2) Anamet Electrical, Inc.; Anaconda Metal Hose.
- 3) Arnco Corporation.
- 4) CANTEX Inc.
- 5) CertainTeed Corp.; Pipe & Plastics Group.
- 6) Condux International, Inc.
- 7) ElecSYS, Inc.
- 8) Electri-Flex Co.
- 9) Lamson & Sessions; Carlon Electrical Products.
- 10) Manhattan/CDT/Cole-Flex.
- 11) RACO; a Hubbell Company.
- 12) Thomas & Betts Corporation.

- c. ENT: NEMA TC 13.
- d. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- e. LFNC: UL 1660.
- f. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- g. Fittings for LFNC: UL 514B.

## 2.3 METAL WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper B-Line, Inc.
  - 2) Hoffman.
  - 3) Square D; Schneider Electric.
- c. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R, unless otherwise indicated.
- d. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- e. Wireway Covers: Screw-cover type.
- f. Finish: Manufacturer's standard enamel finish.

## 2.4 NONMETALLIC WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Hoffman.
  - 2) Lamson & Sessions; Carlon Electrical Products.
- c. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- d. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- e. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.5 SURFACE RACEWAYS

- a. Surface Metal Raceways: Galvanized steel with snap-on covers. Prime coating, ready for field painting.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a) Thomas & Betts Corporation.
    - b) Walker Systems, Inc.; Wiremold Company (The).
    - c) Wiremold Company (The); Electrical Sales Division.
- b. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected manufacturer's standard colors.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a) Butler Manufacturing Company; Walker Division.
  - b) Enduro Systems, Inc.; Composite Products Division.
  - c) Hubbell Incorporated; Wiring Device-Kellems Division.
  - d) Lamson & Sessions; Carlon Electrical Products.
  - e) Panduit Corp.
  - f) Walker Systems, Inc.; Wiremold Company (The).
  - g) Wiremold Company (The); Electrical Sales Division.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2) EGS/Appleton Electric.
  - 3) Erickson Electrical Equipment Company.
  - 4) Hoffman.
  - 5) Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6) O-Z/Gedney; a unit of General Signal.
  - 7) RACO; a Hubbell Company.
  - 8) Robroy Industries, Inc.; Enclosure Division.
  - 9) Scott Fetzer Co.; Adalet Division.
  - 10) Spring City Electrical Manufacturing Company.
  - 11) Thomas & Betts Corporation.
  - 12) Walker Systems, Inc.; Wiremold Company (The).
  - 13) Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- c. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- d. Cast-Metal Outlet and Device Boxes: NEMA FB 1, [ferrous alloy] Type FD, with gasketed cover.
- e. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- f. Metal Floor Boxes: Cast metal , fully adjustable, rectangular.
- g. Nonmetallic Floor Boxes: Nonadjustable, round.
- h. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- i. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, [galvanized, cast iron] with gasketed cover.

- j. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  - 1) Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2) Nonmetallic Enclosures: Plastic

## EXECUTION

### 2.7 GENERAL

- A. Run wiring in raceway unless indicated otherwise.
- B. Install raceways between equipment as indicated.
- C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.
- D. Bends and Offsets
  - 1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.
  - 2. Provide factory elbows wherever possible.
- E. Combined Raceways
  - 1. Raceways other than those containing power conductors may be combined in strict accordance with the NEC and with prior written permission from the ENGINEER.
  - 2. In general, combine only raceways containing the same type (control, signal, and the like) and voltage of conductors/cables, or dedicated conduits from one source to one device/equipment, in accordance with the NEC.
  - 3. Permission from the ENGINEER shall not relieve the CONTRACTOR of responsibility to meet national, state and local requirements.
  - 4. Do not combine wiring for redundant systems into single raceways.
- F. Routing
  - 1. Where raceway routings are indicated, follow those routings to the extent possible.
  - 2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and provided in strict accordance with the NEC as well as customary installation practice.

3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.
  4. Adjust routings in order to avoid obstructions.
- G. Coordination
1. Coordinate between trades prior to installing the raceways.
  2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.
- H. Support wireways in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- I. Install exposed raceways parallel or perpendicular to structural beams.
- J. Install exposed raceways at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.
- K. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

## 2.8 CONDUIT

- A. Size
1. Provide exposed conduit of 3/4-inch minimum trade size.
  2. Provide encased conduit of one-inch minimum trade size.
- B. Install supports at distances required by the NEC.
- C. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.
- D. Penetrations
1. Provide conduit passing through walls or floors with plastic sleeves.
  2. Perform core drilling in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL.
  3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

- E. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.
- F. Coat threads with a conductive lubricant before assembly.
- G. Joints
  - 1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.
  - 2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.
  - 3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.
  - 4. Replace conduit with wrench marks.
- H. Slope
  - 1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.
  - 2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.
  - 3. Take extreme care in order to avoid pockets or depressions in the conduit.
- I. Installation of rigid conduit through a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.
- J. Connections
  - 1. Make connections to lay-in-type grid lighting fixtures by using flexible metal conduit not exceeding 4 feet in length.
  - 2. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.
  - 3. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.
- K. Empty Conduits
  - 1. Tag empty conduits at both ends to indicate the final destination.
  - 2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.
  - 3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

L. Identification of Conduits

1. Identify conduits at ends and at pulling points.
2. Identification shall be the unique conduit number assigned in the Contract Documents.
3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.
5. Provide conduit identification by a stamped or engraved non-corroding stainless steel metal tag attached to the conduit bushing.
6. Provide an engraved phenolic nameplate in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.
7. Markings with a pen or paint will not be accepted.

M. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.
2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the CONTRACTOR shall assign one following the numbering scheme used in the Contract Documents.
3. Provide box identification by a stamped or engraved stainless steel non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, and attached to the box or enclosure.
4. Markings with a pen or paint will not be accepted.

- N. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

**- END OF SECTION -**



## SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

##### A. Scope

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### B. Coordination

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### C. Related Sections

1. Section 26 00 00 – ELECTRICAL WORK, GENERAL.

#### 1.2 CONTRACTOR SUBMITTALS

##### A. Shop Drawings: Furnish submittals in accordance with Division 1.

1. Comply with the requirements below. Submit for approval of the following:
  - a. The complete description and enumeration of proposed electrical identification devices shall be shown on the Shop Drawings for the associated equipment or systems.

##### B. Product Data:

1. Manufacturer's cut sheet, specifications, dimensions and technical data for all products proposed to be furnished under this Section.
2. Any deviation shall be explicitly noted.

##### C. Samples:

1. Nameplates: Samples of nameplates shall be submitted and shall include both applied and unapplied wire and cable label samples. These samples shall be used as quality standards for the wire and cable labeling required by this Section. These samples shall be of material specified in this Section and shall include wire and cable designators meeting the requirements of this Section.

- D. Wiring diagrams annotated with wire numbers and terminal numbers shall be submitted prior to commissioning of associated equipment or systems.
- E. Project Record Documents:
  - 1. Submittals of Record Documents required by other Sections shall show final electrical identification and electrical identification devices.

## **PART 2 -- PRODUCTS**

### **2.1 MANUFACTURED UNITS**

#### **A. Engraved Identification Devices (Nameplates, and Legend):**

##### **1. Nameplates:**

- a. The following items shall be equipped with nameplates: All motors, motor starters, pushbutton stations, control panels, time switches, disconnect or relays in separate enclosures, transformers, receptacles, wall switches boxes and cabinets. All light switches and outlets shall carry a phenolic plate with the supply circuit panel I.D. and circuit number. Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.
- b. 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 motor nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and local control station nameplates for that machine. Nameplates shall be laminated phenolic plastic, white front and back with black core, with lettering etched through the outer covering; black engraved letters on white background. Lettering shall be 3/16 inch high at local control stations, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4 inch high, unless otherwise detailed on the Plans. Nameplates shall be securely fastened to the equipment with No. 4 Phillips, rough-head, cadmium- plated, steel self-tapping screws or nickel-plated brass bolts. For applications on NEMA 4X enclosures, nameplates shall be attached using an epoxy-based adhesive that is resistant to oil and moisture. Motor nameplates may be non-ferrous metal not less than 0.03 inch thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Engraved lettering shall be filled with contrasting enamel. Equipment nameplate schedule for all equipment shall be submitted with Shop Drawing submittal for Engineer's approval.
- c. All junction and splice boxes shall be labeled.

#### **B. Conduit Labels:**

##### **1. Products and Manufacturers:**

- a. **B-915 Series by Brady**, or approved equal.
  - b. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit diameters through five inches or pre-molded to conform to circumference of six-inch conduit.
  - c. Strap-on style for 6-inch conduit shall be attached with stainless steel springs.
  - d. Shall be blank for use with custom printed labels.
  - e. Labels shall be color coded as follows:
    - 1) Power Conduits (600V and less) – Orange
    - 2) Control/Instrumentation – Light Blue
    - 3) Telephone/Intercom – Yellow
    - 4) Data - White
- C. Custom Labels:
1. Shall have black lettering on yellow background
  2. Shall not contain abbreviations in legend
  3. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.
- D. Wire Identification:
1. All wire and cable shall be identified at each termination point and at each pull box, terminal box and manhole. Provide permanent, waterproof, non-metallic (paper unacceptable) tags indicating the circuit number in 3/16 inch letters. Circuit numbers shall be protected with clear shrinkable tubing.
  2. All 120 VAC and lower control circuits shall use vinyl, self-laminating, self-adhesive, wrap type labels that are heat, oil, water, and solvent resistant wire markers. Labels shall be by **Brady**, or approved equal (**Brady** XPS-187-1 and XPS-375-1, as applicable, based on wire size). Wire numbers shall be solid machine printed, and shall not be pieced from other single or double-digit tags.
  3. Where wire numbers change, the appropriate drawings shall include both wire numbers, clearly indicated, at the point of transition. Drawings shall also identify the insulation color for all wiring.
  4. Conductor Identification: Each conductor shall be identified by a 2-line identification. Line 1: X-Y, where X is a unique number and Y is the location of the termination in the cabinet you are looking at; Line 2: A-B, where A is a unique number (which should usually match the X in Line 1), and B is the location of the termination at the other end of the conductor. The termination locations are typically on terminal

- blocks with identifications such as "TB2-1". The CONTRACTOR shall coordinate with the OWNER regarding all conductor identifications prior to installation.
- 5. All terminals and terminal strips and posts shall be identified with terminal block markers.
- 6. All wire labels shall be clearly visible and not hidden by wire duct or other components in the enclosures.
- 7. PLC/DCS/RTU panel wire tag format and content shall be provided by the OWNER.

## 2.2 FABRICATION

### A. Engraved Identification Devices (Nameplates and Legend Plates):

1. All nameplate text shall remain preliminary and subject to change pending final review and acceptance of the nomenclature by the OWNER after commissioning. Temporary tags consisting of removable tape or other accepted material with the preliminary nomenclature legibly hand lettered shall be affixed to enclosures and cover plates to identify the enclosures and mounted components as required during assembly, factory testing, and start-up. Laminated plastic nameplates shall not be engraved until after commissioning of the associated system and release of final engraving information by the OWNER.

## PART 3 -- EXECUTION

### 3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the work is to be installed and notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Electrical identification shall be provided as shown, specified or required.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
  1. Temporary tags shall be provided at all locations until after start-up and release of final engraving information by OWNER.
  2. Unless otherwise specified, permanent nameplates shall be attached with a permanent adhesive and with stainless steel machine screws into drilled and tapped holes.
  3. A nameplate with 1-1/2 inch letters shall be provided to identify each console, cabinet, panel, or enclosure as shown or specified.
  4. Nameplates with 1/2 inch letters shall be provided to identify each junction and terminal box as shown or specified.

5. On switchgear, nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments.
  - a. A nameplate with 1-inch letters shall be provided giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.
  - b. The individual door for each compartment shall be identified with a nameplate giving them designation and circuit number as well as frame ampere size and appropriate trip rating.

C. Motor Control Centers:

1. A nameplate with 1-inch letters shall be provided giving motor control center designation.
2. The individual door for each unit compartment shall be identified with a nameplate identifying the controlled equipment, including the tag number indicated on the Contract Drawings.

D. Except conduit, all other electrical appurtenances including, but not limited to, lighting panels, convenience outlets, fixtures and lighting switches, shall be provided nameplates indicating the appropriate circuit breaker number(s).

E. Safety Sign and Voltage Markers:

1. Safety signs and voltage markers shall be provided on and around electrical equipment as specified and where shown.
2. Rigid safety signs shall be installed using stainless steel fasteners.
3. Surfaces shall be cleaned before application of pressure sensitive signs and markers.
4. Low voltage safety signs shall be mounted on all equipment doors providing access to uninsulated 480-volt conductors (including terminal devices).
5. Low voltage markers shall be installed on each terminal box, safety disconnect switch and panelboard installed, modified or relocated and containing 120/208-volt conductors.

F. Conduit Labels:

1. All conduits shall be provided with conduit labels unless otherwise specified.
2. Flexible conduit shall not be labeled.

3. Exposed single conduit runs of less than 25 feet between local disconnect switches and the equipment they operate shall not be labeled.
4. Conduit labels shall convey the following information:
  - a. Contract Number: Alphanumeric.
  - b. Conduit Number: Alphanumeric. Leftmost character shall be the uppercase letter "C", remaining characters shall be a unique combination for each conduit, as shown on the Drawings and in accordance with conforming submittals.
5. Conduit labels shall be installed at the following locations:
  - a. Where conduit enters or exits walls, ceilings, floors, or slabs.
  - b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
  - c. At intervals of not more than 50 feet along the length of the conduit.
6. Conduit labels shall be oriented so as to be readable, standing on the floor near the conduit.
7. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
8. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

G. Wire and Cable Identification:

1. Color-coding of insulated conductors and identification shall comply with Section 26 05 19 – WIRES AND CABLES.
2. Wire and Cable Labels shall be provided as follows:
  - a. New, re-routed, or revised wire or cable shall be labeled.
  - b. All insulated conductors shall be labeled.
  - c. Bare (non-insulated) conductors shall not be labeled unless otherwise shown or specified.
  - d. Wire and cable terminations shall be labeled.
3. Wire labels shall be applied between ½ and 1 inch of the completed termination.

4. Cable labels shall be applied between  $\frac{1}{2}$  and 1 inch of cable breakout into individual conductors.
  - a. Individual conductors in a cable shall be labeled after the breakout as specified for wires
5. Wire or cable exiting cabinets, consoles, panels, terminal boxes and enclosures shall be labeled.
  - a. Wires or cables shall be labeled within two inches of the entrance to the conduit.
6. Wire and cable installed in electrical manholes shall be labeled.
  - a. Wire and cable shall have wrap-around labels applied within one foot of exiting the manhole.
7. Wire and cable labels shall be installed when the wire or cable is pulled and prior to termination of the conductors. Installation of wire and cable labels after the conductors are terminated is not permitted.

**- END OF SECTION -**

## SECTION 262416 – PANELBOARDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including Conditions of the Contract and Division 1 of the Specifications, apply to the work in this Section.
- B. This Section is hereby made a part of all other sections of Division 260000 as fully as if repeated in each therein.

#### 1.2 SECTION INCLUDES

- A. Branch circuit panelboards.

#### 1.3 RELATED SECTIONS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260553 - Electrical Identification.

#### REFERENCES

- A. NECA – “Standard of Installation”.
- B. NEMA AB1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
- D. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- E. NEMA PB 1 - Panelboards.
- F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- H. NFPA 70 - National Electrical Code.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 260500.
- B. Product Data: Provide for panelboards, fusible switches, and circuit breakers.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch



arrangement and sizes.

- D. Manufacturers' Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- E. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- F. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, unless otherwise specified.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

## 1.7 COORDINATION

- A. Coordinate under provisions of Division 1.
- B. Field Measurements: Verify that field measurements are as shown on Drawings.
- C. Field Locations: Verify locations of panelboards prior to rough-in.

## 1.8 DELIVERY, STORAGE, PROTECTION, AND HANDLING

- A. Protect from moisture by using appropriate coverings. Store in dry interior locations.
- B. Do not install until building is closed in and suitable temperature conditions are controlled.
- C. Maintain suitable temperature and humidity conditions during and after installation of panelboards.

## 1.9 EXTRA MATERIALS

- A. Submit extra materials under provisions of Division 1 and Section 260500

Furnish five of each panelboard key.

## PART 2 PRODUCTS

### 2.1 PANELBOARDS

- A. Phase sequence and balance.
  - 1. Phase sequence: A-B-C, left to right.
  - 2. Load balance: Distribute loads for maximum 10 percent difference.
- B. Each panelboard, and associated over current protection devices shall be of the same manufacturer.
- C. Each panelboard lock shall be operable by the same key.
- D. Each panelboard shall have a door – in – door.

### 2.2 BRANCH CIRCUIT PANELBOARDS

- A. Branch Panelboard Manufacturers - 240Y/120V:
  - 1. GE A series
  - 2. Siemens S1
  - 3. Square D NQOD
- B. Branch CircuitBreaker Manufacturers:
  - 1. GE.
  - 2. Siemens.
  - 3. Square D.
- C. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard, 600 amp maximum bus.
- D. Panelboard Bus: 1000 amp per sq.in. Copper, ampere and voltage ratings as indicated. Provide copper ground bus in each panelboard. Provide insulated ground bus where identified. Provide 200% rated neutral where identified.
- E. Minimum Short Circuit Rating: Fully rated, 10,000 amperes rms symmetrical for 208 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated, or as required to be greater than the available short circuit current.
- F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Shunt trip where indicated, Class A ground fault interrupter circuit breakers where indicated. Quantity and ratings as indicated. Do not use tandem circuit breakers.
- G. Main Circuit Breakers: NEMA AB 1, bolt-on type non-interchangeable thermal magnetic trip unit, two or three pole as required, top or bottom mounted as required, with shunt trip as required, and suitable for the voltage and amperage of the panelboard.
- H. Enclosure: NEMA PB 1, Galvanized steel finished inside and outside with

manufacturer's standard gray enamel. Type 1, 3R, or 4X as suitable for the location, 6 inches deep, 20 inches wide, minimum, or as required to accommodate the number of outgoing conduits. Door-in-door construction.

- I. Cabinet Front: Steel, flush or surface cabinet front as indicated, with concealed trim clamps, concealed hinge, metal directory frame, and flush lock. Finish in manufacturer's standard gray enamel.
- J. Sub-feed or feed-through lugs as scheduled.

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Install multiple pole circuit breakers below single pole circuit breakers.
- D. Height: 6 feet to top of panelboard unless otherwise indicated or as required for specific field conditions. Install panelboards taller than 6 feet with bottom not closer than 4 inches above floor, or provide concrete equipment base in accordance with 262416.
- E. Provide filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard under the provisions of Section 260553. Revise directory to reflect circuiting changes required to balance phase loads.
- G. Provide engraved plastic nameplates under the provisions of Section 260553.
- H. Ground and bond panelboard enclosure according to Section 260526

#### **3.2 CLEANING**

- A. Clean installed work under the provisions of Division 1.
- B. Clean interior of cabinets and enclosures to remove dust, debris, and other material.
- C. Clean surfaces and touch up scratched or marred surfaces to match original finish.

**- END OF SECTION-**

## SECTION 26 50 00 - LIGHTING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide luminaires and accessories, complete and operable, in accordance with the Contract Documents.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes

- NFPA 70 National Electric Code – 2017 Edition

- NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)

- UL-595 UL-924 Standard for Safety Emergency Lighting and Power Equipment

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish the following product information in accordance with the requirements of Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.

- B. Furnish the following information:

- 1. Interior Luminaires

- a. catalog data sheets
    - b. luminaire finish and metal gauge
    - c. lens material, pattern, and thickness
    - d. candlepower distribution curves in 2 or more planes
    - e. lumen output chart
    - f. mounting or suspension details
    - g. lens material, pattern, and thickness
    - h. IES lighting classification and isolux diagram
    - i. fastening details to wall or pole

- 2. Lamps

- a. voltages
    - b. colors
    - c. approximate life (in hours)
    - d. approximate initial lumens
    - e. lamp type

- 3. Drivers

- a. type
    - b. wiring diagram
    - c. nominal watts and input watts
    - d. input voltage

4. Photocells
  - a. voltage and wiring diagram
  - b. capacity
  - c. contacts and time delay
  - d. operating levels
  - e. enclosure type and dimensions

1.4 A sample of each "equal" fixture proposed for use shall be submitted to the ENGINEER for review, if requested.

## **PART 2 -- PRODUCTS**

### **2.1 LUMINAIRES**

#### **A. General**

1. Additional WORK requirements are indicated in the Luminaire Schedule on the Drawings.

B. Provide a feed-through type or separate junction box.

C. Provide minimum 18 AWG wire leads.

D. Provide components that are accessible and replaceable without removing the luminaire from its mounting.

#### **E. Emergency Lighting**

##### **1. Power Pack**

- a. self-contained
- b. 120/277 V
- c. dual voltage
- d. selectable input transformer
- e. 6 V sealed nickel-cadmium, lead-acid or lead-calcium battery (see Luminaire Schedule)
- f. indicator switch in accordance with the requirements of UL 924

2. Lighted, push-to-test pushbutton and indicator

3. Capability of providing full illumination for 1-1/2 hours in emergency mode

4. Capability of full recharge in 24 hours, automatically initiated upon resumption of normal line voltage

5. Capability of protecting against excess charging and discharging

6. LED lighting heads, as indicated

7. Solid state charger

8. Normal and emergency LED indicating lights

9. Mounting stand

10. Provide NEMA-rated enclosures in accordance with the area classifications in which they are installed.

F. Exit Signs

1. Internally illuminated
2. Universal mounting type
3. Internal 6 v maintenance free nickel-cadmium battery
4. Battery charger
5. LED-type emergency and normal indicating lights
6. Press-to-test button
7. Directional arrows
8. Red letters on a white panel, or as indicated

- G. The schedule and details of lighting fixtures, appearing on the Plans, indicate the type, construction, appearance, quality and performance of the fixtures required. Any proposed deviation from the fixtures specified must equal or be superior to the item specified under these headings. Proposed substitute lighting fixtures will be judged on overall quality on construction and on the basis of laboratory tests by the Electrical Testing Laboratory or similar independent testing facility. The fixture manufacturer's products scheduled are considered acceptable. The CONTRACTOR shall furnish, upon request of the ENGINEER, a set of fabrication plans, a set of photometric curves and a physical sample for review of every specific type offered.

2.2 LAMPS

A. LED

1. As indicated on the luminaire schedule on the drawings.

**PART 3 -- EXECUTION**

3.1 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.
2. Provide necessary hangers, pendants, canopies, and other accessories.

3. Install the luminaire plumb and level.
4. Install each luminaire outlet box with a galvanized stud.
5. Mechanical and Electrical Equipment Rooms: In the Mechanical and Electrical Equipment rooms, lighting fixtures shall be installed on ceilings or walls after all piping ductwork and equipment therein are installed. Exact location and switching for such fixtures will be determined at the job site during the course of the work. Fixtures shall be located so as to give maximum illumination to items of equipment requiring servicing, and moving machinery. Any lighting fixtures that are blocked, inaccessible or improperly located shall be relocated at no extra cost.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.

C. Finished Areas

1. Install the luminaires symmetrically with tile pattern.
2. Locate with the centerline of tile or with centerline of the joint between adjacent tile runs.
3. Install recessed luminaires tight to the finished surface such that no spill light will show between the ceilings and the sealing rings.
4. When installing on combustible low-density cellulose fiberboard, provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use luminaires suitable for mounting on low-density ceilings.

5. Junction Boxes

- a. Flush and Recessed Luminaires: Locate a minimum of one foot from the luminaire.
- b. In concealed locations, install junction boxes to be accessible by the removal of the luminaire.

6. Wiring and Conduit

- a. Provide wiring of a suitable temperature rating as required by the luminaire.
- b. Provide liquid tight flexible metal conduit, except in ceiling spaces used as air plenums, where flexible steel conduit meeting NEC requirements shall be used.

7. Provide plaster frames when required by ceiling construction.

8. Independent Supports

- a. Provide each recessed troffer luminaire with 2 safety chains or 2 No. 12

soft- annealed galvanized steel wires of length needed to secure the luminaire to the building structure, independent of the ceiling structure.

- b. Ensure that the tensile strength of chain or wire, and the method of fastening to the structure, is adequate to support the weight of the luminaire.
- c. Fasten the chain or wire to each end of the luminaire.
- d. Chains shall not be the primary supporting means.

D. Unfinished Areas

- 1. Locate the luminaires to avoid conflicts with other building systems and blockage of the luminaire light output.
- 2. Luminaire Suspension
  - a. Provide 3/8-inch threaded stainless steel hanger rods.
  - b. Scissor-type hangers will not be accepted.
- 3. For attachments to steel beams, provide flanged beam clips and straight or angled hangers.

3.2 LAMPS

- A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.3 CLEAN-UP

- A. Remove labels and other markings, except the UL listing mark.
- B. Wipe the luminaires inside and out in order to remove construction dust.
- C. Clean the luminaire plastic lenses with an antistatic cleaner only.
- D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.
- E. Replace defective lamps at the Date of Substantial Completion.

**- END OF SECTION -**



RUCKS PARK - PUMP STATION  
TECHNICAL SPECIFICATIONS

## SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated.
- C. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.
- D. The CONTRACTOR'S attention is directed to the requirement for proper coordination of the WORK of this Section with other trades sections.
- E. Equipment supports and foundations shall be in conformance with the requirements of Structural Specifications.

#### 1.2 REFERENCE STANDARDS

ANSI	American National Standards Institute
FBC	Florida Building Code 2020
NEC (NFPA 70)	National Electrical Code – 2017 Edition
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
NRTL	National Recognized Testing Laboratory

- A. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.
- B. Installation of electrical equipment and materials shall comply with state building standards, and applicable local codes and regulations, all as enforced by the Authority Having Jurisdiction (AHJ).
- C. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

#### 1.3 BASIS FOR WIRING DESIGNS

- A. The Contract Drawings and Specifications describe specific sizes of switches,

breakers, fuses, conduits, conductors, motor starters and other electrical equipment. These sizes are based on specific power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Wherever another trade provides power consuming equipment that differs from the Contract Documents, the wiring, conduits, starters, overcurrent devices, and other electrical devices that may be impacted shall be changed to proper sizes to match at no additional expense to the OWNER.

#### 1.4 SIGNAGE AND MARKINGS

##### A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

##### B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

##### C. Warning Signs

1. 600 Volts Nominal, or Less
  - a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.
2. Arc Flash Signage

#### 1.5 PERMITS AND INSPECTION

- A. Obtain permits and pay inspection fees according to the General Conditions.

#### 1.6 CONTRACTOR SUBMITTALS

##### A. General

1. Furnish submittals in accordance with Section 01 33 00 - Shop Drawings, product data, and samples.
2. Custom-prepare Shop Drawings.
3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.
4. Cross out options not proposed or delete from the Shop Drawings.

- B. Shop Drawings: Include the following as a minimum:

1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Shop drawings for grounding WORK not specifically indicated
3. Front, side, rear elevations, and top views with dimensional data
4. Location of conduit entrances and access plates
5. Component data
6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers
7. Types of materials and finish
8. Nameplates
9. Temperature limitations, as applicable
10. Voltage requirement, phase, and current, as applicable
11. Grounding requirements

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.
2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the ENGINEER a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.
2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Architectural Section for shop drawings requirements.
2. As-Built Drawings
  - a. A set of "Red-Lined" electrical drawings shall be carefully maintained at the job site. Actual conditions are to be put on the drawings in red on a daily basis so the Plans will continuously show locations and routings of cables, conduits, pull boxes, circuit numbers, and other information required by the ENGINEER. An

up-to-date copy of the "Red-Lined" Drawings shall be submitted to the OWNER by the CONTRACTOR once every two weeks. At the end of the Project, the CONTRACTOR shall turn over As-Built Drawings in AutoCAD format to the OWNER.

- b. Furnish the drawings to the ENGINEER in accordance with the requirements of Architectural Section for shop drawings requirements.
- c. Prepare As-Built Drawings of encased concealed and exposed raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

## 1.7 AREA DESIGNATIONS

### A. General

1. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections, unless indicated otherwise.

### B. Material Requirements

1. Construct NEMA 4X enclosures of Type 316 stainless steel, except in chlorine or hypochlorite areas or areas with ferric-based chemicals where non-metallic enclosures shall be provided.
2. Metallic NEMA 4X enclosures shall have a white, powder coated finish.
3. Construct NEMA 7 enclosures of cast aluminum where used with aluminum conduit.
4. Do not coat NEMA 7 and 9 enclosures.
5. Construct NEMA 1, 3R, and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

## 1.8 TESTS

- A. The CONTRACTOR shall be responsible for required factory and field as required by Engineer and other authorities having jurisdiction.
- B. Furnish necessary testing equipment.
- C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.
- D. Reporting
  1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
  2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.

3. Submit field test reports for review prior to Substantial Completion.
- E. Remove and replace equipment or material that fails a test, or, if the ENGINEER approves, repair and retested for compliance.
  - F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.
- 1.9 DEMOLITION AND RELATED WORK
- A. General
    1. Perform electrical demolition WORK as indicated.
    2. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical Contract Drawings.
    3. Coordinate with all trades and building management regarding electrical de-energization, disconnection, and removal, and the overall sequence of construction.
  - B. Electrical Requirements for Removed Equipment
    1. Remove dedicated wiring and exposed conduits back to the source.
    2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring. Remove power wiring from the power source to the first pullbox or manhole remote from the panel, and abandon in place the remaining wiring.
    3. Remove remote-mounted starters, disconnect switches, circuit breakers, sensors, and transmitters. Breakers in Panels that are not replaced or re-used shall be abandoned in place, and nameplates replaced to read, "SPARE".
  - C. Where new lighting and receptacles are installed, remove old lighting, receptacles, switches, wiring, and conduits, and replace in their entirety.
  - D. Junction Boxes
    1. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips.
    2. Provide a junction box with a NEMA rating in accordance with the area in which it is located, and sized as required.
    3. Properly identify wires and terminals before disconnection.
  - E. Removed materials and equipment not indicated to be returned to the OWNER shall, upon removal, become the CONTRACTOR'S property and shall be disposed of off- site.
  - F. Remove and relocate material and equipment indicated to be relocated or reused, and reinstall with care in order to prevent damage.
  - G. Place materials indicated to be returned to the OWNER in boxes, with the contents

clearly marked, and store at a location determined by the OWNER.

#### H. Identification

1. Where panelboards are indicated to have components, assemblies, or circuits removed and reconnected, provide the affected panel compartments with new engraved nameplates worded as indicated and matching the existing, or modify the panelboard schedule to indicate the revised circuits. Replace the panelboard schedule in its entirety if the existing schedule is unreadable or otherwise unusable.
2. Pencil or magic marker markings directly on the panelboard will not be accepted.

### 1.10 CONSTRUCTION SEQUENCING

#### A. General

1. Because the continuance of building operation during the renovation is critical, the CONTRACTOR shall carefully examine the WORK to be provided in, on, or adjacent to existing equipment.
2. Schedule the WORK in phases, subject to OWNER's approval, to minimize disruption to normal operations.
3. Submit a written sequencing request, including the sequence and duration of activities to be performed.
4. In no case shall the CONTRACTOR begin any WORK phase without written authorization from the OWNER.

#### B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.
2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.
3. Repair coatings to match the existing.
4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the WORK.

#### C. Field Verifications

1. Visit the Site before submitting a bid to become better acquainted with the WORK of this Contract.
2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.

3. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL**

- A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.
- B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.
- C. Provide similar items in the WORK as products of the same manufacturer.
- D. Provide equipment and materials of industrial grade standard of construction.
- E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.
- F. On devices indicated to display dates, display the year as 4 digits.
- G. Temperature Ratings of Equipment Terminations
  1. Provide terminations and lugs rated for use with 75-degree C conductors.
  2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

### **2.2 MOUNTING HARDWARE**

- A. Miscellaneous Hardware
  1. Provide nuts, bolts, and washers constructed of stainless steel.
  2. Provide threaded rods for trapeze supports constructed from continuous threaded stainless steel, 3/8-inch diameter minimum.
  3. Struts
    - a. Provide struts for mounting of conduits and equipment of aluminum except where additional strength is needed, then use 316 stainless steel. Coat the back of aluminum struts with bitumastic coating where it comes in contact with concrete.
    - b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
    - c. Do not use aluminum strut for free-standing support frames. Use 316 stainless



steel except in chlorine, hypochlorite or ferric areas where FRP strut shall be used.

d. Strut Manufacturer, or Equal: **Unistrut; B-Line**

4. End Caps

a. Provide plastic protective end caps for all exposed metal strut ends.

b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860**

5. Anchors

a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

b. Wood plugs will not be accepted.

c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Hilti**.

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

##### **A. Incidentals**

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.
2. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

##### **B. Field Control of Location and Arrangement**

1. The Contract Drawings diagrammatically indicate the desired location and arrangement of loads, conduit runs, equipment, and other items.
2. Exact locations shall be determined by the CONTRACTOR in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.
3. Follow the locations on the Contract Drawings, however, as closely as possible.
4. Conduits
  - a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.
  - b. Provide exposed or encased routings as indicated, except conceal conduit in

finished areas unless indicated otherwise.

5. Placement

- a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.
- b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.
- c. Where exact locations are not indicated, such locations will be determined by the ENGINEER.
- d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.
- e. Slightly adjust luminaire locations based on actual field conditions in order to avoid obstructions and to minimize shadows, and update As-Built Drawings accordingly.

6. Circuits

- a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.
- b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).
- c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

7. Workmanship

- a. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer, and using workers skilled in the WORK.
- b. Coordinate installation in the field with other trades in order to avoid interferences.

8. Protection of Equipment and Materials

- a. Fully protect materials and equipment against damage from any cause.
- b. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.
- c. Keep moving parts clean and dry.

- d. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

### 3.2 CORE DRILLING

- A. Perform core drilling as required for the installation of raceways through concrete walls and floors.
- B. Base the locations of floor penetrations, as may be required, on field conditions.
- C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.
- D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities.
- E. Repair damage to walls, floors, encased conduits, wiring, and piping as part of the WORK.

### 3.3 CONCRETE HOUSEKEEPING PADS AND CURBS

- A. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.
- B. Extend housekeeping curbs to 4 inches above the finished floor or grade.

### 3.4 EQUIPMENT ANCHORING

- A. Floor-supported, wall, or ceiling-hung equipment and conductors shall be anchored in place by approved method in the area where the Project is located.
- B. Provide wall-mounted panels that weigh more than 500 pounds with fabricated steel support pedestals.
- C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.
- D. Provide transformers hung from 4-inch stud walls with auxiliary floor supports.
- E. Provide leveling channels anchored to the concrete pad for switchgear and pad-mounted transformer installations.
- F. Manufacturer's Recommendations
  - 1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract.
  - 2. Submit such recommendations as Shop Drawings as indicated.

### 3.5 CLEANING

- A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.
- B. Remove temporary tags, markers, stickers, and the like.
- C. Remove oil and grease spots with a non-flammable cleaning solvent, by carefully wiping and scraping cracks and corners.
- D. Apply touch-up paint to scratches on panels and cabinets.
- E. Vacuum-clean electrical cabinets and enclosures.
- F. Clean luminaires inside and out.
- G. Dispose cleaning debris and refuse off-Site.

**- END OF SECTION -**

## SECTION 26 05 19 - WIRE AND CABLE

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit Shop Drawings in accordance with Division 1 and 26 00 00 – ELECTRICAL WORK, GENERAL.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

#### 2.2 LOW VOLTAGE WIRE AND CABLE

##### A. Power and Lighting Wire

1. Wire rated for 600 volts in conduit for power and lighting circuits shall be type XHHW-2 rated 90 degrees C suitable for wet locations except where required otherwise by the plans.
2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drops on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
4. Wiring for 600 volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.

## B. Control Wire

1. Control wire in conduit shall be the same type as power and lighting wire indicated above.
2. Control wiring shall be #14 AWG, except for current transformer secondary conductors which shall be #12 AWG minimum.
3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable**, or equal.
4. All control wiring of 10 or more #14 shall be preassembled as manufactured by **Clifford of Vermont, Inc.**, Quik-Pull, meeting the following requirements:
  - a. #14 AWG stranded copper XHHW-2, 600 Volt
  - b. Each conductor numbered every 1½ Inches
  - c. Sequential footage tape.
  - d. Round compact units, spiral configuration
  - e. UL listed. Custom wire assembly
5. Assemblies are identified as QP-10, 20 to 100 maximum. Example: Where QP-20 is shown it supersedes the count if 16#14 are shown.
6. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3090A**, similar by **General Cable**, or equal.
7. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3091A**, similar by **General Cable**, or equal.

## 2.3 CABLE SPLICES AND TERMINATIONS

- A. Where cable lugs are required for power cable terminations, utilize copper, capped, one-hole and two-hole compression lugs – **3M** Scotchlok 30000 and 31100 Series, **Penn Union** HBBLU and BLU, **Burndy** Hylug, or equal. Utilize compression tools as recommended by the manufacturer. Open-ended lugs (where the end of the stranded cable is exposed) are not acceptable for power cable terminations. Pressure type, twist-on connectors (wire nuts) will not be acceptable.
- B. Pre-insulated ring lugs for control conductors shall be **Thomas & Betts, Burndy**, or equal.
- C. General purpose insulating tape shall be **Scotch No. 33, Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M**, or equal.

- D. Labels for coding 600 volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.
- E. No splices shall be permitted for low-voltage power cables.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

The CONTRACTOR shall provide, terminate and test all power, control, and instrumentation conductors.

The CONTRACTOR shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares.

### **3.2 INSTALLATION**

- A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.
- C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.
- D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

### **3.3 SPLICES AND TERMINATIONS**

#### **A. General**

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.
2. In general, there shall be no cable splices. Splices may be made only with the prior approval of the ENGINEER, and shall be performed in strict accordance with the cable and splice manufacturers' requirements. Splices will not be permitted for intra-building feeder or branch circuits.
3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug.
4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

#### **B. Control Wire and Cable**

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
2. In motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips. Where terminal strips require lugs, ring lugs shall be used. Fork-type lugs are not acceptable.
3. The CONTRACTOR shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR.
2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape.
3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR shall submit the proposed termination procedure as a Shop Drawing.

3.4 CABLE IDENTIFICATION. Also refer to Section 26 05 53 – ELECTRICAL IDENTIFICATION).

A. **General:** Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

B. **Identification Numbers:** The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on As-Built Drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control and Instrumentation Conductors" shall be defined as any conductor used for control, interlock, alarm, annunciator, or signal purposes.

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
2. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The



480/277 volt system conductors shall be color coded as follows: Phase A- Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs. Any phase changes necessary for proper rotation shall be made at the driven equipment and not in the local disconnect.

3. General purpose AC control cable shall be red. General purpose DC control cable shall be blue. DC power wiring shall be red for positive conductors (+) and black for negative conductors (-).
4. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
5. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

### 3.5 TESTING

- A. **Cable Assembly and Testing:** Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Division 1, prior to shipment of cable. The following field tests shall be the minimum requirements:
  1. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
  2. Field testing shall be done after cable is installed in the raceways.
  3. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.
  4. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.
- B. **Continuity Test:** Control cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

**- END OF SECTION -**

## SECTION 26 05 26 – GROUNDING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical grounding, complete and operable, as indicated in accordance with the Contract Documents.
- B. The requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL apply to this Section.
- C. Single Manufacturer
  - 1. 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.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Division 1 and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Equipment Grounding Circuit Conductors
  - 1. The conductors shall be the same type and insulation as the load circuit conductors.
  - 2. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.
  - 3. Metallic conduit systems shall have an equipment grounding wire as well as being equipment grounding conductors themselves.

### PART 3 -- EXECUTION

#### 3.1 GROUNDING

- A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.
- B. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.
- C. Route the conductors inside the raceway.

- D. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each panelboard.
- E. Individually bond the raceway to the ground bus in the secondary section.
- F. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.
- G. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.
- H. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.
- I. Low Voltage Grounded System (600V or less)
  - 1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.
  - 2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.
  - 3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.
  - 4. The termination of the shield drain wire shall be on its own terminal screw.
  - 5. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.
  - 6. Connect the ground bus via a green #12 conductor to the main ground bus for the panel.

### 3.2 TESTING

#### A. Fall-of-Potential Test

- 1. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
- 2. Main ground electrode system resistance to ground to be no greater than 3 ohms.

#### B. Two-Point Direct Method Test

1. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames and system neutral and derived neutral points.
  2. Equipment ground resistance not to exceed main ground system resistance by 0.25 ohms.
- C. Test several points of the system including: The neutral of every voltage level used in the system, enclosure of switchgears, motor control centers and panelboards and metal enclosure of outlet or fixture at remote location designated by the ENGINEER. Initial resistance to ground shall not be over 2.5 ohms for water pipe grounds and 15 ohms for made grounds.

**- END OF SECTION -**

## SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.
- B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.
  - 2. Submit dimensioned layout drawings of cable tray routings, including elevations.
  - 3. As-Built Drawings
    - a. Prepare as-built drawings of encased concealed and exposed raceways, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.
    - b. Furnish the drawings to the ENGINEER in accordance with the requirements of Division 1.

### PART 2 -- PRODUCTS

#### 2.1 METAL CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.
  - 2) Alflec Inc.
  - 3) Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4) Anamet Electrical, Inc.; Anaconda Metal Hose.

- 5) Electri-Flex Co.
  - 6) Manhattan/CDT/Cole-Flex.
  - 7) Maverick Tube Corporation.
  - 8) O-Z Gedney; a unit of General Signal.
  - 9) Wheatland Tube Company.
- c. Rigid Steel Conduit: ANSI C80.1.
  - d. Aluminum Rigid Conduit: ANSI C80.5.
  - e. IMC: ANSI C80.6.
  - f. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - 1) Comply with NEMA RN 1.
    - 2) Coating Thickness: 0.040 inch (1 mm), minimum.
  - g. EMT: ANSI C80.3.
  - h. FMC: Zinc-coated steel.
  - i. LFMC: Flexible steel conduit with PVC jacket.
  - j. 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.
    - 1) Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
    - 2) Fittings for EMT: Steel type.
    - 3) Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
  - k. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.

- 2) Anamet Electrical, Inc.; Anaconda Metal Hose.
- 3) Arnco Corporation.
- 4) CANTEX Inc.
- 5) CertainTeed Corp.; Pipe & Plastics Group.
- 6) Condux International, Inc.
- 7) ElecSYS, Inc.
- 8) Electri-Flex Co.
- 9) Lamson & Sessions; Carlon Electrical Products.
- 10) Manhattan/CDT/Cole-Flex.
- 11) RACO; a Hubbell Company.
- 12) Thomas & Betts Corporation.

- c. ENT: NEMA TC 13.
- d. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- e. LFNC: UL 1660.
- f. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- g. Fittings for LFNC: UL 514B.

### 2.3 METAL WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper B-Line, Inc.
  - 2) Hoffman.
  - 3) Square D; Schneider Electric.
- c. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R, unless otherwise indicated.
- d. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- e. Wireway Covers: Screw-cover type.
- f. Finish: Manufacturer's standard enamel finish.

## 2.4 NONMETALLIC WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Hoffman.
  - 2) Lamson & Sessions; Carlon Electrical Products.
- c. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- d. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- e. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.5 SURFACE RACEWAYS

- a. Surface Metal Raceways: Galvanized steel with snap-on covers. Prime coating, ready for field painting.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a) Thomas & Betts Corporation.
    - b) Walker Systems, Inc.; Wiremold Company (The).
    - c) Wiremold Company (The); Electrical Sales Division.
- b. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected manufacturer's standard colors.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:



- 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a) Butler Manufacturing Company; Walker Division.
  - b) Enduro Systems, Inc.; Composite Products Division.
  - c) Hubbell Incorporated; Wiring Device-Kellems Division.
  - d) Lamson & Sessions; Carlon Electrical Products.
  - e) Panduit Corp.
  - f) Walker Systems, Inc.; Wiremold Company (The).
  - g) Wiremold Company (The); Electrical Sales Division.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2) EGS/Appleton Electric.
  - 3) Erickson Electrical Equipment Company.
  - 4) Hoffman.
  - 5) Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6) O-Z/Gedney; a unit of General Signal.
  - 7) RACO; a Hubbell Company.
  - 8) Robroy Industries, Inc.; Enclosure Division.
  - 9) Scott Fetzer Co.; Adalet Division.
  - 10) Spring City Electrical Manufacturing Company.
  - 11) Thomas & Betts Corporation.
  - 12) Walker Systems, Inc.; Wiremold Company (The).
  - 13) Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- c. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- d. Cast-Metal Outlet and Device Boxes: NEMA FB 1, [ferrous alloy] Type FD, with gasketed cover.
- e. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- f. Metal Floor Boxes: Cast metal , fully adjustable, rectangular.
- g. Nonmetallic Floor Boxes: Nonadjustable, round.
- h. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- i. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, [galvanized, cast iron] with gasketed cover.

- j. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  - 1) Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2) Nonmetallic Enclosures: Plastic

## EXECUTION

### 2.7 GENERAL

- A. Run wiring in raceway unless indicated otherwise.
- B. Install raceways between equipment as indicated.
- C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.
- D. Bends and Offsets
  - 1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.
  - 2. Provide factory elbows wherever possible.
- E. Combined Raceways
  - 1. Raceways other than those containing power conductors may be combined in strict accordance with the NEC and with prior written permission from the ENGINEER.
  - 2. In general, combine only raceways containing the same type (control, signal, and the like) and voltage of conductors/cables, or dedicated conduits from one source to one device/equipment, in accordance with the NEC.
  - 3. Permission from the ENGINEER shall not relieve the CONTRACTOR of responsibility to meet national, state and local requirements.
  - 4. Do not combine wiring for redundant systems into single raceways.
- F. Routing
  - 1. Where raceway routings are indicated, follow those routings to the extent possible.
  - 2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and provided in strict accordance with the NEC as well as customary installation practice.

3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.
  4. Adjust routings in order to avoid obstructions.
- G. Coordination
1. Coordinate between trades prior to installing the raceways.
  2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.
- H. Support wireways in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- I. Install exposed raceways parallel or perpendicular to structural beams.
- J. Install exposed raceways at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.
- K. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

## 2.8 CONDUIT

- A. Size
1. Provide exposed conduit of 3/4-inch minimum trade size.
  2. Provide encased conduit of one-inch minimum trade size.
- B. Install supports at distances required by the NEC.
- C. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.
- D. Penetrations
1. Provide conduit passing through walls or floors with plastic sleeves.
  2. Perform core drilling in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL.
  3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

- E. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.
- F. Coat threads with a conductive lubricant before assembly.
- G. Joints
  - 1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.
  - 2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.
  - 3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.
  - 4. Replace conduit with wrench marks.
- H. Slope
  - 1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.
  - 2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.
  - 3. Take extreme care in order to avoid pockets or depressions in the conduit.
- I. Installation of rigid conduit through a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.
- J. Connections
  - 1. Make connections to lay-in-type grid lighting fixtures by using flexible metal conduit not exceeding 4 feet in length.
  - 2. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.
  - 3. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.
- K. Empty Conduits
  - 1. Tag empty conduits at both ends to indicate the final destination.
  - 2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.
  - 3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

L. Identification of Conduits

1. Identify conduits at ends and at pulling points.
2. Identification shall be the unique conduit number assigned in the Contract Documents.
3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.
5. Provide conduit identification by a stamped or engraved non-corroding stainless steel metal tag attached to the conduit bushing.
6. Provide an engraved phenolic nameplate in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.
7. Markings with a pen or paint will not be accepted.

M. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.
2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the CONTRACTOR shall assign one following the numbering scheme used in the Contract Documents.
3. Provide box identification by a stamped or engraved stainless steel non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, and attached to the box or enclosure.
4. Markings with a pen or paint will not be accepted.

- N. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

**- END OF SECTION -**

## SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

##### A. Scope

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### B. Coordination

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### C. Related Sections

1. Section 26 00 00 – ELECTRICAL WORK, GENERAL.

#### 1.2 CONTRACTOR SUBMITTALS

##### A. Shop Drawings: Furnish submittals in accordance with Division 1.

1. Comply with the requirements below. Submit for approval of the following:
  - a. The complete description and enumeration of proposed electrical identification devices shall be shown on the Shop Drawings for the associated equipment or systems.

##### B. Product Data:

1. Manufacturer's cut sheet, specifications, dimensions and technical data for all products proposed to be furnished under this Section.
2. Any deviation shall be explicitly noted.

##### C. Samples:

1. Nameplates: Samples of nameplates shall be submitted and shall include both applied and unapplied wire and cable label samples. These samples shall be used as quality standards for the wire and cable labeling required by this Section. These samples shall be of material specified in this Section and shall include wire and cable designators meeting the requirements of this Section.

- D. Wiring diagrams annotated with wire numbers and terminal numbers shall be submitted prior to commissioning of associated equipment or systems.
- E. Project Record Documents:
  - 1. Submittals of Record Documents required by other Sections shall show final electrical identification and electrical identification devices.

## **PART 2 -- PRODUCTS**

### **2.1 MANUFACTURED UNITS**

#### **A. Engraved Identification Devices (Nameplates, and Legend):**

##### **1. Nameplates:**

- a. The following items shall be equipped with nameplates: All motors, motor starters, pushbutton stations, control panels, time switches, disconnect or relays in separate enclosures, transformers, receptacles, wall switches boxes and cabinets. All light switches and outlets shall carry a phenolic plate with the supply circuit panel I.D. and circuit number. Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.
- b. 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 motor nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and local control station nameplates for that machine. Nameplates shall be laminated phenolic plastic, white front and back with black core, with lettering etched through the outer covering; black engraved letters on white background. Lettering shall be 3/16 inch high at local control stations, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4 inch high, unless otherwise detailed on the Plans. Nameplates shall be securely fastened to the equipment with No. 4 Phillips, rough-head, cadmium- plated, steel self-tapping screws or nickel-plated brass bolts. For applications on NEMA 4X enclosures, nameplates shall be attached using an epoxy-based adhesive that is resistant to oil and moisture. Motor nameplates may be non-ferrous metal not less than 0.03 inch thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Engraved lettering shall be filled with contrasting enamel. Equipment nameplate schedule for all equipment shall be submitted with Shop Drawing submittal for Engineer's approval.
- c. All junction and splice boxes shall be labeled.

#### **B. Conduit Labels:**

##### **1. Products and Manufacturers:**

- a. **B-915 Series by Brady**, or approved equal.
  - b. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit diameters through five inches or pre-molded to conform to circumference of six-inch conduit.
  - c. Strap-on style for 6-inch conduit shall be attached with stainless steel springs.
  - d. Shall be blank for use with custom printed labels.
  - e. Labels shall be color coded as follows:
    - 1) Power Conduits (600V and less) – Orange
    - 2) Control/Instrumentation – Light Blue
    - 3) Telephone/Intercom – Yellow
    - 4) Data - White
- C. Custom Labels:
1. Shall have black lettering on yellow background
  2. Shall not contain abbreviations in legend
  3. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.
- D. Wire Identification:
1. All wire and cable shall be identified at each termination point and at each pull box, terminal box and manhole. Provide permanent, waterproof, non-metallic (paper unacceptable) tags indicating the circuit number in 3/16 inch letters. Circuit numbers shall be protected with clear shrinkable tubing.
  2. All 120 VAC and lower control circuits shall use vinyl, self-laminating, self-adhesive, wrap type labels that are heat, oil, water, and solvent resistant wire markers. Labels shall be by **Brady**, or approved equal (**Brady** XPS-187-1 and XPS-375-1, as applicable, based on wire size). Wire numbers shall be solid machine printed, and shall not be pieced from other single or double-digit tags.
  3. Where wire numbers change, the appropriate drawings shall include both wire numbers, clearly indicated, at the point of transition. Drawings shall also identify the insulation color for all wiring.
  4. Conductor Identification: Each conductor shall be identified by a 2-line identification. Line 1: X-Y, where X is a unique number and Y is the location of the termination in the cabinet you are looking at; Line 2: A-B, where A is a unique number (which should usually match the X in Line 1), and B is the location of the termination at the other end of the conductor. The termination locations are typically on terminal



- blocks with identifications such as "TB2-1". The CONTRACTOR shall coordinate with the OWNER regarding all conductor identifications prior to installation.
5. All terminals and terminal strips and posts shall be identified with terminal block markers.
  6. All wire labels shall be clearly visible and not hidden by wire duct or other components in the enclosures.
  7. PLC/DCS/RTU panel wire tag format and content shall be provided by the OWNER.

## 2.2 FABRICATION

### A. Engraved Identification Devices (Nameplates and Legend Plates):

1. All nameplate text shall remain preliminary and subject to change pending final review and acceptance of the nomenclature by the OWNER after commissioning. Temporary tags consisting of removable tape or other accepted material with the preliminary nomenclature legibly hand lettered shall be affixed to enclosures and cover plates to identify the enclosures and mounted components as required during assembly, factory testing, and start-up. Laminated plastic nameplates shall not be engraved until after commissioning of the associated system and release of final engraving information by the OWNER.

## PART 3 -- EXECUTION

### 3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the work is to be installed and notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Electrical identification shall be provided as shown, specified or required.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
  1. Temporary tags shall be provided at all locations until after start-up and release of final engraving information by OWNER.
  2. Unless otherwise specified, permanent nameplates shall be attached with a permanent adhesive and with stainless steel machine screws into drilled and tapped holes.
  3. A nameplate with 1-1/2 inch letters shall be provided to identify each console, cabinet, panel, or enclosure as shown or specified.
  4. Nameplates with 1/2 inch letters shall be provided to identify each junction and terminal box as shown or specified.

5. On switchgear, nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments.

a. A nameplate with 1-inch letters shall be provided giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.

b. The individual door for each compartment shall be identified with a nameplate giving them designation and circuit number as well as frame ampere size and appropriate trip rating.

C. Motor Control Centers:

1. A nameplate with 1-inch letters shall be provided giving motor control center designation.

2. The individual door for each unit compartment shall be identified with a nameplate identifying the controlled equipment, including the tag number indicated on the Contract Drawings.

D. Except conduit, all other electrical appurtenances including, but not limited to, lighting panels, convenience outlets, fixtures and lighting switches, shall be provided nameplates indicating the appropriate circuit breaker number(s).

E. Safety Sign and Voltage Markers:

1. Safety signs and voltage markers shall be provided on and around electrical equipment as specified and where shown.

2. Rigid safety signs shall be installed using stainless steel fasteners.

3. Surfaces shall be cleaned before application of pressure sensitive signs and markers.

4. Low voltage safety signs shall be mounted on all equipment doors providing access to uninsulated 480-volt conductors (including terminal devices).

5. Low voltage markers shall be installed on each terminal box, safety disconnect switch and panelboard installed, modified or relocated and containing 120/208-volt conductors.

F. Conduit Labels:

1. All conduits shall be provided with conduit labels unless otherwise specified.

2. Flexible conduit shall not be labeled.

3. Exposed single conduit runs of less than 25 feet between local disconnect switches and the equipment they operate shall not be labeled.
4. Conduit labels shall convey the following information:
  - a. Contract Number: Alphanumeric.
  - b. Conduit Number: Alphanumeric. Leftmost character shall be the uppercase letter "C", remaining characters shall be a unique combination for each conduit, as shown on the Drawings and in accordance with conforming submittals.
5. Conduit labels shall be installed at the following locations:
  - a. Where conduit enters or exits walls, ceilings, floors, or slabs.
  - b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
  - c. At intervals of not more than 50 feet along the length of the conduit.
6. Conduit labels shall be oriented so as to be readable, standing on the floor near the conduit.
7. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
8. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

G. Wire and Cable Identification:

1. Color-coding of insulated conductors and identification shall comply with Section 26 05 19 – WIRES AND CABLES.
2. Wire and Cable Labels shall be provided as follows:
  - a. New, re-routed, or revised wire or cable shall be labeled.
  - b. All insulated conductors shall be labeled.
  - c. Bare (non-insulated) conductors shall not be labeled unless otherwise shown or specified.
  - d. Wire and cable terminations shall be labeled.
3. Wire labels shall be applied between ½ and 1 inch of the completed termination.

4. Cable labels shall be applied between  $\frac{1}{2}$  and 1 inch of cable breakout into individual conductors.
  - a. Individual conductors in a cable shall be labeled after the breakout as specified for wires
5. Wire or cable exiting cabinets, consoles, panels, terminal boxes and enclosures shall be labeled.
  - a. Wires or cables shall be labeled within two inches of the entrance to the conduit.
6. Wire and cable installed in electrical manholes shall be labeled.
  - a. Wire and cable shall have wrap-around labels applied within one foot of exiting the manhole.
7. Wire and cable labels shall be installed when the wire or cable is pulled and prior to termination of the conductors. Installation of wire and cable labels after the conductors are terminated is not permitted.

**- END OF SECTION -**

## SECTION 262416 – PANELBOARDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including Conditions of the Contract and Division 1 of the Specifications, apply to the work in this Section.
- B. This Section is hereby made a part of all other sections of Division 260000 as fully as if repeated in each therein.

#### 1.2 SECTION INCLUDES

- A. Branch circuit panelboards.

#### 1.3 RELATED SECTIONS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260553 - Electrical Identification.

#### REFERENCES

- A. NECA – “Standard of Installation”.
- B. NEMA AB1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
- D. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- E. NEMA PB 1 - Panelboards.
- F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- H. NFPA 70 - National Electrical Code.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 260500.
- B. Product Data: Provide for panelboards, fusible switches, and circuit breakers.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch

arrangement and sizes.

- D. Manufacturers' Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- E. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- F. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, unless otherwise specified.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

## 1.7 COORDINATION

- A. Coordinate under provisions of Division 1.
- B. Field Measurements: Verify that field measurements are as shown on Drawings.
- C. Field Locations: Verify locations of panelboards prior to rough-in.

## 1.8 DELIVERY, STORAGE, PROTECTION, AND HANDLING

- A. Protect from moisture by using appropriate coverings. Store in dry interior locations.
- B. Do not install until building is closed in and suitable temperature conditions are controlled.
- C. Maintain suitable temperature and humidity conditions during and after installation of panelboards.

## 1.9 EXTRA MATERIALS

- A. Submit extra materials under provisions of Division 1 and Section 260500

Furnish five of each panelboard key.

## PART 2 PRODUCTS

### 2.1 PANELBOARDS

- A. Phase sequence and balance.
  - 1. Phase sequence: A-B-C, left to right.
  - 2. Load balance: Distribute loads for maximum 10 percent difference.
- B. Each panelboard, and associated over current protection devices shall be of the same manufacturer.
- C. Each panelboard lock shall be operable by the same key.
- D. Each panelboard shall have a door – in – door.

### 2.2 BRANCH CIRCUIT PANELBOARDS

- A. Branch Panelboard Manufacturers - 240Y/120V:
  - 1. GE A series
  - 2. Siemens S1
  - 3. Square D NQOD
- B. Branch CircuitBreaker Manufacturers:
  - 1. GE.
  - 2. Siemens.
  - 3. Square D.
- C. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard, 600 amp maximum bus.
- D. Panelboard Bus: 1000 amp per sq.in. Copper, ampere and voltage ratings as indicated. Provide copper ground bus in each panelboard. Provide insulated ground bus where identified. Provide 200% rated neutral where identified.
- E. Minimum Short Circuit Rating: Fully rated, 10,000 amperes rms symmetrical for 208 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated, or as required to be greater than the available short circuit current.
- F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Shunt trip where indicated, Class A ground fault interrupter circuit breakers where indicated. Quantity and ratings as indicated. Do not use tandem circuit breakers.
- G. Main Circuit Breakers: NEMA AB 1, bolt-on type non-interchangeable thermal magnetic trip unit, two or three pole as required, top or bottom mounted as required, with shunt trip as required, and suitable for the voltage and amperage of the panelboard.
- H. Enclosure: NEMA PB 1, Galvanized steel finished inside and outside with

manufacturer's standard gray enamel. Type 1, 3R, or 4X as suitable for the location, 6 inches deep, 20 inches wide, minimum, or as required to accommodate the number of outgoing conduits. Door-in-door construction.

- I. Cabinet Front: Steel, flush or surface cabinet front as indicated, with concealed trim clamps, concealed hinge, metal directory frame, and flush lock. Finish in manufacturer's standard gray enamel.
- J. Sub-feed or feed-through lugs as scheduled.

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Install multiple pole circuit breakers below single pole circuit breakers.
- D. Height: 6 feet to top of panelboard unless otherwise indicated or as required for specific field conditions. Install panelboards taller than 6 feet with bottom not closer than 4 inches above floor, or provide concrete equipment base in accordance with 262416.
- E. Provide filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard under the provisions of Section 260553. Revise directory to reflect circuiting changes required to balance phase loads.
- G. Provide engraved plastic nameplates under the provisions of Section 260553.
- H. Ground and bond panelboard enclosure according to Section 260526

#### **3.2 CLEANING**

- A. Clean installed work under the provisions of Division 1.
- B. Clean interior of cabinets and enclosures to remove dust, debris, and other material.
- C. Clean surfaces and touch up scratched or marred surfaces to match original finish.

**- END OF SECTION-**



## SECTION 26 50 00 - LIGHTING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide luminaires and accessories, complete and operable, in accordance with the Contract Documents.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes

- NFPA 70 National Electric Code – 2017 Edition

- NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)

- UL-595 UL-924 Standard for Safety Emergency Lighting and Power Equipment

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish the following product information in accordance with the requirements of Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.

- B. Furnish the following information:

- 1. Interior Luminaires

- a. catalog data sheets
    - b. luminaire finish and metal gauge
    - c. lens material, pattern, and thickness
    - d. candlepower distribution curves in 2 or more planes
    - e. lumen output chart
    - f. mounting or suspension details
    - g. lens material, pattern, and thickness
    - h. IES lighting classification and isolux diagram
    - i. fastening details to wall or pole

- 2. Lamps

- a. voltages
    - b. colors
    - c. approximate life (in hours)
    - d. approximate initial lumens
    - e. lamp type

- 3. Drivers

- a. type
    - b. wiring diagram
    - c. nominal watts and input watts
    - d. input voltage

4. Photocells
  - a. voltage and wiring diagram
  - b. capacity
  - c. contacts and time delay
  - d. operating levels
  - e. enclosure type and dimensions

1.4 A sample of each "equal" fixture proposed for use shall be submitted to the ENGINEER for review, if requested.

## **PART 2 -- PRODUCTS**

### **2.1 LUMINAIRES**

#### **A. General**

1. Additional WORK requirements are indicated in the Luminaire Schedule on the Drawings.

B. Provide a feed-through type or separate junction box.

C. Provide minimum 18 AWG wire leads.

D. Provide components that are accessible and replaceable without removing the luminaire from its mounting.

#### **E. Emergency Lighting**

##### **1. Power Pack**

- a. self-contained
- b. 120/277 V
- c. dual voltage
- d. selectable input transformer
- e. 6 V sealed nickel-cadmium, lead-acid or lead-calcium battery (see Luminaire Schedule)
- f. indicator switch in accordance with the requirements of UL 924

2. Lighted, push-to-test pushbutton and indicator

3. Capability of providing full illumination for 1-1/2 hours in emergency mode

4. Capability of full recharge in 24 hours, automatically initiated upon resumption of normal line voltage

5. Capability of protecting against excess charging and discharging

6. LED lighting heads, as indicated

7. Solid state charger

8. Normal and emergency LED indicating lights

9. Mounting stand

10. Provide NEMA-rated enclosures in accordance with the area classifications in which they are installed.

F. Exit Signs

1. Internally illuminated
2. Universal mounting type
3. Internal 6 v maintenance free nickel-cadmium battery
4. Battery charger
5. LED-type emergency and normal indicating lights
6. Press-to-test button
7. Directional arrows
8. Red letters on a white panel, or as indicated

- G. The schedule and details of lighting fixtures, appearing on the Plans, indicate the type, construction, appearance, quality and performance of the fixtures required. Any proposed deviation from the fixtures specified must equal or be superior to the item specified under these headings. Proposed substitute lighting fixtures will be judged on overall quality on construction and on the basis of laboratory tests by the Electrical Testing Laboratory or similar independent testing facility. The fixture manufacturer's products scheduled are considered acceptable. The CONTRACTOR shall furnish, upon request of the ENGINEER, a set of fabrication plans, a set of photometric curves and a physical sample for review of every specific type offered.

2.2 LAMPS

A. LED

1. As indicated on the luminaire schedule on the drawings.

**PART 3 -- EXECUTION**

3.1 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.
2. Provide necessary hangers, pendants, canopies, and other accessories.

3. Install the luminaire plumb and level.
4. Install each luminaire outlet box with a galvanized stud.
5. Mechanical and Electrical Equipment Rooms: In the Mechanical and Electrical Equipment rooms, lighting fixtures shall be installed on ceilings or walls after all piping ductwork and equipment therein are installed. Exact location and switching for such fixtures will be determined at the job site during the course of the work. Fixtures shall be located so as to give maximum illumination to items of equipment requiring servicing, and moving machinery. Any lighting fixtures that are blocked, inaccessible or improperly located shall be relocated at no extra cost.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.

C. Finished Areas

1. Install the luminaires symmetrically with tile pattern.
2. Locate with the centerline of tile or with centerline of the joint between adjacent tile runs.
3. Install recessed luminaires tight to the finished surface such that no spill light will show between the ceilings and the sealing rings.
4. When installing on combustible low-density cellulose fiberboard, provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use luminaires suitable for mounting on low-density ceilings.

5. Junction Boxes

- a. Flush and Recessed Luminaires: Locate a minimum of one foot from the luminaire.
- b. In concealed locations, install junction boxes to be accessible by the removal of the luminaire.

6. Wiring and Conduit

- a. Provide wiring of a suitable temperature rating as required by the luminaire.
- b. Provide liquid tight flexible metal conduit, except in ceiling spaces used as air plenums, where flexible steel conduit meeting NEC requirements shall be used.

7. Provide plaster frames when required by ceiling construction.

8. Independent Supports

- a. Provide each recessed troffer luminaire with 2 safety chains or 2 No. 12

soft- annealed galvanized steel wires of length needed to secure the luminaire to the building structure, independent of the ceiling structure.

- b. Ensure that the tensile strength of chain or wire, and the method of fastening to the structure, is adequate to support the weight of the luminaire.
- c. Fasten the chain or wire to each end of the luminaire.
- d. Chains shall not be the primary supporting means.

D. Unfinished Areas

1. Locate the luminaires to avoid conflicts with other building systems and blockage of the luminaire light output.
2. Luminaire Suspension
  - a. Provide 3/8-inch threaded stainless steel hanger rods.
  - b. Scissor-type hangers will not be accepted.
3. For attachments to steel beams, provide flanged beam clips and straight or angled hangers.

3.2 LAMPS

- A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.3 CLEAN-UP

- A. Remove labels and other markings, except the UL listing mark.
- B. Wipe the luminaires inside and out in order to remove construction dust.
- C. Clean the luminaire plastic lenses with an antistatic cleaner only.
- D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.
- E. Replace defective lamps at the Date of Substantial Completion.

**- END OF SECTION -**

SUNSWEPT ISLES – CONTROL STRUCTURE  
TECHNICAL SPECIFICATIONS

ARCH CREEK 1

## SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated.
- C. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.
- D. The CONTRACTOR'S attention is directed to the requirement for proper coordination of the WORK of this Section with other trades sections.
- E. Equipment supports and foundations shall be in conformance with the requirements of Structural Specifications.

#### 1.2 REFERENCE STANDARDS

ANSI	American National Standards Institute
FBC	Florida Building Code 2020
NEC (NFPA 70)	National Electrical Code – 2017 Edition
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
NRTL	National Recognized Testing Laboratory

- A. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.
- B. Installation of electrical equipment and materials shall comply with state building standards, and applicable local codes and regulations, all as enforced by the Authority Having Jurisdiction (AHJ).
- C. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

#### 1.3 BASIS FOR WIRING DESIGNS

- A. The Contract Drawings and Specifications describe specific sizes of switches,

breakers, fuses, conduits, conductors, motor starters and other electrical equipment. These sizes are based on specific power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Wherever another trade provides power consuming equipment that differs from the Contract Documents, the wiring, conduits, starters, overcurrent devices, and other electrical devices that may be impacted shall be changed to proper sizes to match at no additional expense to the OWNER.

#### 1.4 SIGNAGE AND MARKINGS

##### A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

##### B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

##### C. Warning Signs

1. 600 Volts Nominal, or Less
  - a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.
2. Arc Flash Signage

#### 1.5 PERMITS AND INSPECTION

- A. Obtain permits and pay inspection fees according to the General Conditions.

#### 1.6 CONTRACTOR SUBMITTALS

##### A. General

1. Furnish submittals in accordance with Section 01 33 00 - Shop Drawings, product data, and samples.
2. Custom-prepare Shop Drawings.
3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.
4. Cross out options not proposed or delete from the Shop Drawings.

- B. Shop Drawings: Include the following as a minimum:



1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Shop drawings for grounding WORK not specifically indicated
3. Front, side, rear elevations, and top views with dimensional data
4. Location of conduit entrances and access plates
5. Component data
6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers
7. Types of materials and finish
8. Nameplates
9. Temperature limitations, as applicable
10. Voltage requirement, phase, and current, as applicable
11. Grounding requirements

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.
2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the ENGINEER a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.
2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Architectural Section for shop drawings requirements.
2. As-Built Drawings
  - a. A set of "Red-Lined" electrical drawings shall be carefully maintained at the job site. Actual conditions are to be put on the drawings in red on a daily basis so the Plans will continuously show locations and routings of cables, conduits, pull boxes, circuit numbers, and other information required by the ENGINEER. An

up-to-date copy of the "Red-Lined" Drawings shall be submitted to the OWNER by the CONTRACTOR once every two weeks. At the end of the Project, the CONTRACTOR shall turn over As-Built Drawings in AutoCAD format to the OWNER.

- b. Furnish the drawings to the ENGINEER in accordance with the requirements of Architectural Section for shop drawings requirements.
- c. Prepare As-Built Drawings of encased concealed and exposed raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

## 1.7 AREA DESIGNATIONS

### A. General

1. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections, unless indicated otherwise.

### B. Material Requirements

1. Construct NEMA 4X enclosures of Type 316 stainless steel, except in chlorine or hypochlorite areas or areas with ferric-based chemicals where non-metallic enclosures shall be provided.
2. Metallic NEMA 4X enclosures shall have a white, powder coated finish.
3. Construct NEMA 7 enclosures of cast aluminum where used with aluminum conduit.
4. Do not coat NEMA 7 and 9 enclosures.
5. Construct NEMA 1, 3R, and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

## 1.8 TESTS

- A. The CONTRACTOR shall be responsible for required factory and field as required by Engineer and other authorities having jurisdiction.
- B. Furnish necessary testing equipment.
- C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.
- D. Reporting
  1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
  2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.

3. Submit field test reports for review prior to Substantial Completion.
- E. Remove and replace equipment or material that fails a test, or, if the ENGINEER approves, repair and retested for compliance.
  - F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.
- 1.9 DEMOLITION AND RELATED WORK
- A. General
    1. Perform electrical demolition WORK as indicated.
    2. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical Contract Drawings.
    3. Coordinate with all trades and building management regarding electrical de-energization, disconnection, and removal, and the overall sequence of construction.
  - B. Electrical Requirements for Removed Equipment
    1. Remove dedicated wiring and exposed conduits back to the source.
    2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring. Remove power wiring from the power source to the first pullbox or manhole remote from the panel, and abandon in place the remaining wiring.
    3. Remove remote-mounted starters, disconnect switches, circuit breakers, sensors, and transmitters. Breakers in Panels that are not replaced or re-used shall be abandoned in place, and nameplates replaced to read, "SPARE".
  - C. Where new lighting and receptacles are installed, remove old lighting, receptacles, switches, wiring, and conduits, and replace in their entirety.
  - D. Junction Boxes
    1. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips.
    2. Provide a junction box with a NEMA rating in accordance with the area in which it is located, and sized as required.
    3. Properly identify wires and terminals before disconnection.
  - E. Removed materials and equipment not indicated to be returned to the OWNER shall, upon removal, become the CONTRACTOR'S property and shall be disposed of off- site.
  - F. Remove and relocate material and equipment indicated to be relocated or reused, and reinstall with care in order to prevent damage.
  - G. Place materials indicated to be returned to the OWNER in boxes, with the contents

clearly marked, and store at a location determined by the OWNER.

#### H. Identification

1. Where panelboards are indicated to have components, assemblies, or circuits removed and reconnected, provide the affected panel compartments with new engraved nameplates worded as indicated and matching the existing, or modify the panelboard schedule to indicate the revised circuits. Replace the panelboard schedule in its entirety if the existing schedule is unreadable or otherwise unusable.
2. Pencil or magic marker markings directly on the panelboard will not be accepted.

### 1.10 CONSTRUCTION SEQUENCING

#### A. General

1. Because the continuance of building operation during the renovation is critical, the CONTRACTOR shall carefully examine the WORK to be provided in, on, or adjacent to existing equipment.
2. Schedule the WORK in phases, subject to OWNER's approval, to minimize disruption to normal operations.
3. Submit a written sequencing request, including the sequence and duration of activities to be performed.
4. In no case shall the CONTRACTOR begin any WORK phase without written authorization from the OWNER.

#### B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.
2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.
3. Repair coatings to match the existing.
4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the WORK.

#### C. Field Verifications

1. Visit the Site before submitting a bid to become better acquainted with the WORK of this Contract.
2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.

3. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.

## **PART 2 -- PRODUCTS**

### **2.1 GENERAL**

- A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.
- B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.
- C. Provide similar items in the WORK as products of the same manufacturer.
- D. Provide equipment and materials of industrial grade standard of construction.
- E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.
- F. On devices indicated to display dates, display the year as 4 digits.
- G. Temperature Ratings of Equipment Terminations
  1. Provide terminations and lugs rated for use with 75-degree C conductors.
  2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

### **2.2 MOUNTING HARDWARE**

- A. Miscellaneous Hardware
  1. Provide nuts, bolts, and washers constructed of stainless steel.
  2. Provide threaded rods for trapeze supports constructed from continuous threaded stainless steel, 3/8-inch diameter minimum.
  3. Struts
    - a. Provide struts for mounting of conduits and equipment of aluminum except where additional strength is needed, then use 316 stainless steel. Coat the back of aluminum struts with bitumastic coating where it comes in contact with concrete.
    - b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
    - c. Do not use aluminum strut for free-standing support frames. Use 316 stainless

steel except in chlorine, hypochlorite or ferric areas where FRP strut shall be used.

d. Strut Manufacturer, or Equal: **Unistrut; B-Line**

4. End Caps

a. Provide plastic protective end caps for all exposed metal strut ends.

b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860**

5. Anchors

a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

b. Wood plugs will not be accepted.

c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Hilti**.

### **PART 3 -- EXECUTION**

#### **3.1 GENERAL**

##### **A. Incidentals**

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.
2. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

##### **B. Field Control of Location and Arrangement**

1. The Contract Drawings diagrammatically indicate the desired location and arrangement of loads, conduit runs, equipment, and other items.
2. Exact locations shall be determined by the CONTRACTOR in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.
3. Follow the locations on the Contract Drawings, however, as closely as possible.
4. Conduits
  - a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.
  - b. Provide exposed or encased routings as indicated, except conceal conduit in

finished areas unless indicated otherwise.

5. Placement

- a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.
- b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.
- c. Where exact locations are not indicated, such locations will be determined by the ENGINEER.
- d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.
- e. Slightly adjust luminaire locations based on actual field conditions in order to avoid obstructions and to minimize shadows, and update As-Built Drawings accordingly.

6. Circuits

- a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.
- b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).
- c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

7. Workmanship

- a. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer, and using workers skilled in the WORK.
- b. Coordinate installation in the field with other trades in order to avoid interferences.

8. Protection of Equipment and Materials

- a. Fully protect materials and equipment against damage from any cause.
- b. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.
- c. Keep moving parts clean and dry.

- d. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

### 3.2 CORE DRILLING

- A. Perform core drilling as required for the installation of raceways through concrete walls and floors.
- B. Base the locations of floor penetrations, as may be required, on field conditions.
- C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.
- D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities.
- E. Repair damage to walls, floors, encased conduits, wiring, and piping as part of the WORK.

### 3.3 CONCRETE HOUSEKEEPING PADS AND CURBS

- A. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.
- B. Extend housekeeping curbs to 4 inches above the finished floor or grade.

### 3.4 EQUIPMENT ANCHORING

- A. Floor-supported, wall, or ceiling-hung equipment and conductors shall be anchored in place by approved method in the area where the Project is located.
- B. Provide wall-mounted panels that weigh more than 500 pounds with fabricated steel support pedestals.
- C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.
- D. Provide transformers hung from 4-inch stud walls with auxiliary floor supports.
- E. Provide leveling channels anchored to the concrete pad for switchgear and pad-mounted transformer installations.
- F. Manufacturer's Recommendations
  - 1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract.
  - 2. Submit such recommendations as Shop Drawings as indicated.

### 3.5 CLEANING



- A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.
- B. Remove temporary tags, markers, stickers, and the like.
- C. Remove oil and grease spots with a non-flammable cleaning solvent, by carefully wiping and scraping cracks and corners.
- D. Apply touch-up paint to scratches on panels and cabinets.
- E. Vacuum-clean electrical cabinets and enclosures.
- F. Clean luminaires inside and out.
- G. Dispose cleaning debris and refuse off-Site.

**- END OF SECTION -**

## SECTION 26 05 19 - WIRE AND CABLE

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit Shop Drawings in accordance with Division 1 and 26 00 00 – ELECTRICAL WORK, GENERAL.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

#### 2.2 LOW VOLTAGE WIRE AND CABLE

##### A. Power and Lighting Wire

1. Wire rated for 600 volts in conduit for power and lighting circuits shall be type XHHW-2 rated 90 degrees C suitable for wet locations except where required otherwise by the plans.
2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drops on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
4. Wiring for 600 volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.

## B. Control Wire

1. Control wire in conduit shall be the same type as power and lighting wire indicated above.
2. Control wiring shall be #14 AWG, except for current transformer secondary conductors which shall be #12 AWG minimum.
3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable**, or equal.
4. All control wiring of 10 or more #14 shall be preassembled as manufactured by **Clifford of Vermont, Inc.**, Quik-Pull, meeting the following requirements:
  - a. #14 AWG stranded copper XHHW-2, 600 Volt
  - b. Each conductor numbered every 1½ Inches
  - c. Sequential footage tape.
  - d. Round compact units, spiral configuration
  - e. UL listed. Custom wire assembly
5. Assemblies are identified as QP-10, 20 to 100 maximum. Example: Where QP-20 is shown it supersedes the count if 16#14 are shown.
6. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3090A**, similar by **General Cable**, or equal.
7. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3091A**, similar by **General Cable**, or equal.

## 2.3 CABLE SPLICES AND TERMINATIONS

- A. Where cable lugs are required for power cable terminations, utilize copper, capped, one-hole and two-hole compression lugs – **3M** Scotchlok 30000 and 31100 Series, **Penn Union** HBBLU and BLU, **Burndy** Hylug, or equal. Utilize compression tools as recommended by the manufacturer. Open-ended lugs (where the end of the stranded cable is exposed) are not acceptable for power cable terminations. Pressure type, twist-on connectors (wire nuts) will not be acceptable.
- B. Pre-insulated ring lugs for control conductors shall be **Thomas & Betts, Burndy**, or equal.
- C. General purpose insulating tape shall be **Scotch No. 33, Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M**, or equal.

- D. Labels for coding 600 volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.
- E. No splices shall be permitted for low-voltage power cables.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

The CONTRACTOR shall provide, terminate and test all power, control, and instrumentation conductors.

The CONTRACTOR shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares.

### **3.2 INSTALLATION**

- A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.
- C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.
- D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

### **3.3 SPLICES AND TERMINATIONS**

#### **A. General**

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.
2. In general, there shall be no cable splices. Splices may be made only with the prior approval of the ENGINEER, and shall be performed in strict accordance with the cable and splice manufacturers' requirements. Splices will not be permitted for intra-building feeder or branch circuits.
3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug.
4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

#### **B. Control Wire and Cable**

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
2. In motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips. Where terminal strips require lugs, ring lugs shall be used. Fork-type lugs are not acceptable.
3. The CONTRACTOR shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR.
2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape.
3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The CONTRACTOR shall submit the proposed termination procedure as a Shop Drawing.

3.4 CABLE IDENTIFICATION. Also refer to Section 26 05 53 – ELECTRICAL IDENTIFICATION).

A. **General:** Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

B. **Identification Numbers:** The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on As-Built Drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control and Instrumentation Conductors" shall be defined as any conductor used for control, interlock, alarm, annunciator, or signal purposes.

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
2. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The

480/277 volt system conductors shall be color coded as follows: Phase A- Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs. Any phase changes necessary for proper rotation shall be made at the driven equipment and not in the local disconnect.

3. General purpose AC control cable shall be red. General purpose DC control cable shall be blue. DC power wiring shall be red for positive conductors (+) and black for negative conductors (-).
4. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
5. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

### 3.5 TESTING

- A. **Cable Assembly and Testing:** Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Division 1, prior to shipment of cable. The following field tests shall be the minimum requirements:
  1. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
  2. Field testing shall be done after cable is installed in the raceways.
  3. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.
  4. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.
- B. **Continuity Test:** Control cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

**- END OF SECTION -**

## SECTION 26 05 26 – GROUNDING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide the electrical grounding, complete and operable, as indicated in accordance with the Contract Documents.
- B. The requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL apply to this Section.
- C. Single Manufacturer
  - 1. 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.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Division 1 and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Equipment Grounding Circuit Conductors
  - 1. The conductors shall be the same type and insulation as the load circuit conductors.
  - 2. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.
  - 3. Metallic conduit systems shall have an equipment grounding wire as well as being equipment grounding conductors themselves.

### PART 3 -- EXECUTION

#### 3.1 GROUNDING

- A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.
- B. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.
- C. Route the conductors inside the raceway.

- D. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each panelboard.
- E. Individually bond the raceway to the ground bus in the secondary section.
- F. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.
- G. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.
- H. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.
- I. Low Voltage Grounded System (600V or less)
  - 1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.
  - 2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.
  - 3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.
  - 4. The termination of the shield drain wire shall be on its own terminal screw.
  - 5. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.
  - 6. Connect the ground bus via a green #12 conductor to the main ground bus for the panel.

### 3.2 TESTING

#### A. Fall-of-Potential Test

- 1. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
- 2. Main ground electrode system resistance to ground to be no greater than 3 ohms.

#### B. Two-Point Direct Method Test



1. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames and system neutral and derived neutral points.
  2. Equipment ground resistance not to exceed main ground system resistance by 0.25 ohms.
- C. Test several points of the system including: The neutral of every voltage level used in the system, enclosure of switchgears, motor control centers and panelboards and metal enclosure of outlet or fixture at remote location designated by the ENGINEER. Initial resistance to ground shall not be over 2.5 ohms for water pipe grounds and 15 ohms for made grounds.

**- END OF SECTION -**

## SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.
- B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- B. Shop Drawings
  - 1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.
  - 2. Submit dimensioned layout drawings of cable tray routings, including elevations.
  - 3. As-Built Drawings
    - a. Prepare as-built drawings of encased concealed and exposed raceways, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.
    - b. Furnish the drawings to the ENGINEER in accordance with the requirements of Division 1.

### PART 2 -- PRODUCTS

#### 2.1 METAL CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.
  - 2) Alflec Inc.
  - 3) Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4) Anamet Electrical, Inc.; Anaconda Metal Hose.

- 5) Electri-Flex Co.
  - 6) Manhattan/CDT/Cole-Flex.
  - 7) Maverick Tube Corporation.
  - 8) O-Z Gedney; a unit of General Signal.
  - 9) Wheatland Tube Company.
- c. Rigid Steel Conduit: ANSI C80.1.
  - d. Aluminum Rigid Conduit: ANSI C80.5.
  - e. IMC: ANSI C80.6.
  - f. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    - 1) Comply with NEMA RN 1.
    - 2) Coating Thickness: 0.040 inch (1 mm), minimum.
  - g. EMT: ANSI C80.3.
  - h. FMC: Zinc-coated steel.
  - i. LFMC: Flexible steel conduit with PVC jacket.
  - j. 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.
    - 1) Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
    - 2) Fittings for EMT: Steel type.
    - 3) Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
  - k. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## 2.2 NONMETALLIC CONDUIT AND TUBING

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) AFC Cable Systems, Inc.

- 2) Anamet Electrical, Inc.; Anaconda Metal Hose.
- 3) Arnco Corporation.
- 4) CANTEX Inc.
- 5) CertainTeed Corp.; Pipe & Plastics Group.
- 6) Condux International, Inc.
- 7) ElecSYS, Inc.
- 8) Electri-Flex Co.
- 9) Lamson & Sessions; Carlon Electrical Products.
- 10) Manhattan/CDT/Cole-Flex.
- 11) RACO; a Hubbell Company.
- 12) Thomas & Betts Corporation.

- c. ENT: NEMA TC 13.
- d. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- e. LFNC: UL 1660.
- f. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- g. Fittings for LFNC: UL 514B.

### 2.3 METAL WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper B-Line, Inc.
  - 2) Hoffman.
  - 3) Square D; Schneider Electric.
- c. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 3R, unless otherwise indicated.
- d. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- e. Wireway Covers: Screw-cover type.
- f. Finish: Manufacturer's standard enamel finish.

## 2.4 NONMETALLIC WIREWAYS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Hoffman.
  - 2) Lamson & Sessions; Carlon Electrical Products.
- c. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- d. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- e. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

## 2.5 SURFACE RACEWAYS

- a. Surface Metal Raceways: Galvanized steel with snap-on covers. Prime coating, ready for field painting.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a) Thomas & Betts Corporation.
    - b) Walker Systems, Inc.; Wiremold Company (The).
    - c) Wiremold Company (The); Electrical Sales Division.
- b. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected manufacturer's standard colors.
  - 1) Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 2) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a) Butler Manufacturing Company; Walker Division.
  - b) Enduro Systems, Inc.; Composite Products Division.
  - c) Hubbell Incorporated; Wiring Device-Kellems Division.
  - d) Lamson & Sessions; Carlon Electrical Products.
  - e) Panduit Corp.
  - f) Walker Systems, Inc.; Wiremold Company (The).
  - g) Wiremold Company (The); Electrical Sales Division.

## 2.6 BOXES, ENCLOSURES, AND CABINETS

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2) EGS/Appleton Electric.
  - 3) Erickson Electrical Equipment Company.
  - 4) Hoffman.
  - 5) Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6) O-Z/Gedney; a unit of General Signal.
  - 7) RACO; a Hubbell Company.
  - 8) Robroy Industries, Inc.; Enclosure Division.
  - 9) Scott Fetzer Co.; Adalet Division.
  - 10) Spring City Electrical Manufacturing Company.
  - 11) Thomas & Betts Corporation.
  - 12) Walker Systems, Inc.; Wiremold Company (The).
  - 13) Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- c. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- d. Cast-Metal Outlet and Device Boxes: NEMA FB 1, [ferrous alloy] Type FD, with gasketed cover.
- e. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- f. Metal Floor Boxes: Cast metal , fully adjustable, rectangular.
- g. Nonmetallic Floor Boxes: Nonadjustable, round.
- h. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- i. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, [galvanized, cast iron] with gasketed cover.

- j. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  - 1) Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2) Nonmetallic Enclosures: Plastic

## EXECUTION

### 2.7 GENERAL

- A. Run wiring in raceway unless indicated otherwise.
- B. Install raceways between equipment as indicated.
- C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.
- D. Bends and Offsets
  - 1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.
  - 2. Provide factory elbows wherever possible.
- E. Combined Raceways
  - 1. Raceways other than those containing power conductors may be combined in strict accordance with the NEC and with prior written permission from the ENGINEER.
  - 2. In general, combine only raceways containing the same type (control, signal, and the like) and voltage of conductors/cables, or dedicated conduits from one source to one device/equipment, in accordance with the NEC.
  - 3. Permission from the ENGINEER shall not relieve the CONTRACTOR of responsibility to meet national, state and local requirements.
  - 4. Do not combine wiring for redundant systems into single raceways.
- F. Routing
  - 1. Where raceway routings are indicated, follow those routings to the extent possible.
  - 2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and provided in strict accordance with the NEC as well as customary installation practice.

3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.
  4. Adjust routings in order to avoid obstructions.
- G. Coordination
1. Coordinate between trades prior to installing the raceways.
  2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.
- H. Support wireways in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – ELECTRICAL WORK, GENERAL.
- I. Install exposed raceways parallel or perpendicular to structural beams.
- J. Install exposed raceways at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.
- K. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

## 2.8 CONDUIT

- A. Size
1. Provide exposed conduit of 3/4-inch minimum trade size.
  2. Provide encased conduit of one-inch minimum trade size.
- B. Install supports at distances required by the NEC.
- C. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.
- D. Penetrations
1. Provide conduit passing through walls or floors with plastic sleeves.
  2. Perform core drilling in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL.
  3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.



- E. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.
- F. Coat threads with a conductive lubricant before assembly.
- G. Joints
  - 1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.
  - 2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.
  - 3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.
  - 4. Replace conduit with wrench marks.
- H. Slope
  - 1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.
  - 2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.
  - 3. Take extreme care in order to avoid pockets or depressions in the conduit.
- I. Installation of rigid conduit through a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.
- J. Connections
  - 1. Make connections to lay-in-type grid lighting fixtures by using flexible metal conduit not exceeding 4 feet in length.
  - 2. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.
  - 3. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.
- K. Empty Conduits
  - 1. Tag empty conduits at both ends to indicate the final destination.
  - 2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.
  - 3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

L. Identification of Conduits

1. Identify conduits at ends and at pulling points.
2. Identification shall be the unique conduit number assigned in the Contract Documents.
3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.
5. Provide conduit identification by a stamped or engraved non-corroding stainless steel metal tag attached to the conduit bushing.
6. Provide an engraved phenolic nameplate in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.
7. Markings with a pen or paint will not be accepted.

M. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.
2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the CONTRACTOR shall assign one following the numbering scheme used in the Contract Documents.
3. Provide box identification by a stamped or engraved stainless steel non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, and attached to the box or enclosure.
4. Markings with a pen or paint will not be accepted.

- N. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

**- END OF SECTION -**

## SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

##### A. Scope

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### B. Coordination

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with wire labels, wire color coding, terminal block labels, conduit identification, legend plates, nameplates and other identification for electrical apparatus.

##### C. Related Sections

1. Section 26 00 00 – ELECTRICAL WORK, GENERAL.

#### 1.2 CONTRACTOR SUBMITTALS

##### A. Shop Drawings: Furnish submittals in accordance with Division 1.

1. Comply with the requirements below. Submit for approval of the following:
  - a. The complete description and enumeration of proposed electrical identification devices shall be shown on the Shop Drawings for the associated equipment or systems.

##### B. Product Data:

1. Manufacturer's cut sheet, specifications, dimensions and technical data for all products proposed to be furnished under this Section.
2. Any deviation shall be explicitly noted.

##### C. Samples:

1. Nameplates: Samples of nameplates shall be submitted and shall include both applied and unapplied wire and cable label samples. These samples shall be used as quality standards for the wire and cable labeling required by this Section. These samples shall be of material specified in this Section and shall include wire and cable designators meeting the requirements of this Section.

- D. Wiring diagrams annotated with wire numbers and terminal numbers shall be submitted prior to commissioning of associated equipment or systems.
- E. Project Record Documents:
  - 1. Submittals of Record Documents required by other Sections shall show final electrical identification and electrical identification devices.

## **PART 2 -- PRODUCTS**

### **2.1 MANUFACTURED UNITS**

#### **A. Engraved Identification Devices (Nameplates, and Legend):**

##### **1. Nameplates:**

- a. The following items shall be equipped with nameplates: All motors, motor starters, pushbutton stations, control panels, time switches, disconnect or relays in separate enclosures, transformers, receptacles, wall switches boxes and cabinets. All light switches and outlets shall carry a phenolic plate with the supply circuit panel I.D. and circuit number. Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.
- b. 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 motor nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and local control station nameplates for that machine. Nameplates shall be laminated phenolic plastic, white front and back with black core, with lettering etched through the outer covering; black engraved letters on white background. Lettering shall be 3/16 inch high at local control stations, receptacles, wall switches and similar devices, where the nameplate is attached to the device plate. At all other locations, lettering shall be 1/4 inch high, unless otherwise detailed on the Plans. Nameplates shall be securely fastened to the equipment with No. 4 Phillips, rough-head, cadmium- plated, steel self-tapping screws or nickel-plated brass bolts. For applications on NEMA 4X enclosures, nameplates shall be attached using an epoxy-based adhesive that is resistant to oil and moisture. Motor nameplates may be non-ferrous metal not less than 0.03 inch thick, die stamped. In lieu of separate plastic nameplates, engraving directly on device plates is acceptable. Engraved lettering shall be filled with contrasting enamel. Equipment nameplate schedule for all equipment shall be submitted with Shop Drawing submittal for Engineer's approval.
- c. All junction and splice boxes shall be labeled.

#### **B. Conduit Labels:**

##### **1. Products and Manufacturers:**

- a. **B-915 Series by Brady**, or approved equal.
  - b. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit diameters through five inches or pre-molded to conform to circumference of six-inch conduit.
  - c. Strap-on style for 6-inch conduit shall be attached with stainless steel springs.
  - d. Shall be blank for use with custom printed labels.
  - e. Labels shall be color coded as follows:
    - 1) Power Conduits (600V and less) – Orange
    - 2) Control/Instrumentation – Light Blue
    - 3) Telephone/Intercom – Yellow
    - 4) Data - White
- C. Custom Labels:
1. Shall have black lettering on yellow background
  2. Shall not contain abbreviations in legend
  3. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.
- D. Wire Identification:
1. All wire and cable shall be identified at each termination point and at each pull box, terminal box and manhole. Provide permanent, waterproof, non-metallic (paper unacceptable) tags indicating the circuit number in 3/16 inch letters. Circuit numbers shall be protected with clear shrinkable tubing.
  2. All 120 VAC and lower control circuits shall use vinyl, self-laminating, self-adhesive, wrap type labels that are heat, oil, water, and solvent resistant wire markers. Labels shall be by **Brady**, or approved equal (**Brady** XPS-187-1 and XPS-375-1, as applicable, based on wire size). Wire numbers shall be solid machine printed, and shall not be pieced from other single or double-digit tags.
  3. Where wire numbers change, the appropriate drawings shall include both wire numbers, clearly indicated, at the point of transition. Drawings shall also identify the insulation color for all wiring.
  4. Conductor Identification: Each conductor shall be identified by a 2-line identification. Line 1: X-Y, where X is a unique number and Y is the location of the termination in the cabinet you are looking at; Line 2: A-B, where A is a unique number (which should usually match the X in Line 1), and B is the location of the termination at the other end of the conductor. The termination locations are typically on terminal

- blocks with identifications such as "TB2-1". The CONTRACTOR shall coordinate with the OWNER regarding all conductor identifications prior to installation.
5. All terminals and terminal strips and posts shall be identified with terminal block markers.
  6. All wire labels shall be clearly visible and not hidden by wire duct or other components in the enclosures.
  7. PLC/DCS/RTU panel wire tag format and content shall be provided by the OWNER.

## 2.2 FABRICATION

### A. Engraved Identification Devices (Nameplates and Legend Plates):

1. All nameplate text shall remain preliminary and subject to change pending final review and acceptance of the nomenclature by the OWNER after commissioning. Temporary tags consisting of removable tape or other accepted material with the preliminary nomenclature legibly hand lettered shall be affixed to enclosures and cover plates to identify the enclosures and mounted components as required during assembly, factory testing, and start-up. Laminated plastic nameplates shall not be engraved until after commissioning of the associated system and release of final engraving information by the OWNER.

## PART 3 -- EXECUTION

### 3.1 INSPECTION

- A. CONTRACTOR shall examine the conditions under which the work is to be installed and notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Electrical identification shall be provided as shown, specified or required.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
  1. Temporary tags shall be provided at all locations until after start-up and release of final engraving information by OWNER.
  2. Unless otherwise specified, permanent nameplates shall be attached with a permanent adhesive and with stainless steel machine screws into drilled and tapped holes.
  3. A nameplate with 1-1/2 inch letters shall be provided to identify each console, cabinet, panel, or enclosure as shown or specified.
  4. Nameplates with 1/2 inch letters shall be provided to identify each junction and terminal box as shown or specified.

5. On switchgear, nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments.
  - a. A nameplate with 1-inch letters shall be provided giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number and item number.
  - b. The individual door for each compartment shall be identified with a nameplate giving them designation and circuit number as well as frame ampere size and appropriate trip rating.

C. Motor Control Centers:

1. A nameplate with 1-inch letters shall be provided giving motor control center designation.
2. The individual door for each unit compartment shall be identified with a nameplate identifying the controlled equipment, including the tag number indicated on the Contract Drawings.

D. Except conduit, all other electrical appurtenances including, but not limited to, lighting panels, convenience outlets, fixtures and lighting switches, shall be provided nameplates indicating the appropriate circuit breaker number(s).

E. Safety Sign and Voltage Markers:

1. Safety signs and voltage markers shall be provided on and around electrical equipment as specified and where shown.
2. Rigid safety signs shall be installed using stainless steel fasteners.
3. Surfaces shall be cleaned before application of pressure sensitive signs and markers.
4. Low voltage safety signs shall be mounted on all equipment doors providing access to uninsulated 480-volt conductors (including terminal devices).
5. Low voltage markers shall be installed on each terminal box, safety disconnect switch and panelboard installed, modified or relocated and containing 120/208-volt conductors.

F. Conduit Labels:

1. All conduits shall be provided with conduit labels unless otherwise specified.
2. Flexible conduit shall not be labeled.

3. Exposed single conduit runs of less than 25 feet between local disconnect switches and the equipment they operate shall not be labeled.
4. Conduit labels shall convey the following information:
  - a. Contract Number: Alphanumeric.
  - b. Conduit Number: Alphanumeric. Leftmost character shall be the uppercase letter "C", remaining characters shall be a unique combination for each conduit, as shown on the Drawings and in accordance with conforming submittals.
5. Conduit labels shall be installed at the following locations:
  - a. Where conduit enters or exits walls, ceilings, floors, or slabs.
  - b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
  - c. At intervals of not more than 50 feet along the length of the conduit.
6. Conduit labels shall be oriented so as to be readable, standing on the floor near the conduit.
7. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.
8. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

G. Wire and Cable Identification:

1. Color-coding of insulated conductors and identification shall comply with Section 26 05 19 – WIRES AND CABLES.
2. Wire and Cable Labels shall be provided as follows:
  - a. New, re-routed, or revised wire or cable shall be labeled.
  - b. All insulated conductors shall be labeled.
  - c. Bare (non-insulated) conductors shall not be labeled unless otherwise shown or specified.
  - d. Wire and cable terminations shall be labeled.
3. Wire labels shall be applied between ½ and 1 inch of the completed termination.



4. Cable labels shall be applied between  $\frac{1}{2}$  and 1 inch of cable breakout into individual conductors.
  - a. Individual conductors in a cable shall be labeled after the breakout as specified for wires
5. Wire or cable exiting cabinets, consoles, panels, terminal boxes and enclosures shall be labeled.
  - a. Wires or cables shall be labeled within two inches of the entrance to the conduit.
6. Wire and cable installed in electrical manholes shall be labeled.
  - a. Wire and cable shall have wrap-around labels applied within one foot of exiting the manhole.
7. Wire and cable labels shall be installed when the wire or cable is pulled and prior to termination of the conductors. Installation of wire and cable labels after the conductors are terminated is not permitted.

**- END OF SECTION -**

## SECTION 262416 – PANELBOARDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including Conditions of the Contract and Division 1 of the Specifications, apply to the work in this Section.
- B. This Section is hereby made a part of all other sections of Division 260000 as fully as if repeated in each therein.

#### 1.2 SECTION INCLUDES

- A. Branch circuit panelboards.

#### 1.3 RELATED SECTIONS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260553 - Electrical Identification.

#### REFERENCES

- A. NECA – “Standard of Installation”.
- B. NEMA AB1 - Molded Case Circuit Breakers.
- C. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.
- D. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- E. NEMA PB 1 - Panelboards.
- F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- H. NFPA 70 - National Electrical Code.

#### 1.4 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 260500.
- B. Product Data: Provide for panelboards, fusible switches, and circuit breakers.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch

arrangement and sizes.

- D. Manufacturers' Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- E. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- F. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70, unless otherwise specified.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

## 1.7 COORDINATION

- A. Coordinate under provisions of Division 1.
- B. Field Measurements: Verify that field measurements are as shown on Drawings.
- C. Field Locations: Verify locations of panelboards prior to rough-in.

## 1.8 DELIVERY, STORAGE, PROTECTION, AND HANDLING

- A. Protect from moisture by using appropriate coverings. Store in dry interior locations.
- B. Do not install until building is closed in and suitable temperature conditions are controlled.
- C. Maintain suitable temperature and humidity conditions during and after installation of panelboards.

## 1.9 EXTRA MATERIALS

- A. Submit extra materials under provisions of Division 1 and Section 260500

Furnish five of each panelboard key.

## PART 2 PRODUCTS

### 2.1 PANELBOARDS

- A. Phase sequence and balance.
  - 1. Phase sequence: A-B-C, left to right.
  - 2. Load balance: Distribute loads for maximum 10 percent difference.
- B. Each panelboard, and associated over current protection devices shall be of the same manufacturer.
- C. Each panelboard lock shall be operable by the same key.
- D. Each panelboard shall have a door – in – door.

### 2.2 BRANCH CIRCUIT PANELBOARDS

- A. Branch Panelboard Manufacturers - 240Y/120V:
  - 1. GE A series
  - 2. Siemens S1
  - 3. Square D NQOD
- B. Branch CircuitBreaker Manufacturers:
  - 1. GE.
  - 2. Siemens.
  - 3. Square D.
- C. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard, 600 amp maximum bus.
- D. Panelboard Bus: 1000 amp per sq.in. Copper, ampere and voltage ratings as indicated. Provide copper ground bus in each panelboard. Provide insulated ground bus where identified. Provide 200% rated neutral where identified.
- E. Minimum Short Circuit Rating: Fully rated, 10,000 amperes rms symmetrical for 208 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated, or as required to be greater than the available short circuit current.
- F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Shunt trip where indicated, Class A ground fault interrupter circuit breakers where indicated. Quantity and ratings as indicated. Do not use tandem circuit breakers.
- G. Main Circuit Breakers: NEMA AB 1, bolt-on type non-interchangeable thermal magnetic trip unit, two or three pole as required, top or bottom mounted as required, with shunt trip as required, and suitable for the voltage and amperage of the panelboard.
- H. Enclosure: NEMA PB 1, Galvanized steel finished inside and outside with

manufacturer's standard gray enamel. Type 1, 3R, or 4X as suitable for the location, 6 inches deep, 20 inches wide, minimum, or as required to accommodate the number of outgoing conduits. Door-in-door construction.

- I. Cabinet Front: Steel, flush or surface cabinet front as indicated, with concealed trim clamps, concealed hinge, metal directory frame, and flush lock. Finish in manufacturer's standard gray enamel.
- J. Sub-feed or feed-through lugs as scheduled.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."
- B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- C. Install multiple pole circuit breakers below single pole circuit breakers.
- D. Height: 6 feet to top of panelboard unless otherwise indicated or as required for specific field conditions. Install panelboards taller than 6 feet with bottom not closer than 4 inches above floor, or provide concrete equipment base in accordance with 262416.
- E. Provide filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard under the provisions of Section 260553. Revise directory to reflect circuiting changes required to balance phase loads.
- G. Provide engraved plastic nameplates under the provisions of Section 260553.
- H. Ground and bond panelboard enclosure according to Section 260526

### **3.2 CLEANING**

- A. Clean installed work under the provisions of Division 1.
- B. Clean interior of cabinets and enclosures to remove dust, debris, and other material.
- C. Clean surfaces and touch up scratched or marred surfaces to match original finish.

**- END OF SECTION-**

## SECTION 26 50 00 - LIGHTING

### PART 1 -- GENERAL

#### 1.1 THE SUMMARY

- A. Provide luminaires and accessories, complete and operable, in accordance with the Contract Documents.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Codes

- NFPA 70 National Electric Code – 2017 Edition

- NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)

- UL-595 UL-924 Standard for Safety Emergency Lighting and Power Equipment

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish the following product information in accordance with the requirements of Division 1, and Section 26 00 00 – ELECTRICAL WORK, GENERAL.

- B. Furnish the following information:

- 1. Interior Luminaires

- a. catalog data sheets
    - b. luminaire finish and metal gauge
    - c. lens material, pattern, and thickness
    - d. candlepower distribution curves in 2 or more planes
    - e. lumen output chart
    - f. mounting or suspension details
    - g. lens material, pattern, and thickness
    - h. IES lighting classification and isolux diagram
    - i. fastening details to wall or pole

- 2. Lamps

- a. voltages
    - b. colors
    - c. approximate life (in hours)
    - d. approximate initial lumens
    - e. lamp type

- 3. Drivers

- a. type
    - b. wiring diagram
    - c. nominal watts and input watts
    - d. input voltage

4. Photocells
  - a. voltage and wiring diagram
  - b. capacity
  - c. contacts and time delay
  - d. operating levels
  - e. enclosure type and dimensions

1.4 A sample of each "equal" fixture proposed for use shall be submitted to the ENGINEER for review, if requested.

## **PART 2 -- PRODUCTS**

### **2.1 LUMINAIRES**

#### **A. General**

1. Additional WORK requirements are indicated in the Luminaire Schedule on the Drawings.

B. Provide a feed-through type or separate junction box.

C. Provide minimum 18 AWG wire leads.

D. Provide components that are accessible and replaceable without removing the luminaire from its mounting.

#### **E. Emergency Lighting**

##### **1. Power Pack**

- a. self-contained
- b. 120/277 V
- c. dual voltage
- d. selectable input transformer
- e. 6 V sealed nickel-cadmium, lead-acid or lead-calcium battery (see Luminaire Schedule)
- f. indicator switch in accordance with the requirements of UL 924

2. Lighted, push-to-test pushbutton and indicator

3. Capability of providing full illumination for 1-1/2 hours in emergency mode

4. Capability of full recharge in 24 hours, automatically initiated upon resumption of normal line voltage

5. Capability of protecting against excess charging and discharging

6. LED lighting heads, as indicated

7. Solid state charger

8. Normal and emergency LED indicating lights

9. Mounting stand

10. Provide NEMA-rated enclosures in accordance with the area classifications in which they are installed.

F. Exit Signs

1. Internally illuminated
2. Universal mounting type
3. Internal 6 v maintenance free nickel-cadmium battery
4. Battery charger
5. LED-type emergency and normal indicating lights
6. Press-to-test button
7. Directional arrows
8. Red letters on a white panel, or as indicated

- G. The schedule and details of lighting fixtures, appearing on the Plans, indicate the type, construction, appearance, quality and performance of the fixtures required. Any proposed deviation from the fixtures specified must equal or be superior to the item specified under these headings. Proposed substitute lighting fixtures will be judged on overall quality on construction and on the basis of laboratory tests by the Electrical Testing Laboratory or similar independent testing facility. The fixture manufacturer's products scheduled are considered acceptable. The CONTRACTOR shall furnish, upon request of the ENGINEER, a set of fabrication plans, a set of photometric curves and a physical sample for review of every specific type offered.

2.2 LAMPS

A. LED

1. As indicated on the luminaire schedule on the drawings.

**PART 3 -- EXECUTION**

3.1 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.
2. Provide necessary hangers, pendants, canopies, and other accessories.



3. Install the luminaire plumb and level.
4. Install each luminaire outlet box with a galvanized stud.
5. Mechanical and Electrical Equipment Rooms: In the Mechanical and Electrical Equipment rooms, lighting fixtures shall be installed on ceilings or walls after all piping ductwork and equipment therein are installed. Exact location and switching for such fixtures will be determined at the job site during the course of the work. Fixtures shall be located so as to give maximum illumination to items of equipment requiring servicing, and moving machinery. Any lighting fixtures that are blocked, inaccessible or improperly located shall be relocated at no extra cost.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.

C. Finished Areas

1. Install the luminaires symmetrically with tile pattern.
2. Locate with the centerline of tile or with centerline of the joint between adjacent tile runs.
3. Install recessed luminaires tight to the finished surface such that no spill light will show between the ceilings and the sealing rings.
4. When installing on combustible low-density cellulose fiberboard, provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use luminaires suitable for mounting on low-density ceilings.

5. Junction Boxes

- a. Flush and Recessed Luminaires: Locate a minimum of one foot from the luminaire.
- b. In concealed locations, install junction boxes to be accessible by the removal of the luminaire.

6. Wiring and Conduit

- a. Provide wiring of a suitable temperature rating as required by the luminaire.
- b. Provide liquid tight flexible metal conduit, except in ceiling spaces used as air plenums, where flexible steel conduit meeting NEC requirements shall be used.

7. Provide plaster frames when required by ceiling construction.

8. Independent Supports

- a. Provide each recessed troffer luminaire with 2 safety chains or 2 No. 12

soft- annealed galvanized steel wires of length needed to secure the luminaire to the building structure, independent of the ceiling structure.

- b. Ensure that the tensile strength of chain or wire, and the method of fastening to the structure, is adequate to support the weight of the luminaire.
- c. Fasten the chain or wire to each end of the luminaire.
- d. Chains shall not be the primary supporting means.

D. Unfinished Areas

1. Locate the luminaires to avoid conflicts with other building systems and blockage of the luminaire light output.
2. Luminaire Suspension
  - a. Provide 3/8-inch threaded stainless steel hanger rods.
  - b. Scissor-type hangers will not be accepted.
3. For attachments to steel beams, provide flanged beam clips and straight or angled hangers.

3.2 LAMPS

- A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.3 CLEAN-UP

- A. Remove labels and other markings, except the UL listing mark.
- B. Wipe the luminaires inside and out in order to remove construction dust.
- C. Clean the luminaire plastic lenses with an antistatic cleaner only.
- D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.
- E. Replace defective lamps at the Date of Substantial Completion.

**- END OF SECTION -**

SECTION 13630

REMOTE TERMINAL UNITS

## SECTION 13630 – REMOTE TERMINAL UNITS

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. General: Work under this Section is subject to the requirements of the Contract Documents.
- B. This specification covers the technical requirements for the fabrication, installation, engineering, wiring, adjustment, testing, start-up, commissioning, and training for the remote terminal unit (RTU) required for:
  - Miami – Dade County Public Works Telemetry System  
Miami, Florida
- C. The RTU shall be provided complete, including all hardware, system cabling, network cabling, and installation which may be necessary for a complete and working system.
- D. The programming of the RTUs shall be covered under this contract.

#### 1.2 RELATED WORK

- A. Division 13: General Instrumentation and Control
- B. Division 13: Instrument Panel and Enclosure Construction.
- C. Division 16: Grounding
- D. Division 16: Wires and Cables

#### 1.3 QUALITY ASSURANCE

- A. Electrical Component Standards: Components and installation shall comply with the latest edition of NFPA 70, National Electrical Code (NEC).
- B. All work and materials of the remote terminal unit (RTU) systems shall be furnished by Emerson Process Management.
- C. Drawings and specifications shown are intended to convey information required for a complete control system for the purposes specified. The

System Integrator shall be responsible for all details (such as load resistors, surge protectors, signal isolators, interposing relays, etc.), which may be necessary to properly install, adjust, and place in operation a complete and working system.

- D. The System Integrator and the Contractor shall be responsible for all coordination between the RTU systems and the field mounted process equipment and instrumentation.
- E. Installation shall be in strict compliance with the equipment manufacturer's instructions. The System Integrator shall assume full responsibility for additional costs which may result from unauthorized deviation from these specifications and from the equipment manufacturer's instructions.

#### 1.4 SUBMITTALS

- A. Submittals shall comply with the Contract Documents. Shop drawings shall be submitted complete, in a single submittal. Partial submittals will be returned unchecked. Exceptions can only be made with prior approval from the Engineer.
- B. Submit shop drawings in the following sequence:
  - 1. Submit for approval: system hardware configuration block diagrams, equipment cut-sheets, and instruction bulletin for each type used.
- C. After system hardware configuration is reviewed, submit the following:
  - 1. Panel/enclosure shop drawings, which shall include front elevation, internal panel elevation, conduit hole penetrations, and panel bill of material. Each item of panel mounted equipment shall be shown.
  - 2. Panel wiring diagrams, which shall show input/output wiring and terminations, and panel power wiring and terminations.
  - 3. Detailed calculations, including power supply sizing calculation.
  - 4. Other descriptive information that will assist the Engineer with approval of the shop drawings.

5. Submit the RTU system and the operator interface system technical manuals and instruction bulletins, which shall include but not be limited to the following items:
  - a. Complete system overview
  - b. Programming instructions
  - c. Installation and start-up instructions
  - d. Trouble shooting instructions
  - e. Specifications of the various I/O devices
  - f. Specifications of the various programming devices

## 1.5 EQUIPMENT IDENTIFICATION AND TAG NUMBERS

All apparatus, control equipment and instruments, both panel and field mounted, shall be identified by engraved laminated labels. Description on the labels and methods of attachment shall be as approved by the Owner / Engineer during shop drawing approval. Labels shall be in accordance with Division 16 – Electrical Identification.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. RTU System: Emerson Bristol®,
  1. ControlWave-Micro or FB3000 for sites with utility supplied power.
  2. ControlWave-Micro or FB3000 for solar-powered sites
- B. All RTU panels to be manufactured and supplied by Emerson Bristol®.

### 2.2 GENERAL

- A. See Division 13 General Instrumentation and Controls for the Process Control Description.
- B. All input and output modules, racks, power supplies, etc. shall be by one RTU manufacturer.
- C. Racks or housings shall accept any mixture of inputs, outputs, communication cards, etc. as required. Dedicated racks for any I/O type are not acceptable.
- D. All input and output circuits shall be optically isolated from the RTU.

- E. Provide removable terminal strips to allow replacement of modules without disturbing panel wiring. Use wiring harnesses where available for connecting the I/O modules to the interposing relays.
- F. LED indicators shall show status of each I/O to aid in troubleshooting.
- G. Provide power supplies as required to operate and protect all I/O modules, communication cards, processors, remote I/O adapters, etc. as required.
- H. The equipment manufacturer shall provide remote-access and phone support to the Owner for a period of 1 year from the date of system delivery.

### 2.3 OVERVIEW

- A. The controller shall be an industrial-grade, microprocessor-based unit capable of accepting inputs from discrete (single point), analog, and high speed pulse data sources.
- B. The controller shall execute user-entered logic instructions from memory and perform output functions as required by the logic instructions to discrete, analog, parallel, and serial data outputs.
- C. The central processor unit (CPU) shall not require the use of external storage devices (i.e., disk drives) to execute user programs.
- D. The controller shall be fully modular in design and have a pin-and-socket connector for easy field upgrades or card placement.

### 2.4 CENTRAL PROCESSOR UNIT (CPU)

- A. The central processing unit shall be a single printed circuit board assembly utilizing surface mount technology.
- B. The CPU shall plug directly into the I/O base and have integral wiring to the base, power supply, and the local I/O system.
- C. The unit will have indicators on the front bezel that monitor the controller operation, the battery (if required), the status and the CPU's mode of operation.
- D. Shall include integral communication ports: Two(2) Ethernet, two(2) RS232, and two(2) RS485 ports.

## 2.5 MEMORY

- A. The standard user program storage medium shall consist of flash EPROMs. The flash EPROM shall store the RTU program plus all program documentation including symbols and ladder rung comments. All symbols and ladder rung comments must remain resident in the RTU memory.
- B. The CPU and associated memory shall be incorporated into the same printed circuit board assembly.
- C. Under normal operating conditions, the RAM or storage medium shall retain setpoint values for no less than six months in the event of power failure. Under normal operating conditions, the FLASH or storage medium shall retain a program for 5 years in the event of power failure.
- D. Main program memory size of 4 Mbytes minimum, with word lengths of 32 bits. Unit shall include an additional memory for data storage. The RTU must be able to store the program, plus all symbols and comments for the program.

## 2.6 COMMUNICATIONS

- A. Protocols: RTU shall natively communicate through ModBus, DF1, BSAP, HART, and/or **DNP3** SCADA Telemetry protocols. BSAP and/or DNP3 shall also provide complete access to RTU configuration and diagnostics.
- B. Sampling: RTU shall provide polled, report-on-exception (alarms/events), and report-by-exception (RBE) data-acquisition of SCADA signals.
- C. Media: RTU shall have built-in connections to Ethernet (RJ45), RS232 (D9), and RS485 (D9). RTU shall provide additional ports if needed by application or instrumentation.

## 2.7 PROGRAM EXECUTION

- A. Memory scan time shall be less than 0.1 milliseconds per 1000 Boolean instructions. The entire ladder logic program shall be completed once each scan. Each scan cycle shall allocate time to update all I/O, execute the program, communicate with special function I/O modules and execute specific task request.
- B. The processor shall be equipped with no less than 16,384 internal relay equivalents and shall be capable of employing Master Control Relays to perform program control functions.



- C. The processor shall contain no less than 65,536 variable memory registers, and each register shall be capable of storing 32-bit floating-point decimal values. Variable memory shall be have non-volatile backup.

## 2.8 TIMERS AND COUNTERS

- A. The controller shall have the capability of up to 4096 counters and 4096 timers. Each counter can store 32-bit floating-point values, and each timer shall be capable of storing double-integer values (milliseconds).

## 2.9 INPUTS AND OUTPUTS

- A. The system shall have the capacity to accommodate no less than 96 inputs or outputs in increments of four, eight, or sixteen points within rack limitations. Modules and their rack assemblies shall contain all circuitry for interfacing inputs and outputs to the controller.

- B. The I/O assemblies will provide mounting slots for the processor, power supply and I/O modules. The following standard I/O modules shall be utilized.

1. Discrete Inputs: 24 VDC, 16 point.
2. Discrete Outputs: 24 VDC, 16 point
3. Analog Inputs: 8 channel, isolated, accept 4-20 mA DC or 1-5 VDC input signals. Each channel pair shall be configurable.
4. Analog Outputs: 4 channel, isolated, individually configurable as 4-20 mA DC or 1-5 VDC.

- C. Provide interposing relays for all discrete inputs and outputs. See Div 13 Instrument Panel and Enclosure Construction sub-part Interposing Relays. Provide pre-wired cable assemblies where available for connecting the inputs and outputs to the interposing relays

- D. Provide signal isolation for all analog inputs and outputs. See specification "Instrument Panel and Enclosure Construction" sub-part "Signal Isolation and Protection". Provide pre-wired cable assemblies where available for connecting the inputs and outputs to the isolators

## 2.9 RATINGS

- A. Electrical

1. Input power supplied by a power supply module
2. Input Voltage Requirements: +5 VDC

B. Environmental

1. Operating Temperature: -40°C to 75°C (-40°F to 167 °F)
2. Storage Temperature: -40°C to 85°C (-40°F to 185°F)
3. Relative Humidity: IEC68-2-3; 5-95% non-condensing
4. Vibration: 1g over 10 to 150 — 0.5g over 150 to 200 Hz
5. Noise Immunity: NEMA (ICS-304) and EN 61326-1:2013

2.10 STANDARDS AND REGULATORY AGENCY APPROVALS

A. The CPU and associated racks, power supplies and I/O modules shall have major approvals include:

1. UL Listing
2. CSA Certification

2.11 RELAY LADDER INSTRUCTIONS

A. There shall exist, instructions which will skip any number of ladder logic rungs to a specified rung. There shall also exist, an end program instruction to skip all unprogrammed lines in memory.

B. There shall exist, discrete and motor alarm timer instructions which shall use a feedback loop to confirm control action occurrence. In the event control actions to not occur in the desired time, an alarm bit shall be set.

C. The RTU and its software shall provide all five programming languages standard as referenced by the PLC IEC 61131-3 standard.

D. Ladder logic documentation shall consist of one comment block for each output coil and a synonym for each contact or output coil. The I/O documentation shall display on a case-by-case basis what type module is in each slot and the synonym for each I/O point. All documentation shall be able to be printed out for reference (variable and constant memory documentation, program title), and stored in the RTU memory.

E. Ladder Logic Labeling

1. All inputs shall be labeled with a description that indicates its function when the input is "true", "energized", or "on". For example, "Sump Level GE 12 in." instead of "Sump Low Level". All descriptions shall be expressed in a positive fashion, i.e.,

"Shearpin Limit Switch OK", instead of "Shearpin Limit Switch Not Tripped".

2. Ladder logic contacts and coils shall be labeled in a similar fashion. Modify labels accordingly for normally closed contacts. Example, a normally open contact indicating "Sump Level GE 12 in." should become "Sump Level LT 12 in" for a normally closed contact.

- F. The system logic shall be structured into logical code blocks to facilitate future code revision and troubleshooting.

## 2.12 POWER SUPPLY AND BATTERIES

- A. Input power shall be 10.7 to 30 VDC from power supplies as specified in Division 13, Instrument Panel and Enclosure Construction.
- B. Provide diagnostic indication (LED) and alarm for memory backup battery.
- C. Provide capability for redundant configurations utilizing second or third power supply in critical areas of plant as specified. Provide failure detection.

## 2.13 SOFTWARE

- A. Transfer all software licenses and service to the Engineer

# PART 3 - EXECUTION

## 3.1 SYSTEM INSTALLATION

- A. The Contractor shall provide all materials and work necessary for a complete and functioning RTU system and shall have full coordination responsibility of the electrical, instrumentation and control, variable speed drives, mechanical, and structural work as specified in these specifications and/or shown on the drawings.
- B. The Contractor shall ensure that RTU system work is properly interfaced with equipment and other work not furnished by the system provider.
- C. The Contractor shall install, make final connections to, adjust, test, and start-up the complete RTU system utilizing the technical services of the system provider.

### 3.2 COMMISSIONING

- A. This activity shall consist of two sequential performance tests:
  - 1. Operational test
  - 2. Functional test
- B. The proposed format and documentation of these tests shall be submitted to the Engineer for review and comment prior to commencement of this activity.
- C. Each test shall be witnessed by representatives of the RTU system provider, the Contractor, the Engineer and the Owner.
- D. The objective of the Operational Test shall be to demonstrate that the RTU system is ready for final operation. The system shall be checked for proper installation, adjustment, and calibration on a loop-by-loop basis to verify that it is ready to function as specified.
- E. The objective of the Functional Test is to demonstrate that the RTU systems are operating properly and are in compliance with the specified performance requirement, and that the system is ready for use by the Engineer.

### 3.3 ACCEPTANCE

- A. Upon the successful completion of commissioning and training activities, the RTU system provider may request formal acceptance of the system.
- B. All plans, cd's, documentation, etc. to be given to the Engineer. Obtain receipt for same.
- C. Assist Engineer with transferring licensing of all software.
- D. Back-up and restore all programs and data after system is on-line. Train Engineer in procedure.

### 3.4 SPARE PARTS

- A. Provide the following spare parts.
  - 1. Provide 1 spare input/output cards of each type.
- B. Deliver all spare parts to the Engineer. Obtain receipt for same.

END OF SECTION 13630

SECTION 13660  
RADIO TELEMETRY SYSTEM

## SECTION 13660 - RADIO TELEMETRY SYSTEM

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. This specification section covers the technical requirements for the Radio Telemetry System as described in Division 13, "General Instrumentation and Control", and as shown on the Drawings.
- B. It is the intent of these specifications that all components necessary for a complete and functioning system shall be included. This includes but is not limited to the following: programming of all radios, maintenance software, mounting brackets, grounding systems, 120 VAC power surge suppressors, lightning arresters, poles, directional antennas, 12/24 VDC power supplies, enclosures, etc.
- C. The field radio path survey shall be complete before purchasing of radio and antenna equipment for that site.

#### 1.2 SUBMITTALS

- A. Submittals shall be as specified in the following specification sections:
- B. Division 01: General Requirements
- C. Division 13: General Instrumentation and Control
- D. Submit agenda for all coordination meetings at least one week in advance. Prepare and distribute meeting minutes within two weeks following each coordination meeting.
- E. Submit product brochures and installation guidelines on all radios, antennas, cables, grounding kits, mounting hardware, surge suppressors, diagnostic software, management software, etc.

#### 1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70 "National Electrical Code (NEC)", latest edition, for components and installation.
- B. Listing and Labeling: Provide products specified in this section that are listed and labeled as defined in NEC article #100.
- C. Comply with all Federal Communications Commission (FCC) requirements for a licensed 5-watt data telemetry radio system.

- D. Comply with all Federal Communications Commission (FCC) requirements for an unlicensed 1-watt spread spectrum data telemetry radio system.
- E. The radio manufacturer shall be certified as an ISO 9001 approved facility. A certificate of ISO 9001 registration shall be included with the bid documents.
- F. Company performing installation work shall have a minimum of 2 years' experience in wireless communications for SCADA systems.

#### 1.4 DEFINITIONS

- A. Bridge: A device for connecting different types of physical media networks, i.e. coaxial cable to twisted pair cable. Protocols are the same on both networks.
- B. Router: A managed Ethernet type switch that isolates traffic from one network to another. It provides network address translation (NAT) and may serve as firewall.
- C. Master / Access Point (AP): The transceiver in the network that provides synchronization information to one or more remote units.
- D. Latency: The delay expressed in milliseconds between when data is received at the input port of one radio and it appears at the output port of another radio.
- E. Slave / Remote: A transceiver in a network that communicates with an associated AP or master radio.

#### 1.5 GUARANTEE

- A. The radio vendor shall guarantee in writing that if it is contracted to plan, design, and deploy the wireless network: The radio network shall meet or exceed all promised levels of performance and functionality including accurate, complete coverage, signal strength, and data throughput.

#### 1.6 SERVICES PROVIDED BY OWNER

- A. Person designated as Engineer liaison. This person shall serve as the point of contact for the contractor and vendors.
- B. Copy of On-Site Radio Survey that includes the latitude and longitude in decimal format for all master, repeater and remote locations.
- C. Assistance in identifying other facilities, buildings, poles, etc. that can be used as master / repeater locations.

- D. Soils report prepared by a local testing firm.

## PART 2 - PRODUCTS

### 2.1 FIELD RADIO SURVEY

- A. The field radio survey will be provided.

### 2.2 MANUFACTURERS

- A. The radio manufacturer must be certified as an ISO 9001 approved facility. A certificate of ISO 9001 registration must be included with the bid documents.

- B. Radio Equipment

- 1. Microwave Data Systems (MDS), #9710A
  - 2. No substitutions will be allowed.

- C. Antennas

- 1. MDS Clearwave
  - 2. Dataradio
  - 3. Maxrad
  - 4. Andrew
  - 5. PCTEL
  - 6. Or approved equal

- D. Cables

- 1. Andrew Company, Heliex types FSJ and VXL
  - 2. Times Microwave Systems, type LMR-400, LMR-600, LMR-1200

- E. Antenna Cable Surge Arrestors

- 1. Polyphaser
  - 2. Phoenix Contact type CoaxTRAB
  - 3. Or approved equal

### 2.3 LICENSED LOW SPEED DATA RADIOS

- A. General

- 1. Integrated wireless modem hardware shall be supplied which complies with applicable Federal Communications Commission (FCC) or National Telecommunications and Information Administration (NTIA) requirements for FCC Part 15. The radio



and the modem must be packaged together and internally interfaced with each other.

2. Wireless modems shall operate within the 800 to 960 MHz frequency band.
3. On-line, non-intrusive RF network diagnostic monitoring shall be provided as a standard feature in the system architecture.
4. Wireless modem hardware of a 'packetized' design may not be used. Units shall be data transparent to allow for a minimum amount of data transmission latency, and to limit data transmission overhead thus to allowing the wireless modem to obtain the data rates specified.
5. The wireless modem hardware must be protocol transparent and independent. It must support 7 or 8 data bits, 1 or 2 stop bits, even, odd, or no parity in any combination. Communication port speeds shall be 9600 bps.
6. Units shall operate in a Master / Remote configuration.
7. Front panel mounted LED indicators shall be available for status monitoring. RUN/POWER, CS/SYN, RX/TX, AND RD/TD.
8. Separate data ports must be provided for both application data and for on-line, non-intrusive diagnostic monitoring.
9. Field configurable as 'Master' or 'Remote'.

B. Physical / Environmental

1. Shall operate on 10 to 16 VDC nominal
2. Operating temperature range: -30<sup>o</sup> C to +60<sup>o</sup> C.
3. Rated for Class 1 Division 2 environments
4. Humidity: Less than 95% non-condensing
5. Standard

C. Transmitters

1. RF output power of at least 5 watt (30 dBm) and must be adjustable down to 0.1 watt (20 dBm) and any level in between in 0.5 dB increments.
2. Frequency Stability: 1.5 ppm between -30 to +60 Celsius
3. RTS-CTS Delay for RTS Mode: 0 to 255 ms.
4. RF Output Impedance: 50 ohms.

D. Receivers

1. Type: Dual conversion, superheterodyne
2. Sensitivity (at antenna input port): -110 dBm with  $1 \times 10^{-6}$  BER
3. Conducted Spurious: Per FCC Part 15
4. Frequency Stability: 1.5 ppm from -30 to +60 Celsius.
5. RF Input Impedance: 50 ohms.

E. Diagnostics

1. The wireless modem shall be capable of passing both on-line, non-intrusive system diagnostic capability, as well as off-line diagnostic capability with loop-back testing.
2. On-line diagnostics shall originate at each remote site and will be compiled at the master station. Each remote site with each transmission of data generates diagnostics.
3. Diagnostics shall support an OPC driver and deliver data in an I/O tagged format.
4. Diagnostics reported to the central polling location shall include the following parameters:
  - a. A unique ID number.
  - b. Receive signal strength in dBm for local and remote units.
  - c. Temperature.
  - d. Power supply voltage.
  - e. Forward and reflected RF power.
  - f. A receive quality based on the last 15 data blocks received. This information must be communicated seamlessly over the air with RTU data, during the polling cycle.
5. Off-line intrusive diagnostics must also be supported that provide for the active and immediate querying of remote units, independent of the system polling cycle.
6. Off-line diagnostics must provide the following additional functionality:
  - a. Retrieving statistics of operation from any particular remote site.
  - b. Sampling of the last 10 stations heard in the network by the remote unit.
  - c. Cause the remote unit to send a 'fox' type message over the air.
7. The following off-line diagnostic parameters must be made available over the air, from a remote unit(s):
  - a. Remote transmitter B+ voltage.
  - b. Analog supply voltage.
  - c. Transmitter and receiver voltages.
  - d. Temperature.
  - e. Forward and reflected RF power.
8. Diagnostic data must be digital in nature and may not use DTMF (Dual Tone Modulated Frequency) encoding for reasons of

- security, for the off-line diagnostic capability can disrupt wireless data network operations.
9. The equipment vendor must supply off-line diagnostic software as is available from the wireless modem manufacturer.
  10. Support for on-line diagnostics must be written into and supported as an integral function of the system control/polling software.
    - a. The wireless system control software must provide alarm capability. Alarms are to be issued on the control system CRT when unusual RF network diagnostic values are received at the control point.
    - b. The wireless system control software must log diagnostic data to hard disk for later review. Diagnostic data from at least the previous fourteen days must be retained on computer hard disk.
    - c. A catalog of diagnostic data, which reflects system start-up values, must be retained for later review.
    - d. Diagnostic parameters must be examined weekly by the control software to detect any significant system operational trends.
  11. Diagnostics shall include the capability to acquire spectrum usage analysis from both the local unit and a specified or series of specified remote units. This spectrum analysis information shall be a part of the programming software. The tool shall reflect the Received Signal Strength Indication (RSSI) in dBm, the channel associated with the RSSI indication, and a dynamically placed noise floor indication based on a user selected dBm indication. Information will be available as a dynamic graphic presentation.
  12. The programming software shall have the capability to display the number of synchronization counts on a per-band/per-channel basis. This information shall be accessible from both the local unit and a specified remote unit (or remotes). All information shall be available as a dynamic graphic presentation.
  13. **Master-Station Radio shall provide Terminal-Server connections to SCADA Server. This connection will provide:**
    - a. **Redundant encapsulated serial transmissions through two Ethernet connections to the SCADA Server.**
    - b. **Radio Diagnostics using the GE-MDS PulseNET management software running in the SCADA Server.**

## 2.4 CABLES

- A. Cables shall be installed in strict accordance with manufacturer's recommendations and industry practices. Cables shall be supported every 10 feet maximum.

- B. Antenna cables shall be low loss foam filled type. Cable loss shall not exceed 2 dB for the length installed. Cables shall have 900 MHz attenuation not exceeding the following:
  - 1. 4.0 dB per 100 feet for distances up to 50 feet.
  - 2. 2.0 dB per 100 feet for distances between 50 and 100 feet
  - 3. 1.0 dB per 100 feet for distances greater than 100 feet.
- C. Antenna cable shall only be cut with the special cutting tool recommended by the cable manufacturer. After installation, each antenna cable shall be tested with a Time Domain Reflectometer. There shall be no reflections other than from the cable ends.
- D. At all points where a cable enters/exits a conduit and is exposed to the weather, the entry shall be shaped and positioned so as to minimize the danger of water intrusion. Any unused entry space shall be filled to further prevent any water from following the cables into the conduit.
- E. Antenna cables shall be outdoor type 50 ohm Heliax type as manufactured by Andrew Company, (types FSJ4 or VXL), Times Microwave LMR-400-DB, or equal. All connectors shall be by the same manufacturer as the cable.
- F. All connectors shall be corrosion resistant, designed for outdoor installations. Provide “O” ring seals on all connections.
- G. Provide heat shrink type covers or similar to seal all outdoor connectors against moisture and corrosion.

## 2.5 ANTENNAS

### A. REMOTE SITES

- 1. Frequency Range: 902-928 MHz
- 2. Gain: 6 dB minimum to 15 dB maximum
- 3. Lightning Protection: Direct ground protection.
- 4. Front-to-Back Ratio: 20 dB, minimum.
- 5. Connector: Flexible extension TNC with neoprene housing to appropriate connector type of antenna cable. Nominal cable length of 72” for radios.
- 6. Mounting Hardware: Heavy duty weatherproof clamp suitable for direct mount to 2 inch pipe, or as required..
- 7. Antenna Hardware Kits: All the aforementioned items should be supplied from the equipment provider in a complete, easy to use kit that provides all the necessary items to properly connect the wireless modem to the antenna.

- B. Units shall include gold anodized aluminum radiator components, gold plated connector, solid aluminum mounting clamp, and stainless steel hardware.
- C. Antennas shall be factory tuned to the radio frequencies being used. Coordinate with radio manufacturer for tuning to the frequencies being used for this project. Verify before ordering.
- D. Provide all masts, lightning suppressors, and any other apparatus required to assemble a complete, operable, and reliable fixed wireless data system.

## 2.6 SOFTWARE

- A. Provide three (3) copies of radio management software. Software shall include three (3) years of product support and upgrades. Software shall be MDS NETview MS.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. All radios, antennas, cables, etc. shall be installed in strict accordance with the manufacturer's instructions.
- B. All units shall be programmed with all necessary information for proper operation.

### 3.2 GROUNDING

Provide grounding for all systems as shown on the Drawings and as recommended by the radio systems vendor.

### 3.3 OPERATIONS

- A. Install all antennas, cables, and other equipment as required for a complete system. Place system into operation and tune for optimum operation.
- B. Document radio paths showing data throughput, dB losses, fade margins, etc.
- C. Instruct Owner in basic operations and troubleshooting of the system.

### 3.4 FINAL REPORT

- A. Submit final report of radio system design. This shall include the following:

1. Site listing with GPS coordinates and elevations. Include street addresses where available.
  2. Station radio numbers
  3. System block diagram showing signal routing,
  4. Antenna details: type, mounting arrangement, heights, gain, aiming, etc.
  5. Serial numbers of all radio equipment
  6. Radiated power at all sites
  7. RSSI, BER data, and other signal parameters.
- B. Take a minimum of ten (10) digital photographs of each site after all work is complete. Pictures shall show new and old equipment, general area, access, locations of the new panels and antenna supports, etc. Organize by putting each site into a folder with site name, e.g. Arch Creek Estates 1. At end of project provide two copies of all pictures on CD-ROM or DVD. These are to serve as the post-construction references.

END OF SECTION 13660

SECTION 13661

RADIO TELEMETRY SYSTEM FIELD TESTING

## SECTION 13661 - RADIO TELEMETRY SYSTEM **FIELD TESTING**

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes: Field testing requirements for the Telemetry System.
- B. Items specified in this section shall conform to general requirements of Division 13, General Instrumentation and Controls.

#### 1.2 SUBMITTALS

- A. In addition to submittal requirements of Division 13, General Instrumentation and Controls, provide completed test documentation and sign-off sheets and punch list forms.
- B. Submit documentation in accordance with Division 13, General Instrumentation and Controls.

### PART 2 - PRODUCTS

(NOT USED)

### PART 3 - PREPARATION

#### 3.1 FIELD TESTING AND DEMONSTRATIONS

- A. General
  - 1. Field testing is intended to check installation of the Telemetry System in addition to provide a diagnostic check of associated field equipment and wiring.
  - 2. Install RTU programming and provide any configuration required to establish communications with the Master-Station Radio in the SPCC Building, 111 NW 1st Street, Miami, FL.
  - 3. Testing shall begin after Remote Terminal Panel (RTU) is installed and all terminations are complete.
- B. Operational Acceptance Test
  - 1. The objective of these tests is to demonstrate that the Telemetry System is ready for operation.
  - 2. The Telemetry System shall be checked for proper installation, adjustment, and calibration on a loop-by-loop basis to verify that it is ready to function as specified.



3. Run hardware diagnostics.
4. Testing of all input and output (I/O) signals by activation or injection of signal at field device.
5. Discrete input signals:
  - a. For all equipment RUNNING signals, test by on - off operation of equipment. If operation of equipment is deemed inadvisable by Owner or System Integrator due to potential process upset, inaccessibility of generating device, hazard to personnel, or other factors, test by jumpering of motor starter auxiliary contact or other source of run signal.
  - b. For all alarm or status signals, test by activation of device generating alarm or status signal. If generation of signal is deemed inadvisable by Owner or System Integrator due to potential process upset, inaccessibility of generating device, hazard to personnel, or other factors, test by jumpering of contact at nearest accessible location to generating device.
  - c. For signals designated as spare, test by jumpering of signal at RTU panel field termination point.
  - d. Demonstrate change of state in local RTU data table.
  - e. Demonstrate change of state at “Master” site.
6. Analog input signals:
  - a. Verify impedance capabilities of transmitting device has not been exceeded by installation of the RTU.
  - b. Disconnect transmitting device and inject 4, 12, and 20 mA D.C. signals into loop.
  - c. Demonstrate proper response to various signals in RTU data table.
  - d. Demonstrate proper response to various signals at “Master” site for that area.
  - e. For signals designated as spare, test by injection of signal at RTU panel field termination point.
7. Discrete output signals:
  - a. Manipulate RTU data table or use forces to test response of all discrete output signals.
  - b. Manipulate signals at “Master” site for that area to force all discrete output signals ON and OFF.
  - c. Verify proper response of other devices in loop to signals.
  - d. For signals designated as spare, test by checking signal at RTU panel field termination point.

8. Analog output signals:
  - a. Verify impedance capabilities of analog output is not exceeded.
  - b. Generate 4, 12, and 20 mA D.C. signals through RTU data table for all analog outputs at "Master" site for that area.
  - c. Verify proper response of other devices in analog loop to various signals. Verify proper loop current through measurement.
  - d. For signals designated as spare, test by measuring of signal at RTU panel field termination point across a 250 ohm resistor or similar.

C. Documentation

1. Prepare field testing, sign-off document. Document shall include following as a minimum:
2. Project description and number.
3. Company name for System integrator, Owner, and Engineer.
4. Include separate line for each I/O point to be tested.
5. Include area for handwritten notes of any corrections required.

D. Problem field devices or wiring.

1. Provide written documentation of any problems encountered with Owner's field devices or wiring during testing.
2. Correction of such problems are not considered part of this project.

E. Alarm displays shall be tested for all analog and digital alarm points.

F. All historical data collection, trending, computation, totalization and reporting functions shall be checked and tested to confirm proper operation and accuracy of data.

G. Any defects or problems found with the Telemetry System or documentation shall be corrected by Contractor and then retested or resubmitted to demonstrate proper operation.

### 3.2 PROVING DEMONSTRATION

- A. Before substantial completion will be considered for any site, all site system functions, including but not limited to RTU and radio, shall be run and fully operational for a continuous 48 hours period.
- B. Contractor shall notify Engineer before each 48 hours test is conducted and shall document any failure that occurs during the test.

- C. Sites that experience any component failure shall be retested until successful completion. Contractor shall submit documentation of each test.

### 3.3 OPERATION DEMONSTRATION

- A. The Operation Demonstration (OD) shall be defined as all Telemetry System components supplied under this contract, in addition to all components modified or connected to this Telemetry System. The OD is intended to demonstrate the operation of the Telemetry System for each site.
- B. OD shall begin following completion of the field testing and the 48-hour Proving Demonstration.
- C. OD shall continue until a time frame has been achieved wherein the Telemetry System (both hardware and software) availability meets or exceeds 99.7 percent for 30 consecutive days and no system failures have occurred that result in starting the OD over again. During the OD, the Telemetry System shall be available to Owner's operating personnel for use in normal operation of the facilities.
- D. The conditions listed below shall constitute system failures that are considered critical to the operability and maintainability of the system. The OD shall be terminated if one or more of these conditions occur. Following correction of the problem, a new 30 consecutive day OD shall begin.
  - 1. Failure to repair a hardware or software problem within 72 consecutive hours from the time of notification of a system failure.
  - 2. Recurrent type hardware or software problems, if the same type of problem occurs three times or more.
  - 3. Software problem causing a RTU processor to halt execution.
- E. The following conditions shall constitute a system failure in determining the system availability based on the equation specified below.
  - 1. Failure of one or more input/output modules.
  - 2. Failures of any type affecting four or more input/output points simultaneously.
  - 3. Failure of a RTU power supply.
  - 4. The system availability shall be calculated based on the following equation:

$$A = \frac{MTBF}{MTBF + MTTR} \times 100 \text{ percent}$$

A = system availability in percent  
MTBF= mean (average) time interval between consecutive system failures  
MTTR = mean (average) time required to repair system failures

5. Time between failures shall be the period between the time that a reported system failure has been corrected and the time of subsequent notification of the Contractor that another system failure has occurred in terms of operating hours.
  6. Time to repair shall be the period between the time that the Contractor is notified of a system failure and the time that the system has been restored to proper operation in terms of operating hours.
  7. Time to repair shall be the period between the time that the Contractor is notified of a system failure and the time that the system has been restored to proper operation in terms of hours, minus an allowance for the following dead times which shall not be counted as part of the time to repair period.
  8. Actual travel time for service personnel to get to the to the plant site up to a maximum of 6 hours from the time the Contractor is notified of a system failure.
  9. Time for receipt of spare parts to the plant site once requested up to a maximum of 24 hours. No work shall be done on the system while waiting for delivery of spare parts.
  10. Completion of a 30 consecutive day period without any restarts of the OD and with a system availability more than 99.7 percent shall constitute acceptance of the Radio Telemetry System.
- F. All parts and maintenance materials required to repair the system prior to completion of the OD shall be supplied by Contractor at no additional cost to the Owner. If parts are obtained from the required plant spare parts inventory, they shall be replaced to provide a full complement of parts as specified.
- G. An instrumentation and control system Malfunction/Repair Reporting Form shall be completed by Engineer to document failures, to record Contractor notification, arrival and repair times and Contractor repair actions. Format of the form shall be developed and agreed upon prior to the start of the OD.

END OF SECTION 13661

SLUICE GATES  
TECHNICAL SPECIFICATION

## SECTION 11021

### STAINLESS STEEL SLUICE GATES

#### PART 1 GENERAL

##### 1.01 SCOPE

###### A. Description of Work

1. Provide all labor, material and equipment to remove the existing self-contained, cast iron sluice gate from the existing partition wall in the wet well of the Ridge Street Pump Station and furnish and install stainless steel sluice gates with floor stands and gear operators. The existing wall thimbles will remain.
2. Except as modified or supplemented herein, all gates and operators shall conform to the applicable requirements of AWWA C561, latest addition.
3. It is noted that the size of the gate is estimated. Under Section 01011, Sequence of Construction, the Contractor is required to remove the existing cast iron sluice gate and verify its size prior to the submitting of information on the proposed gate for review and approval.

###### B. Work and Components Included (But Not Limited to the Following Items):

1. Stainless Steel Gate
2. Floor Stand and Gear Operator
3. Anchor Bolts

###### C. Related Work Specified Elsewhere

1. The provisions of this Section are a direct extension of SECTION 11000, MECHANICAL EQUIPMENT - GENERAL, and although set forth only once within the Specification, shall apply equally to this Section.
2. SECTION 01011, SEQUENCE OF CONSTRUCTION
3. SECTION 11700, BYPASS PUMPING

##### 1.02 QUALIFICATIONS

###### A. Manufacture

1. It is the intention of the Specifications to cover minimum acceptable quality equipment for a complete installation with the exception of the motor controls, electrical work and piping requirements.
2. Part numbers or trade names are used in this Specification only to facilitate the description of the equipment and in no way implies that equal equipment of other manufacturers cannot be used.

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### STAINLESS STEEL SLUICE GATES

#### B. Manufacturer's Experience

1. The Equipment Manufacturer shall have not less than five (5) successful years experience in the design, construction, and operation of equipment of the type specified at fifty (50) installations.
2. The manufacturer's shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirement of the latest edition of ASME, Section IX.
3. Gates shall be shop inspected for proper operation before shipping.
4. The manufacturer shall be ISO 9001 : 2000 certified.

#### C. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following are acceptable:
  - a. Stainless Steel Gates
    - (1) H. Fontaine Ltd.
2. All products, whether named as "acceptable" or proposed as "equal", must fully comply with these Specifications. If the standard product cannot be modified to meet the Specifications, then each non-compliant item must be listed as an exception in the space provided on the Bid form.

#### 1.03 SUBMITTALS

- A. Operating instructions, manuals and shop drawings shall be submitted in accordance with SECTION 11000, MECHANICAL EQUIPMENT - GENERAL.

#### 1.04 EQUIPMENT MANUFACTURER'S SERVICE REPRESENTATIVE

##### A. General

1. See SECTION 11000, MECHANICAL EQUIPMENT - GENERAL, for complete requirements for the Manufacturer's Service Representative.

##### B. Installation Assistance

1. Provide for installation assistance for the equipment supplied.

##### C. Equipment Start-Up Assistance

1. Provide for equipment start-up and/or process stabilization and balancing assistance for the equipment supplied.

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### STAINLESS STEEL SLUICE GATES

#### D. Operating Instructions and/or Operator Training

1. Provide for one (1) eight (8) hour working day total to instruct pump station Operators for the equipment supplied. The training period will be coordinated by the Owner with overall plant training.

#### 1.05 GUARANTEE AND WARRANTY

- A. The equipment shall be unconditionally guaranteed to meet or exceed the design criteria detailed in Part 2 of this Specification.

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. The equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.
- B. Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete, properly operating installation, and shall be the latest standard product of a manufacturer regularly engaged in the production of fabricated gates.
- C. Gates supplied under this Section shall be Series 20, Model 204 Stainless Steel Flow Control Sluice Gates as manufactured by H. Fontaine Ltd.

#### 2.02 PERFORMANCE

- A. Leakage: Sluice gates shall be substantially watertight under the design head conditions. Under the design seating head, the leakage shall not exceed 0.05 U.S. gallon per minute per foot (0.60 l/min per meter) of seating perimeter. Under the design unseating head, the leakage for heads of 20 feet (6m) or less shall not exceed 0.1 U.S. gallon per minute per foot (1.25 l/min per meter) of perimeter. For unseating heads greater than 20 feet (6m), the allowable leakage shall not exceed the rate per foot (meter) of perimeter specified by the following equations:

*Maximum allowable leakage*

$$\begin{aligned} &\text{Gallons per minute per foot of perimeter:} \\ &= 10 + (0.0025 \times (\text{unseating head in feet} - 20)) \end{aligned}$$

- B. Design Head: The sluice gates shall be designed to withstand the design head shown in the schedule.
- C. Seal Performance Test: The gate's sealing system shall have been tested through a cycle test in an abrasive environment and should show that the



## SECTION 11021

### STAINLESS STEEL SLUICE GATES

leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.

#### 2.03 PRODUCT

- A. Each sluice gate shall be of the self-contained, rising stem type.
- B. Frame: The gate frame shall be constructed of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be of the flange back design suitable for mounting on a concrete wall with extra-wide flange. The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene).

The frame configuration shall be of the flush-bottom type and shall allow the replacement of the top and side seals without removing the gate frame from the concrete or wall thimble.

- C. Slide: The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to  $1/720$  of the gate's span under the design head.
- D. Guides and Seals: The guides shall be made of UHMWPE and shall be of such length as to retain and support at least two thirds ( $2/3$ ) of the vertical height of the slide in the fully open position.

Side and top seals shall be made of UHMWPE of the self adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate.

The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.

- E. Stem and Couplings: The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 40 lbs (178 N) effort on the crank or handwheel.

The stem shall have a slenderness ratio ( $L/r$ ) less than 200. The threaded portion of the stem shall have machined cut threads of the Acme type.

Where a hydraulic, pneumatic or electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic or pneumatic cylinder with a pressure equal to the maximum working pressure of the supply, or 1.25 times the output thrust of the electric motor in the stalled condition.

The stem shall be one (1) piece and sized for use with no stem guide.

The couplings shall be grooved and keyed and shall be of greater strength than the stem.

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### STAINLESS STEEL SLUICE GATES

Gates having a width greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.

- F. Stem Guides: No stem guides shall be permitted.
- G. Stem Cover: Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents and a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.
- H. Lifting Mechanism: All gates shall be provided with a crank operated floor stand mounted to a concrete slab. The gear box shall be single speed with a 1.5:1 ratio.

All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings.

The manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lbs (178 N) on the crank or handwheel, and shall be able to withstand, without damage, an effort of 80 lbs (356 N).

The crank shall be removable and fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 15 inches (381mm) and the maximum handwheel diameter shall be 24 inches (610mm).

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## SECTION 11021

## STAINLESS STEEL SLUICE GATES

## I. Materials

<b>Part</b>	<b>Material</b>
Frame, yoke, stem guides, Slide, stem extension	Stainless steel ASTM A-240 Type 304L or 316L
Side seals, Stem guide liner	Ultra high molecular weight polyethylene (UHMWPE) ASTM D-4020
Compression cord	Nitrile ASTM D-2000 M6BG 708, A14, B14, E014, E034
Bottom Seal	Neoprene ASTM D-2000 Grade 2 BC-510
Threaded stem	Stainless steel ASTM A-276 Type 303 MX or 316
Fasteners	ASTM F593 and F594 GR1 for type 304 and GR2 for type 316
Pedestal, handwheel, crank	Tenzaloy aluminum
Gasket (between frame and wall)	EPDM ASTM 1056
Stem cover	Polycarbonate ASTM D-3935
Lift nut, couplings	Manganese bronze STM B-584 UNS-C86500
Anchor bolts	316 Stainless Steel

SECTION 11021

STAINLESS STEEL SLUICE GATES

2.04 GATE SCHEDULE

<b>Gate Type</b>	Self-Contained
<b>Size</b>	16" SQ.
<b>Operating Floor Elevation</b>	345.82
<b>Invert Elevation</b>	335.85
<b>Head (feet)</b>	7.21

PART 3 EXECUTION

3.01 INSTALLATION

- A. Gates and appurtenances shall be handled and installed in accordance with the manufacturer's recommendations.

3.02 FIELD TESTS

- A. Following the completion of each gate installation, the gates shall be operated through at least two complete open/close cycles. If an electric or hydraulic operator is used, limit switches shall be adjusted following the manufacturer's instructions.
- B. Gates should be checked for leakage by the Contractor (refer to the "Performance" section for approval criteria).

\*\*\*\*END OF SECTION\*\*\*\*

## **SECTION 8: ENGINEERING DRAWINGS**

ENGINEERING DRAWINGS ARE PROVIDED SEPARATELY