Lee County
Southwest Florida

FORT MYERS BEACH WATER RECLAMATION FACILITY
MAIN SWITCHGEAR REPLACEMENT

ISSUED FOR BIDDING
MAY 2023

Prepared by:

RK CONSULTING ENGINEERS
ELECTRICAL • INSTRUMENTATION • CONTROL DESIGN
12651 McGregor Blvd. Ste 4-402 | Fort Myers, FL 33919
239.481.6775 | Certificate of Authorization #8212

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SELECT STRUCTURAL
12573 New Brittany Blvd
Fort Myers, Florida 33907
Phone: (239) 210-5090
info@selectstructural.com
Certification Auth. 28357

Signatures and Seals

RKS Consulting Engineers
Responsible for Divisions:
01, 02, 09, 26, 31, 32 & 40

TRACY MARIE PROKOPETZ LICENSE NO. 62427 STATE OF FLORIDA PROFESSIONAL ENGINEER

Digitally signed by Tracy M Prokopetz
Date: 2023.09.12 16:04:12-04'00'

Tracy Marie Prokopetz, PE - FL #62427

Select Structural –
Structural Engineering
Responsible for Divisions:
03, 04, & 05

Shawn Anderson

Digitally signed by Shawn Anderson
DN: CN=Shawn Anderson, dnQualifier=A01410D0000018709DE20C70004A0DD, O=SELECT STRUCTURAL, C=US
Date: 2023.09.12 17:41:53-04'00'

Shawn Anderson, PE, SE - FL #53515

Matern Professional Engineering
Responsible for Divisions:
23

K. TODD GRIFFITH LICENSE No 67083 STATE OF FLORIDA PROFESSIONAL ENGINEER

Digitally signed by Kevin T Griffith
DN: c=US, o=Florida, dnQualifier=A01410D00000186E1DB56AC00011D59, cn=Kevin T Griffith
Reason: This item has been electronically signed and sealed by K. Todd Griffith using a digital signature and date. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies. Mechanical.
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K. Todd Griffith, PE - FL #67083

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LEE COUNTY UTILITIES
FORT MYERS BEACH WATER RECLAMATION FACILITY
MAIN SWITCHGEAR REPLACEMENT

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Fort Myers Beach Water Reclamation Facility Main Switchgear Replacement
as Prepared by RKS Consulting Engineers, Inc. & Sub-Consultants.

(NO TEXT FOR THIS PAGE)

DIVISION 01 – GENERAL REQUIREMENTS

SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description of Work

B. Constraints

C. Work by Others

D. CONTRACTOR's Use of Site

E. Work Sequence

F. Owner Occupancy

1.2 DESCRIPTION OF WORK

A. General: General: The Work to be done under this Contract is located at the Fort Myers Beach Water Reclamation Facility (17155 Pine Ridge Road, Fort Myers Beach, FL 33931). The Work consists of the following as shown and specified in the Contract Documents entitled Fort Myers Beach WRF Switchgear Replacement:

1. New Electrical Switchgear Building and Generator Pad.

2. Two (2) New HVAC Systems.

3. Asphalt demolition and restoration.

4. Temporary electrical feeders from new Switchgear to existing Motor Control Centers and Blowers.

5. Demolition of existing FPL Transformer Vault.

6. Demolition/Relocation of existing Stand-by generator and above ground fuel tank to tractor trailers for transport to auction.

7. Installation of owner provided stand-by generator with sub-base fuel tank.

8. Concrete encased ductbank systems with precast manholes.

9. Class 1 reliable service entrance switchgear and electrical services.

10. Four (4) Effluent Transfer Pump VFDs

11. One (1) Motor Control Center

12. One (1) Plant PLC.

13. PLC and SCADA Integration/programming.

14. Provide complete plant Arc Flash Evaluation and Short Circuit and Coordination Study.

B. The Work includes:

1. Furnishing of all labor, material, superintendence, plant, power, light, heat, fuel, water, tools, appliances, equipment, supplies, services and other means of construction necessary or proper for performing and completing the Work.

2. Sole responsibility for adequacy of plant and equipment.

3. Maintaining the Work area and site in a clean and acceptable manner.

4. Maintaining existing facilities in service at all times except where specifically provided for otherwise herein.

5. Protection of finished and unfinished Work.

6. Repair and restoration of Work damaged during construction.

7. Furnishing as necessary proper equipment and machinery, of a sufficient capacity, to facilitate the Work and to handle all emergencies normally encountered in Work of this character.

8. Furnishing, installing, and protecting all necessary guides, track rails, bearing plates, anchor and attachment bolts, and all other appurtenances needed for the installation of the devices included in the equipment specified. Make anchor bolts of appropriate size, strength and material for the purpose intended. Furnish substantial templates and shop drawings for installation.

C. Implied and Normally Required Work: It is the intent of these Specifications to provide the OWNER with complete operable systems, subsystems and other items of Work. Any part or item of Work which is reasonably implied or normally required to

make each installation satisfactorily and completely operable is deemed to be included in the Work and the Contract Amount. All miscellaneous appurtenances and other items of Work incidental to meeting the intent of these Specifications are included in the Work and the Contract Amount even though these appurtenances may not be specifically called for in these Specifications.

D. Quality of Work: Regard the apparent silence of the Contract Documents as to any detail, or the apparent omission from them of a detailed description concerning any Work to be done and materials to be furnished as meaning that only the best general practice is to prevail and that only materials and workmanship of the best quality are to be used. Interpretation of these specifications will be made upon this basis.

1.3 CONSTRAINTS

A. The Contract Documents are intended to allow the CONTRACTOR flexibility in construction of the Work, however, the following constraints apply:
   1. The existing plant must maintain power at all time throughout construction.
   2. Unscheduled outages will not be allowed and the contractor must make all reasonable attempts to avoid unscheduled outages.

1.4 CONTRACTOR'S USE OF SITE

A. In addition to the requirements of the General Conditions, limit use of site and premises for work and storage to allow for the following:

   1. Coordination of the Work under this CONTRACT with the work of the other contractors where Work under this CONTRACT encroaches on the Work of other contractors.

   2. OWNER occupancy and access to operate existing facilities.

   3. Coordination of site use with ENGINEER.

   4. Responsibility for protection and safekeeping of products under this CONTRACT.

   5. Providing additional off site storage at no additional cost to OWNER as needed.

1.5 WORK SEQUENCE

A. Construct Work in stages to accommodate OWNER's use of premises during construction period and in accordance with the limitations on the sequence of construction specified. Coordinate construction schedules and operations with ENGINEER.

B. Coordinate Work of all subcontractors.

1.6 OWNER OCCUPANCY

A. OWNER will occupy premises during entire period of construction in order to maintain normal operations. Cooperate with OWNER's representative in all construction operations to minimize conflict, and to facilitate OWNER usage.

B. Conduct operations so as to inconvenience the general public in the least.

1.7 HOURS OF WORK

A. Contractor work hours Monday- Friday 7a.m. – 5p.m. Work outside of these hours (nights, weekends and holidays) must be requested in writing 1 week before the proposed, alternate work hours.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

A. Starting Work: Start Work as indicated in the Notice to Proceed and execute with such progress as may be required to prevent delay to other contractors or to the general completion of the project. Execute Work at such items and in or on such parts of the project, and with such forces, material and equipment, as to complete the Work in the time established by the Contract. At all times, schedule and direct the Work so that it provides an orderly progression to completion within the specified time for completion.

END OF SECTION

SECTION 01 22 13

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Explanation and Definitions

B. Measurement

C. Payment

D. Schedule of Values

E. Application for Payment

F. Release of Lien

G. Payment Item Descriptions

1.2 EXPLANATION AND DEFINITIONS

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

1.3 MEASUREMENT

A. The quantities set forth in the bid form are approximate and are given to establish a uniform basis for the comparison of bids. The OWNER reserves the right to increase or decrease the quantity of any class or portion of the work during the progress of construction in accord with the terms of the Contract.

1.4 PAYMENT

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

B. Estimated and mutually agreed upon percent complete values shall be used as a means of computing the amount for periodic payments for work performed. Determining value of additions or deletions during construction may rely upon applicable values as broken down by individual items listed in the approved Schedule of Values.

1.5 SCHEDULE OF VALUES

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

B. Format: Utilize the submitted Bid Schedule for the list of individual pay items finalizing actual amounts to be used for payment if different than that initially submitted with the bid. Identify each line item with number and title of the major specification items. Identify site mobilization, bonds and insurance. Include with each line item, a direct proportional amount of Contractor's overhead and profit. Within the Schedule of Values, break down the individual bid schedule items into more specific items included in that bid schedule item (concrete, individual equipment, electrical components, instrumentation, piping sections, startup, training, O&M Manuals, etc). Intent is to break down the work by areas that can more easily allow estimation of the percent complete for each item. Attempt to break down the individual items listed in values of $50,000 or less wherever possible.

C. Sum of individual values shown on the Schedule of Values shall equal the total of associated payment item. Sum of payment item totals in the Schedule of Values shall equal the Contract Price.

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

1.6 APPLICATION FOR PAYMENT

A. Required copies: submit three copies of each application on EJCDC form no. 620 (latest Version) or approved equal.

B. Execute certification by signature of authorized officer.

C. Use data from approved schedule of values.

D. Stored materials: when payment for materials stored is permitted, submit a separate Schedule for materials stored showing line item, description, previous value received, value incorporated into the work and present value.

E. Change Orders: List each authorized Change Order as an extension on continuation sheet, listing Change Order number and dollar amount as for an original item of work.
   1. Final Payment: Prepare Application for Final Payment as required in the General Conditions.

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

1.7 RELEASE OF LIEN

A. For any item included in a pay application that is to a third party, either a subcontractor or material supplier, a release of lien for those amounts shall be submitted with the next pay application before further payment can be considered.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 MEASUREMENT AND PAYMENT

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

   1. Mobilization/Demobilization: Included in this item are all general conditions and requirements, including but not limited to mobilization activities, scheduling, temporary facilities, obtaining permits, indemnification, general conditions, demobilization, close out, and all other activities necessary to complete the contract work general requirements (pay applications, meetings, submittals, audio-video recordings, photographs, site protections, quality control testing

services, field offices, and final close out items). Payment shall be made at the contract lump sum price for this bid item in accordance with the schedule listed below. This price shall be full compensation for furnishing all materials, for all labor, equipment, tools, and incidentals necessary to complete this item. Partial payment shall be made in accordance with the following:

Percent of Original Contract Amount Earned	Allowable Maximum Precent of Lump Sum Price for this Item
5	25
25	50
50	75
75	90
100	100

2. Performance and Payment Bond Premiums and Insurance: Payment shall be divided equally over the number of pay request anticipated from the Notice to Proceed. No additional payments shall be made due to time extension.

3. Pre-Construction Video: Payment for audio-video tape of existing conditions at the project site will be made for at the Contract lump sum price.

4. Record Survey/Drawings: Payment for record survey and drawings will be made at a percentage of the Contract lump sum price site as work is completed. This item includes completion of the record survey and submittal of contractor red line drawings to the ENGINEER.

5. Demolition: Payment for the existing equipment and conduit demolition will be made at a percentage of the Contract lump sum price as the demolition of all equipment is complete. This item includes taking the equipment out of service, removal from the site, to either salvage or delivery to the County and all necessary materials and labor to complete the demolition in accordance with the project plans.

6. Temporary Wiring: Payment for furnishing and installing the temporary conduit and wire systems will be made at a percentage of the Contract lump sum price as work is complete. This item includes all labor, equipment and materials to install all necessary temporary conduit, wire, cables, terminations, roadway modifications, cleanup and all other work for a complete installation.

7. Ductbank, Conduit and Wire: Payment for furnishing and installing the ductbank, conduit and wire systems will be made at a percentage of the Contract lump sum price site by site as the conduit and wire work is complete. This item includes all

labor, equipment and materials to install all necessary conduit, wire, cables, terminations, testing, cleanup and all other work for a complete installation.

8. Lightning Protection, Bonding and Grounding: Payment for furnishing and installing lightning protection, bonding and grounding systems and components will be made at a percentage of the Contract lump sum price site by site as the grounding and bonding work is complete. Surface restoration required for addition of bonding and grounding shall be included in this item.

9. Switchgear: Payment for furnishing and installing the electrical service switchgear will be made at a percentage of the Contract lump sum price as the gear is brough on-line and fully started up by the manufacturer's representatives. This item includes all labor, equipment and materials to install the switchgear, concrete housekeeping pads, testing, cleanup and all other work for a complete installation.

10. Electrical Equipment: Payment for furnishing and installing the modifications to existing panelboards and motor control centers, new panelboards, new motor control center, new VFDs, power surge suppression and other applicable electrical equipment as outlined in the Contract Documents and specified herein will be made at a percentage of the Contract lump sum price as the work is completed. This item includes all labor, equipment and materials to install the electrical equipment, provide new equipment racks or mounting stands, site preparation, surface restoration, testing, cleanup and all other work for a complete installation.

11. PLC Panel/Ethernet Rack: Payment for furnishing and installing the PLC control panel and Ethernet Rack and other applicable electrical equipment as outlined in the Contract Documents and specified herein will be made at a percentage of the Contract lump sum price as the work is completed. This item includes all labor, equipment and materials to install the equipment, testing, cleanup and all other work for a complete installation.

12. Control Panel Modifications: Payment for furnishing and installing field modifications to existing PLC Control panels and other applicable control panel modifications as outlined in the Contract Documents and specified herein will be made at a percentage of the Contract lump sum price site by site as the sites are completed. This item includes all labor, equipment and materials to perform the panel modifications, testing, cleanup and all other work for a complete installation.

13. Control System Integration: Payment for providing control system integration, including SCADA and PLC programming at the Fort Myers Beach WRF Plant and other applicable control system integration work as outlined in the Contract Documents and specified herein will be made at a percentage of the Contract sum price site by site as the work is completed. This item includes all labor, equipment and materials to perform the integration work, testing, cleanup and all other work for a complete installation.

14. Railings: Payment for furnishing and installing railings and related components will be made at a percentage of the Contract lump sum price as the work is complete.

15. Roofing, Fascia .Downspouts, and Gutters: Payment for all labor, materials, tools, and equipment necessary and required for roofing, fascia, downspouts, gutters and related components will be made at a percentage of the Contract lump sum price as the work is complete.

16. Insulation: Payment for furnishing and installing insulation and related components will be made at a percentage of the Contract lump sum price as the work is complete.

17. Doors, Frames, and Hardware: Payment for furnishing and installing doors, frames, hardware and related components will be made at a percentage the Contract lump sum price as the work is complete.

18. Portland Cement Plaster: Payment for all labor, materials, tools, and equipment necessary and required to apply portland cement plaster and related components will be made at a percentage the Contract lump sum price as the work is complete.

19. Paint and Sealant: Payment for furnishing and installing Portland cement plaster and related components will be made at a percentage of the Contract lump sum price as the work is complete.

20. Fire Extinguishers: Payment for furnishing and installing fire extinguishers and related components will be made at a percentage of the Contract lump sum price as the work is complete.

21. Termite Protection: Payment for all labor, materials, tools, and equipment necessary and required to provide termite protection and related components will be made at a percentage of the Contract lump sum price as the work is complete.

22. Clearing and Grubbing: Payment for all labor, materials, tools, and equipment necessary and related components required to clear and grub the area of the electrical service building and generator pad and will be made at a percentage of the Contract lump sum price as the work is complete.

23. Remove Existing Pipe: Payment for all labor, materials, tools, and equipment necessary and related components required to remove abandoned pipe will be made at a percentage of the Contract lump sum price as the work is complete.

24. Erosion Control: Payment for all labor, materials, tools, and equipment necessary and related components will be made at a percentage of the Contract lump sum price as the work is complete.

25. Rough Grading: Payment for all labor, materials, tools, and equipment necessary for rough grading and related components will be made at a percentage of the Contract lump sum price as the work is complete.

26. Import Fill: Payment for furnishing and installing fill and related components will be made at a percentage of the Contract lump sum price as the work is complete.

27. Subgrade Prep: Payment for all labor, materials, tools, and equipment necessary for subgrade prep and related components will be made at a percentage of the Contract lump sum price as the work is complete.

28. Base Rock: Payment for furnishing and installing base rock and related components will be made at a percentage of the Contract lump sum price as the work is complete.

29. Concrete Pad: Payment for furnishing and installing concrete and related components will be made at a percentage of the Contract lump sum price as the work is complete.

30. Sidewalk: Payment for furnishing and installing concrete and related components will be made at a percentage of the Contract lump sum price as the work is complete.

31. Final Grading: Payment for all labor, materials, tools, and equipment necessary for final grading and related components will be made at a percentage of the Contract lump sum price as the work is complete.

32. Cut/Replace Road: Payment for all labor, materials, tools, and equipment necessary for final grading and related components will be made at a percentage of the Contract lump sum price as the work is complete.

33. 6 inch Watermain & Fittings: Payment for furnishing and installing modifications to existing watermain and related components will be made at a percentage of the Contract lump sum price as the work is complete.

34. Storm Drainage: Payment for furnishing and installing modifications to existing storm drainage and related components will be made at a percentage of the Contract lump sum price as the work is complete.

35. Electrical Switchgear Service Building: Payment for furnishing and installing 2400 sq ft building and related components will be made at a percentage of the

Contract lump sum price as the work is complete. Stairs and Decking should be included in this line item.

36. Generator Pad: Payment for furnishing and installing generator pad and related components will be made at a percentage of the Contract lump sum price as the work is complete.

37. HVAC Equipment: Payment for furnishing HVAC equipment and control panel will be made at a percentage of the Contract lump sum price as the work is complete.

38. HVAC Labor: Payment for installing HVAC equipment, control panel and related components will be made at a percentage of the Contract lump sum price as the work is complete.

39. HVAC Miscellaneous Materials: Payment for furnishing HVAC related components will be made at a percentage of the Contract lump sum price as the work is complete.

END OF SECTION

SECTION 01 26 00

CHANGE ORDER AND FIELD DIRECTIVE CHANGE PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Definitions

B. Change Orders

C. Field Directive Change

1.2 DEFINITIONS

A. Change Order: Refer to the Change Order definition in Article 2 of the General Conditions.

B. Field Directive Change: Field Directive Change is a written directive to the Contractor issued on or after the effective date of the agreement; signed by the Owner, recommended by the Engineer ordering an addition, deletion, or revision in the Work. A Field Directive Change will subsequently be followed by the issuance of a Change Order.

C. Overhead: Overhead is defined as the cost of administration, field office and home office costs, general superintendence, office engineering and estimating costs, other required insurance, materials used in temporary structures (not including form work), additional premiums on the performance bond of the Contractor, the use of small tools, scheduling costs, and all other costs incidental to the performance of the change or the cost of doing business.

1.3 CHANGE ORDERS

A. Initiation of Proposals:

B. From time to time, the Owner or the Engineer may issue a Request for a Change Order Proposal. The Request will contain a description of the intended change with supplementary or revised Drawings and Specifications as applicable, and the projected time for accomplishing the change.

C. The Contractor may propose a change in the Work by submittal of a Change Order Request to the Engineer describing the proposed change with a statement

of the reason for the change and the effect on the Contract time and price, along with supporting documentation.

1. Execution of Change Order Proposal:

   a. When a Proposal is requested for changed work, submit proposal within 15 days following receipt of the Request from Owner or Engineer. State the increase or decrease, if any, in Contract Completion time and Contract Price.

   b. Explain proposal in sufficient detail to permit review by Owner.

   c. For Omitted Work the decrease in the Contract Price will be determined by the Engineer and will include appropriate amounts for profit and overhead.

   d. The Owner and Engineer will review the Proposal and may request additional information and documentation. Provide these items upon request.

   e. If the Owner decides to proceed with the change, the Owner will issue a Change Order for signature first by the Contractor and then by the Owner.

   f. The Contractor will promptly complete the approved change in the Work on receipt of the executed Change Order.

      (1) Failure to sign the Change Order does not relieve the Contractor from performing the Work if the Change Order is signed by the Owner.

      (2) Compute the cost of both additive and deductive changes in the Work in accordance with Article 11 of the General Conditions and as follows:

         (a) Include, the costs of labor, crew foreman and general foreman performing or directly supervising the changed Work on the site. Include travel and subsistence, but only to the extent incurred.

         (b) To the labor cost add all net premium for Workman's Compensation, taxes pursuant to the Federal Social Security Act, and payments required under State and Federal unemployment laws.

(c) Add necessary extra materials, delivered at the site.

(d) Include Subcontractor's costs, including a maximum of 10 percent overhead and 10 percent profit for the first $20,000; 7-1/2 percent overhead and 7-1/2 percent profit on the next $30,000; and 5 percent overhead and 5 percent profit on balance over $50,000.

(e) For all subcontract work add 5 percent overhead and 5 percent profit to the subcontractor's costs. For work performed by the Contractor's own forces add a maximum of 10 percent overhead and 10 percent profit for the first $20,000; 7-1/2 percent overhead and 7-1/2 percent profit on the next $30,000; and 5 percent overhead and 5 percent profit on balance over $50,000.

1.4 FIELD DIRECTIVE CHANGE

A. Initiation by Owner: Owner may issue a Field Directive Change with a Notice to Proceed without a prior Request for a Change Order Proposal or the Contractor's signature.

B. Payment Determination: The Owner will designate the method of determining the amount of compensation or credit, if any, based on one of the methods contained in Article 11 of the General Conditions.

C. Timing: Proceed with the change in the Work immediately upon receipt of the Field Directive Change.

D. Addition to Contract: The Field Directive Change will be incorporated into the Contract Documents via a Change Order at a later date.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 31 13

PROJECT COORDINATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work Progress

B. Private Land

C. Work Locations

D. Open Excavations

E. Test Pits

F. Maintenance of Plant Operation

G. Shutdown and Tie-In Coordination

H. Suggested Sequence of Construction

I. Out-of-service Duration Limits

1.2 WORK PROGRESS

A. Furnish personnel and equipment which will be efficient, appropriate and large enough to secure a satisfactory quality of work and a rate of progress which will allow the completion of the work within the time stipulated in the Bid of these Specifications. If at any time such personnel appears to the ENGINEER to be inefficient, inappropriate or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, he may order the CONTRACTOR to increase the efficiency, change the character or increase the personnel and equipment, and the CONTRACTOR shall conform to such order. Failure of the ENGINEER to give such order shall in no way relieve the CONTRACTOR of his obligations to secure the quality of the work and rate of progress.

1.3 PRIVATE LAND

A. Do not enter or occupy private land outside of easements, except by permission of OWNER. Construction operations shall be conducted in accordance with Section 01 57 00.

1.4 WORK LOCATIONS

A. Structures and pipelines shall be located substantially as indicated on the Drawings, but the ENGINEER reserves the right to make such modifications in locations as may be found desirable to avoid interference noted on the Drawings, such notation is for the CONTRACTOR's convenience and does not relieve him from laying and jointing different or additional items where required.

1.5 OPEN EXCAVATIONS

A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons, and damage to property. The CONTRACTOR shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by the public and workmen.

1.6 TEST PITS

A. Test pits for the purpose of locating underground pipeline or structures in advance of the construction shall be excavated and backfilled by the CONTRACTOR. Test pits shall be backfilled immediately after their purpose has been satisfied and maintained in a manner satisfactory to the ENGINEER. The costs for such test pits shall be borne by the CONTRACTOR.

1.7 MAINTENANCE OF PLANT OPERATION

A. The existing plant must be maintained in continuous operation during the entire construction period of the Contract as hereinafter specified. The intent of this Section is to outline the minimum requirements necessary to provide continuous treatment and meeting of all facility permit requirements throughout the construction period.

B. Operational Access: Owner’s personnel shall have access to equipment and areas that remain in operation.

C. Work under the Contract shall be scheduled and conducted by the Contractor so as not to impede any treatment process, reduce the quality of the plant effluent, interfere with the plant’s ability to meet permit requirements, or cause odor or other nuisances to the plant operations and maintenance staff. In performing the work shown and specified, the Contractor shall plan and schedule the work to meet the plant operating requirements in accordance with the constraints and construction requirements as outlined in this Section. No discharge of raw or treated wastewater shall be allowed. The Contractor shall pay all civil penalties, costs, assessments, etc., associated with any discharge of raw or treated wastewater resulting from the Contractor's work.

D. The Contractor shall be responsible for coordinating the general construction and the schedules of all subcontractors and for ensuring that permanent or temporary power

and controls are available for all existing, proposed, and temporary facilities that are required at any given time.

E. The Contractor has the option of providing additional temporary facilities that can eliminate a constraint, provided it is done without additional cost to the Owner and provided that all requirements of these Specifications are fulfilled. Work not specifically covered in the following paragraphs may, in general, be done at any time during the contract period, subject to the operating requirements and constraints and construction requirements outlined hereinafter. All references to days in this Section are in consecutive calendar days.

F. Provide for the flow of sewers, drains, courses interrupted during the progress of the work, and shall immediately cart away and remove all offensive matter. The entire procedure of maintaining existing flow shall be fully discussed with the Engineer well in advance of the interruption of any flow.

G. Do not shut off or disconnect existing operating systems, unless accepted by Engineer in writing. Operation of existing equipment will be by Owner unless otherwise specified or indicated. Where necessary for the Work, Contractor shall seal or bulkhead Owner-operated gates and valves to prevent leakage that may affect the Work, Owner's operations, or both. Provide temporary watertight plugs, bulkheads, and line stops as required. After completing the Work, remove seals, plugs, bulkhead, and line stops to satisfaction of Engineer.

H. General Constraints:

1. The Contractor shall schedule the work so that the plant is maintained in continuous operation. All treatment processes shall be maintained in continuous operation during the construction period except during approved process interruptions. All short-term system or partial system shutdowns and/or diversions shall be approved by the engineer with concurrence from Owner's operations staff. Long-term process shutdowns and diversions shall conform to the requirements hereinafter specified and shall be minimized by the Contractor as much as possible. If in the judgment of the Owner a requested shutdown is not required for the Contractor to perform the work, the Contractor shall utilize approved alternative methods to accomplish the work. All shutdowns shall be coordinated with the Owner and scheduled at times suitable to the Owner. Shutdowns shall not begin until all required materials are on hand and ready for installation. Each shutdown period, with no temporary services in place, shall commence at a time approved by the Owner, and the Contractor shall proceed with the work continuously, (24 hours/day, 7 days/week) start to finish, until the work is completed and normal plant operation is restored. If the Contractor completes all required work before the specified shutdown period has ended, the Owner may immediately place the existing system back into service once accepted.

2. Short-term shutdowns in ability to operate equipment will be allowed for tie-ins to existing piping or for disconnection and/or reconnection of equipment power feeds. All such shutdowns shall be scheduled at times approved by the Owner and shall be for durations as agreed to with the Owner, but no more than four (4) hours. The schedule and duration of short-term shutdowns shall be at the discretion of the Owner.

3. The Contractor shall schedule shutdowns in advance and shall present all desired shutdowns in the 30 and 60-day schedules at the progress meetings. Shutdowns shall be fully coordinated with the plant superintendent at least 72 hours before the scheduled shutdown. Owner personnel shall operate Owner's facilities involved in the shutdowns.

4. Any temporary work, access ramps, equipment, pathways, protection of existing structures, piping, blind flanges, valves, equipment, etc. that may be required within the Contractor's work limits to maintain continuous and dependable plant operation shall be furnished by the Contractor at the direction of the Engineer at no additional cost to the Owner.

5. The Owner shall have the authority to order work postponed, stopped, or prohibited that would, in their opinion, unreasonably result in interrupting the necessary functions of the plant operations.

6. If the Contractor impairs performance or operation of the plant as a result of not complying with specified provisions for maintaining plant operations, then the Contractor shall immediately make all repairs or replacements and do all work necessary to restore the plant to operation to the satisfaction of the Owner. Such work shall progress continuously to completion on a 24-hours per day, seven work days per week basis at the Contractor’s expense.

7. Plumbing Facilities: Sanitary facilities in the existing structures shall be operational at all times and shall be for plant operating personnel exclusively. Temporary sanitary facilities for the Contractor’s use shall be supplied by the Contractor and shall be either connected to waste collection facilities approved by the Owner or periodically pumped out by the Contractor at appropriate intervals.

8. Building Air Conditioning and Ventilating: Building air conditioning and ventilating for the existing plant structures shall be in service for the entire construction period. For air conditioning and ventilation systems being replaced under this contract, the existing system shall remain in service until the replacement system is ready to be installed and temporary air conditioning and ventilation shall be provided as required to adequately cool and vent facilities under construction and/or while systems are being replaced.

9. Power, Light and Communications Systems (General): Electric power, lighting service and communications systems shall be maintained in uninterrupted operation in all areas of the facility. Individual units may be disconnected as required for replacement, but service shall be available at all times including periods when plant elements are out of service. The Contractor and electrical subcontractor shall coordinate shutdowns required to minimize the total number of shutdowns needed to complete construction. Owner's phone service to the plant shall be maintained in continuous operation during construction. Temporary excavations, blocking of normal access routes, and areas of active construction shall be well marked and cordoned off for safety of plant personnel and well lit at night using temporary lighting. CONTRACTOR shall pay all necessary costs related to continuously maintain the plant's power, lighting, and communications systems which may be impacted by the Work either as needed to complete the Work or for repairs resulting from accidental interruption.

10. Draining Process Pipes and Conduits (General): The contents of all pipes and conduits to be removed, replaced or relocated (or dewatered for a specific purpose) shall be transferred to a suitable facility in a manner approved by the Owner through hoses or piping, or by using pumps if hydraulic conditions so require them. The Contractor shall provide the pumps, piping and hoses at no additional cost to the Owner. No uncontrolled spillage of a pipe or conduit shall be permitted. Any spillage, other than potable water, shall be immediately washed down and flushed into an appropriate collection area. Contractor shall be responsible for making required notifications to applicable regulatory agency and pay all fees associated with such spills caused by construction activities.

11. Potable Water System: Potable water service shall be maintained in continuous service at all times during construction except for short term interruptions required for tie-ins. Shutdown of the potable water system shall be fully planned and coordinated with the Owner and shall be limited to not more than two (2) hours. Existing fire hydrants on potable water lines within the plant site shall be operational at all times, unless otherwise approved by the Owner.

12. Non-potable Water System: The existing non-potable water (reuse water) service shall be maintained in continuous operation during construction except for short term tie-ins of new or temporary facilities to existing facilities, until the new or re-routed non-potable water lines are brought into service. Temporary non-potable service for seal water systems shall be provided by the Contractor as necessary to insure continuous, uninterrupted service of these critical systems.

13. Sump Pumps and Sumps: All existing sumps shall be maintained in an operable condition with either existing pumps or temporary pumps. Interim piping, power and controls shall be provided as required by the staged construction sequence.

14. Stormwater Ponds and Drainage: All existing drainage inlets, swales, and drainage culverts shall remain in service throughout the construction period such that no flooding of the existing facilities or grounds occurs.

1.8 SHUTDOWN AND TIE-IN COORDINATION

A. Coordination:

1. Review installation procedures under other Specification sections and coordinate Work that must be performed with or before the Work specified in this Section.

2. Notify other contractors in advance of Work requiring coordination with Owner's operations, to provide other contractors sufficient time for work included in their contracts that must be installed with or before Work specified in this Section.

3. When possible, combine multiple tie-ins into a single shutdown to minimize impacts on Owner's operations and processes.

B. Pre-Shutdown Meetings: Contractor shall schedule and conduct meeting with Owner and Engineer prior to scheduling shutdown.

C. Sequencing:

1. Perform the Work in the specified sequence. Certain phases or stages of the Work may require working 24-hour days or work during hours outside of regular working hours. Work may be accelerated from a later stage to an earlier stage if Owner's operations are not adversely affected by proposed sequence change, with Engineer's acceptance. Stages specified in this Section are sequential in performance of the Work.

D. Scheduling:

1. Work that may interrupt normal operations shall be accomplished at times convenient to Owner.

2. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, equipment, spare parts and materials, both temporary and permanent, necessary to successfully complete the shutdown. Complete to the extent

possible, prefabrication of piping and other assemblies prior to the associated shutdown Demonstrate to Engineer's satisfaction that Contractor has complied with these requirements before commencing the shutdown.

3. If Contractor's operations cause an unscheduled interruption of Owner's operations, immediately re-establish satisfactory operation for Owner.

4. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of Owner's facilities that result in fines or penalties by authorities having jurisdiction shall be paid solely by Contractor if, in Engineer's opinion, Contractor did not conform to the requirements of the Contract Documents, or was negligent in the Work, or did not exercise proper precautions in conducting the Work.

5. Work requiring service interruptions for tie-ins shall be performed during scheduled shutdowns.

6. Temporary, short-term shutdowns of smaller piping, conduits, equipment, and systems may be required. Coordinate requirements for such shutdowns with Engineer and Owner.

E. Submittals

1. Action/Informational Submittals:

a. Shutdown Planning Submittal:

(1) For each shutdown, submit an inventory of labor and materials required to perform the shutdown and tie-in tasks, an estimate of time required to accomplish the complete shutdown including time for Owner to take down and start up existing equipment, systems, or conduits, and written description of steps required to complete the Work associated with the shutdown.

(2) Furnish submittal to Engineer at least thirty (30) days prior to proposed shutdown start date. Do not start shutdown until obtaining Engineer's acceptance of shutdown planning submittal.

b. Shutdown Notification: After acceptance of shutdown planning submittal and prior to starting the shutdown, provide written notification to Owner and Engineer of date and time each shutdown is to start. Provide notification at least 72 hours in advance of each shutdown.

1.9 SUGGESTED SEQUENCE OF CONSTRUCTION

A. Work under the Contract shall be scheduled and performed in such a manner as to result in the least possible disruption to the operation of the existing treatment facilities. Process control modifications shall not be made without first obtaining written permission from the Engineer. Areas of the work may require the Contractor to dewater wastewater lines. The Contractor shall be responsible for the proper containment and disposal of wastewater drained from pipelines during construction. The Contractor shall contain such wastewater (in accordance with all applicable codes) and shall dispose of such to an on-site wastewater basin as directed by the Owner.

B. The sequence of construction shall be such as to minimize interferences and disruptions to the wastewater reclamation facility, roads, homeowners, other utilities, and to the normal operation of other agencies having jurisdiction over the project.

C. At no time shall the Contractor undertake to close off any pipelines, or open valves, or take any other action that would affect the operation of the existing system, except as specifically required by the Contract Documents, after authorization is granted by the Owner or Engineer and after proper notification.

D. At no time shall the Contractor interrupt traffic, close streets or redirect traffic without previous authorization from the agencies having jurisdiction over the project.

E. The Owner may require the Contractor to finish certain portions of work that is in progress before work is started on any additional portion. The Owner may also require the Contractor to wait for completion of work being performed by other contractors.

F. Perform the Work in the specified sequence or as otherwise approved by Engineer. Certain phases or stages of the Work may require working 24-hour days or work during hours outside of regular working hours. Work may be accelerated from a later stage to an earlier stage if Owner’s operations are not adversely affected by proposed sequence change, and with Engineer’s acceptance. The sequence of construction is a precedence requirement and does not attempt to schedule the Contractor's work. It is intended only to indicate which activities must precede other activities in order to minimize interferences and disruptions. The construction sequence described herein includes recommended phasing of the work. If an alternate phasing is proposed by the Contractor, the Contractor shall gain full approval of the Engineer before proceeding.

G. Stage 1:

1. Mobilize and prepare the Site to receive the Work.
2. Prepare site for generator slab and building construction.
3. Construct generator slab and switchgear building.
4. Supply and install lightning protection, bonding & grounding systems.
5. Construct underground ductbanks and FPL service lateral.
6. Install owner provided stand-by generator.
7. Supply and install new HVAC equipment.
8. Supply and install new switchgear and electrical equipment.
9. Supply and install new MCC VFDs.
10. Supply and install new PLC control panel.
11. Perform Electrical Testing.
12. Supply Arc Flash and Coordination Study.
13. Start up and test PLC.
14. Start up and test generator, switchgear, MCC and VFDs.

H. Stage 2:

1. Install temporary wiring.
2. Bring (1) Motor Control Center online with the new service at a time. After a 3 day performance test with uninterrupted power move on to the next MCC.
3. Bring (1) Blower online with the new service at a time. After a 3 day performance test with uninterrupted power move on to the next Blower.
4. Bring (1) Effluent Pump online with the new service at a time. After a 3 day performance test with uninterrupted power move on to the next Effluent Pump.
5. Substantial Completion

I. Stage 3:

1. Complete demolition of generator and above ground fuel tank.

2. Complete demolition of FPL vault equipment and underground primary.

3. Complete Surface restoration and cleaning activities.

4. Final walkthrough and punch list.

5. Final Completion.

1.10 OUT OF SERVICE DURATION LIMITS

A. At no time during the project should the plant be completely out of electrical service. The contractor shall plan to use the existing generator, existing electrical service and new generator in order to limit service disruptions.

B. The temporary power feeds shall be sequenced such that the out of service duration for each feeder replacement is limited to 2 hours.

PART 2 PRODUCTS

2.1 PROTECTION OF CONSTRUCTION AND EQUIPMENT

A. All newly constructed work shall be carefully protected from damage in any way. No wheeling or walking or placing of heavy loads on it shall be allowed and all portions damaged shall be reconstructed by the CONTRACTOR at his own expense.

B. All structures shall be protected in a manner approved by the ENGINEER. Should any of the floors or other parts of the structures become heaved, cracked or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the CONTRACTOR at his own expense and to the satisfaction of the ENGINEER. Special attention is directed to substructure bracing requirements, described in Section 31 40 00. If, in the final inspection of the work, any defects, faults or omissions are found, the CONTRACTOR shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. The CONTRACTOR shall be fully responsible for the satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the guarantee period described in the contract.

C. Take all necessary precautions to prevent damage to any structure due to water pressure during and after construction and until such structure is accepted and taken over by the OWNER.

PART 3 EXECUTION

3.1 PROTECTION OF CONSTRUCTION AND EQUIPMENT

A. Sequence and schedule work in a manner to preclude delays and conflicts between the work of various trades and contractors. Each trade shall keep informed as to the work of other trades on the project and shall execute their work in a manner that will not interfere with the work of other trades.

3.2 DIAGRAMMATIC NATURE OF DRAWINGS

A. Where layout is diagrammatic, such as pipelines, conduits, ductwork, etc., it shall be followed as closely as other work will permit. Changes from diagrams shall be made as required to conform to the construction requirements.

B. Before running lines, carefully verify locations, depths and sizes and confirm that lines can be run as contemplated without interfering with other construction. Any deviation shall be referred to the ENGINEER for approval before lines are run. Minor changes in location of the equipment, fixtures, piping, etc., from those shown on the Drawings, shall be made without extra charge if so directed by the ENGINEER before installation.

C. Determine the locations and sizes of equipment, fixtures, conduit, ducts, openings, etc., in order that there will be no interference in the installation of the work or delay in the progress of other work. In the event that interferences develop, the ENGINEER's decision regarding relocation of work will be final.

D. Any changes made necessary through failure to make proper arrangements to avoid interference shall not be considered as extras. Cooperate with those performing other work in preparation of interference drawings, to the extent that the location of piping, ductwork, etc., with respect to the installations of other trades shall be mutually agreed upon by those performing the work.

3.3 PROVISIONS FOR LATER INSTALLATION

A. Where any work cannot be installed as the construction is progressing, provide for boxes, sleeves, inserts, fixtures or devices as necessary to permit installation of the omitted work during later phases of construction. Arrange for chases, holes, and other openings in the masonry, concrete or other work and provide for subsequent closure after placing equipment. Arrangement for and closure of openings shall be subject to the approval of the ENGINEER and all costs therefor shall be included in the contract price for the work.

3.4 COORDINATION

A. The CONTRACTOR shall be fully responsible for the coordination of his work and the wok of his employees, subcontractors, and suppliers with the OWNER, and regulatory agencies, and assure compliance with schedules.

END OF SECTION

SECTION 01 31 19

PROJECT MEETINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Coordination

B. Preconstruction Conference

C. Progress Meetings

D. Submittals

1.2 COORDINATION

A. General: Coordinate scheduling, submittals, and Contract work to assure efficient and orderly sequence of installation of interdependent construction elements.

1.3 PRECONSTRUCTION CONFERENCE

A. General: Prior to commencement of the Work, in accordance with the General Conditions, the OWNER will conduct a preconstruction conference to be held at a predetermined time and place.

B. Delineation of Responsibilities: The purpose of the conference is to designate responsible personnel, to establish a working relationship among the parties and to identify the responsibilities of the OWNER, plant personnel and the CONTRACTOR/VENDOR. Matters requiring coordination will be discussed and procedures for handling such matters, established. The agenda will include:

1. Submittal procedures
2. Partial Payment procedures
3. Maintenance of Records
4. Schedules, sequences and maintenance of facility operations
5. Safety and First Aid responsibilities
6. Change Orders and Field Directive Changes
7. Use of site
8. Housekeeping
9. Equipment delivery

C. Attendees: The preconstruction conference is to be attended by the representatives of the CONTRACTOR/VENDOR, the OWNER and plant personnel that will be

associated with the project. Representatives of regulatory agencies, subcontractors, and principal suppliers may also attend when appropriate.

D. Chair and Minutes: The preconstruction conference will be chaired by the Owner who will also arrange for the keeping and distribution of minutes to all attendees.

1.4 PROGRESS MEETINGS

A. Meeting Frequency and Format: Schedule progress meetings on at least a monthly basis or more frequently as warranted by the complexity of the Project, to review the Work, discuss changes in schedules, maintain coordination and resolve potential problems. Invite OWNER, ENGINEER and all SUBCONTRACTOR/VENDORs. Suppliers may be invited as appropriate. Minutes of the meeting will be maintained by CONTRACTOR/VENDOR and reviewed by ENGINEER prior to distribution by the CONTRACTOR/VENDOR. Distribute reviewed minutes to attendees within 7 calendar days after each meeting.

1. Agenda, minimum:
   a. Review, comment, and amendment (if required) of minutes of previous progress meeting.

   b. Review of progress since the previous progress meeting.

   c. Planned progress through next 30 – 60 days.

   d. Review of Progress Schedule

      (1) Contract Times, including Milestones (if any)

      (2) Critical path.

      (3) Schedules for fabrication and delivery of materials and equipment.

      (4) Corrective measures, if required.

   e. Submittals:

      (1) Review of status of critical submittals.

      (2) Review revisions to schedule of submittals.

   f. Contract Modifications:

(1) Requests for interpretation

(2) Clarification notices

(3) Field Orders

(4) Proposal requests

(5) Change Proposals

(6) Work Change Directives

(7) Change Orders

(8) Claims

g. Applications for progress payments.

h. Problems, conflicts, and observations.

i. Quality standards, testing, and inspections.

j. Coordination between parties.

k. Site management issues, including access, security, maintenance and protection of traffic, maintenance, cleaning, and other Site issues.

l. Safety.

m. Permits.

n. Record documents status.

o. Punch list status, as applicable.

p. Other business.

1.5 SUBMITTALS

A. Pre-Construction Meeting Submittals: Prior to the conference, submit the following preliminary schedules in accordance with the General Conditions.

1. Progress schedule.

2. Schedule of submittals.

3. Schedule of values.

4. Contractor's safety and first aid procedures.

5. Confined space entry plan.

6. List of emergency contact information.

B. Progress Meeting Submittals:

1. List of Work accomplished since the previous progress meeting.

2. Up-to-date Progress Schedule.

3. Up-to-date Schedule of Submittals.

4. Detailed "look-ahead" schedule of Work planned through the next progress meeting, with specific starting and ending dates for each activity, including shutdowns, deliveries of important materials and equipment, Milestones (if any), and important activities affecting the Owner, Project, and Site.

5. When applicable, list of upcoming, planned time off (with dates) for personnel with significant roles on the Project, and the designated contact person in their absence.

C. Emergency Contact Information

1. Contractor shall provide list of emergency contact information for 24-hour use throughout the Project. Emergency contact information shall be updated and kept current throughout the Project. If personnel or contact information change, provide updated emergency contact information list at the next progress meeting.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 32 16

PROGRESS SCHEDULE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Form of Schedules

B. Content of Schedules: Submit for approval, a preliminary progress schedule in accordance with the General Conditions.

C. Schedule Revisions

D. Submittal Requirements

1.2 FORM OF SCHEDULES

A. Prepare schedules in form of a horizontal bar chart.

1. Provide separate horizontal bar for each trade or operation.

2. Utilize a horizontal time scale and identify first work day of each week.

3. Utilize scale and spacings to allow space for notations and future revisions.

B. Utilize a listing format which chronologically indicates the order of start of each item of work.

C. Identify each listing by major specification section numbers.

D. The Contractor's progress schedule shall be computer generated and resource loaded. Each construction progress schedule and associated report shall include the following tabulations: a list of activities in numerical order, a list of activity precedence, schedules sequenced by Early Start Date, Total Float, and Late Start Date. Each schedule and report shall include the following minimum items.

1. Activity Numbers

2. Estimated Duration

3. Activity Description

4. Early Start Date (Calendar Dated)

5. Early Finish Date (Calendar Dated)

6. Latest Allowable Start Date (Calendar Dated)

7. Latest Allowable Finish Date (Calendar Dated)

8. Status (whether critical)

9. Estimated Cost of the Activity

10. Total Float and Free Float

E. In addition, each construction progress schedule, network analysis and report shall be prefaced with the following summary data:

1. Contract Name and Number

2. Contractor's Name

3. Contract Duration and Float

4. Contract Schedule

5. The Effective or Starting Date of The Schedule (the date indicated in the Notice-to-Proceed)

1.3 CONTENT OF SCHEDULES

A. Completion Dates: Show the beginning and ending contract dates stated in documents. Schedules showing completion prior to the contract completion date will be accepted but in no event will they be considered basis for a claim for delay against the OWNER by the CONTRACTOR for the period between the early completion date and the completion date provided in the Contract Documents.

B. Show complete sequence of construction by activity.

C. Show dates for beginning and completion of each major element of construction and installation dates for major items of equipment. Elements shall include, but not be limited to, the following:

1. Shop drawing receipt from supplier/manufacturer submitted to ENGINEER, review and return to supplier/manufacturer

2. Material and equipment order, manufacturer, delivery, installation, and checkouts

3. Performance tests and supervisory services activity

4. Construction of various facilities

5. Demolition

6. Excavation, sheeting, shoring, dewatering

7. Concrete Placement sequence

8. Structural Construction

9. Building Construction

10. Generator pad construction

11. Electrical work activity

12. HVAC Work Activity

13. Instrumentation and Control work activity

14. Subcontractor's items of work

15. Backfilling, grading, seeding, sodding, landscaping, fence construction, and paving

16. Final cleanup

17. Allowance for inclement weather

D. Show projected percentage of completion for each item as of first day of each month.

1.4 SCHEDULE REVISIONS

A. As a minimum, revise construction schedule every 30 calendar days to reflect changes in progress of Work for duration of Contract.

B. Indicate progress of each activity at date of submittal.

C. Show changes occurring since previous submittal of schedule.

1. Major change in scope
2. Activities modified since previous submittal
3. Revised projections of progress and completion
4. Other identifiable changes

D. Provide a written report as needed to define:

1. Problem areas, anticipated delays, and impact on schedule
2. Corrective action recommended and its effect
3. Effect of changes on schedules of other Contractors

E. If the Contractor desires to make changes in its method of operating which affect the construction progress schedule and related items, the Contractor shall notify the Engineer in writing stating what changes are proposed and the reason for the change. If the Engineer accepts these changes, in writing, the Contractor shall revise and submit, without additional cost to the Owner, all of the affected portions of the construction progress schedule, and associated reports. The construction progress schedule and related items shall be adjusted by the Contractor only after prior acceptance, in writing by the Engineer. Adjustments may consist of changing portions of the activity sequence, activity durations, division of activities, or other adjustments as may be required. The addition of extraneous, nonworking activities and activities which add restraints to the construction progress schedule shall not be accepted.

F. Except where earlier completions are specified, schedule dates which show completion of all Work prior to the contract completion date shall, in no event, be the basis for claim for delay against the Owner by the Contractor.

G. Construction progress schedules and related items which contain activities showing negative float or which extend beyond the contract completion date will not be accepted by the Engineer.

H. Whenever it becomes apparent from the current construction progress schedule and associated reports that delays to the critical path have resulted and the contract completion date will not be met, or when so directed by the Engineer, the Contractor shall take some or all of the following actions at no additional cost to the Owner. They shall submit to the Engineer for approval, a written statement of the steps they intend to take to remove or arrest the delay to the critical path in the

current construction progress schedule, including a computer-generated schedule revision to reflect proposed actions.

1. Increase construction manpower in such quantities and crafts as will substantially eliminate the backlog of work.

2. Increase the number of working hours per shift, shifts per day, working days per week, the amount of construction equipment, or any combination of the foregoing, sufficiently to substantially eliminate the backlog of work.

3. Reschedule activities to achieve maximum practical concurrency of accomplishment of activities, and comply with the revised schedule.

I. If so requested by the Engineer, the Contractor should fail to submit a written statement of the steps they intend to take or should fail to take such steps as reviewed and accepted in writing by the Engineer, the Engineer may direct the Contractor to increase the level of effort in manpower (trades), equipment and work schedule (overtime, weekend and holiday work, etc.) to be employed by the Contractor in order to remove or arrest the delay to the critical path in the current construction progress schedule, and the Contractor shall promptly provide such level of effort at no additional cost to the Owner.

J. If the completion of any activity, whether or not critical, falls more than 100 percent behind its previously scheduled and accepted duration, the Contractor shall submit for approval a schedule adjustment showing each such activity divided into two activities reflecting completed versus uncompleted work.

K. Shop drawings which are not approved on the first submittal or within the time scheduled, and equipment which does not pass the specified tests and certifications shall be immediately rescheduled.

L. The contract time will be adjusted only in accordance with the General Conditions and other portions of the Contract Documents as may be applicable. If the Engineer finds that the Contractor is entitled to any extension of the contract completion date, the Engineer's determination as to the total number of days extension shall be based upon the current construction progress schedule and on all data relevant to the extension. Such data shall be included in the next updating of the schedule and related items. Actual delays in activities which, according to the construction progress schedule, do not affect any contract completion date will not be the basis for a change therein.

M. From time to time it may be necessary for the contract schedule of completion time to be adjusted by the Engineer in accordance with the General Conditions and other portions of the Contract Documents as may be applicable. Under such conditions, the Engineer will direct the Contractor to reschedule the Work or contract completion time to reflect the changed conditions, and the Contractor

shall revise the construction progress schedule and related items accordingly, at no additional cost to the Owner.

N. Float belongs to the Project and may be used by Owner, Engineer, or Contractor to accommodate modifications, regardless of origination, in the Work or to mitigate the effect of events that may delay performance or completion of the Work. Changes or delays that influence scheduled Work Activities with Float and that do not extend the critical path will not be justification for an extension in Contract Times.

O. The Owner controls the float time and, therefore, without obligation to extend either the overall completion date or any intermediate completion dates, the Owner may initiate changes that absorb float time only. Owner initiated changes that affect the critical path on the network diagram shall be the sole grounds for extending the completion dates. Contractor initiated changes that encroach on the float time may be accomplished only with the Engineer's concurrence. Such changes, however, shall give way to Owner initiated changes competing for the same float time.

P. To the extent that the construction project schedule, or associated report or any revision thereof shows anything not jointly agreed upon or fails to shown anything jointly agreed upon, it shall not be deemed to have been accepted by the Engineer. Failure to include on a schedule any element of Work required for the performance of this Contract shall not excuse the Contractor from completing all Work required within any applicable completion date, not withstanding the review of the schedule by the Engineer.

Q. Review and acceptance of the construction progress schedule, and related reports, by the Engineer is advisory only and shall not relieve the Contractor of the responsibility for accomplishing the Work within the contract completion date. Omissions and errors in the construction progress schedule, and related reports shall not excuse performance less than that required by the Contract and in no way make the Engineer an insurer of the Contractor's success or liable for time or cost overruns flowing from any shortcomings in the construction progress schedule, and related reports.

1.5 SUBMITTAL REQUIREMENTS

A. Schedule: Submit final progress schedule in accordance with the General Conditions.

B. For preliminary and final submittal of construction progress schedule and subsequent revisions thereof furnish three copies to ENGINEER.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

(NO TEXT FOR THIS SECTION)

SECTION 01 33 00

SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description of Requirements

B. Submittal Procedures

C. Specific Submittal Requirements

D. Action on Submittals

E. Submittal Identification System

F. Repetitive Review

1.2 DESCRIPTION OF REQUIREMENTS

A. This section specifies procedural requirements for Shop Drawings, product data, samples, and other miscellaneous Work-related submittals.

B. Procedures concerning items such as listing of manufacturers, suppliers, subcontractors, construction progress schedule, schedule of Shop Drawing submissions, bonds, payment applications, insurance certificates, and schedule of values are specified elsewhere.

C. A general summary of the format and types of submittals required is as follows:

Format of Submittal	Type of Submittal
Digital and Hard Copy	Construction Schedule
Digital and Hard Copy	Schedule of Payment Items
Digital	Shop Drawings
Digital and Hard Copy	Warranties
Digital and Hard Copy	Certifications
Actual Samples	Product Samples

Digital	Preliminary O&M Manuals
Digital and Hard Copy	Final O&M Manuals
Digital	Photographs

D. At the preconstruction conference, submit a detailed list of items for which shop drawings, construction drawings, and samples will be submitted. Included in this list shall be the names of all proposed Suppliers furnishing specified items. Review of this list by the Engineer shall not relieve Contractor from submitting complete drawings and data and providing materials, equipment, etc., fully in accordance with the Contract Documents.

E. All submittals shall be submitted in digital, electronic, pdf format, other than samples. When hard copies are required, as noted above, submit the number of copies as noted herein. For all digital submittals, the Contractor shall submit one electronic copy to the Engineer via email or approved file share site. The Engineer will return one electronic file of each submittal with engineer's stamp and response comments via email or approved file share site with notification to the Contractor and Owner via e-mail. The Contractor shall be responsible to distribute the submittal response as needed to subcontractors impacted by each individual submittal. In the case of samples, an electronic submittal transmittal shall still be made with a description of the sample submitted with all samples delivered to an address approved by the Owner.

F. All graphical and textual-type submittals and documentation including operation and maintenance manuals shall be rendered and submitted in PDF format via email in the latest version of Microsoft Word or Adobe Acrobat Reader format or equivalent browser-based format. Graphical images shall be JPEG or equivalent browser-based formats.

G. Work-Related Submittals:

1. Substitution or "Or Equal" Items:

    a. Includes material or equipment CONTRACTOR requests ENGINEER to accept, after Bids are received, as substitute for items specified or described in Specifications by using name of a proprietary item or name of particular supplier.

2. Shop Drawings:

    a. Includes technical data and drawings specially prepared for this Project, including fabrication and installation drawings, diagrams, actual performance curves, data sheets, schedules, templates, patterns, reports,

instructions, design mix formulas, measurements, and similar information not in standard printed form.

b. Standard information prepared without specific reference to the Project is not considered a Shop Drawing.

3. Product Data:

a. Includes standard printed information on manufactured products, and systems that has not been specially prepared for this Project, including manufacturer's product specifications and installation instructions, catalog cuts, standard wiring diagrams, printed performance curves, mill reports, and standard color charts.

4. Samples:

a. Includes both fabricated and manufactured physical examples of materials, products, and units of work, partial cuts of manufactured or fabricated work, swatches showing color, texture, and pattern, and units of work to be used for independent inspection and testing.

b. Mock-ups are special forms of samples which are too large or otherwise inconvenient for handling in manner specified for transmittal of sample submittals.

5. Working Drawings:

a. When used in the Contract Documents, the term “working drawings” shall be considered to mean the CONTRACTOR’S plans for temporary structures such as temporary bulkheads, support of open cut excavation, support of utilities control systems, forming and falsework for underpinning; temporary by-pass pumping and for such other work as may be required for construction but does not become an integral part of the project.

b. Copies of working drawings shall be submitted to the ENGINEER at least fourteen (14) calendar days (unless otherwise specified by the ENGINEER) in advance of the required work.

c. Working drawings shall be signed by a registered Professional Engineer currently licensed to practice in the State of Florida and shall convey, or be accompanied by, calculation or other sufficient information to completely explain the structure, machine, or system described and its intended manner of use.

6. Miscellaneous Submittals:

a. Work-related submittals that do not fit in the previous categories, such as guarantees, warranties, certifications, experience records, maintenance agreements, Operating and Maintenance Manuals, workmanship bonds, survey data and reports, physical work records, quality testing and certifying reports, copies of industry standards, record drawings, field measurement data, and similar information, devices, and materials applicable to the Work.

1.3 SUBMITTAL PROCEDURES

A. Scheduling:

1. Submit for approval, a preliminary schedule of shop drawings and samples submittals, in duplicate, and in accordance with the General Conditions.

2. Prepare and transmit each submittal to ENGINEER sufficiently in advance of scheduled performance of related work and other applicable activities.

B. Coordination:

1. Coordinate preparation and processing of submittals with performance of work. Coordinate each submittal with other submittals and related activities such as substitution requests, testing, purchasing, fabrication, delivery, and similar activities that require sequential activity.

2. Coordinate submission of different units of interrelated work so that one submittal will not be delayed by ENGINEER's need to review a related submittal. ENGINEER may withhold action on any submittal requiring coordination with other submittals until related submittals are forthcoming.

C. Submittal Preparation:

1. Stamp and sign each submittal certifying to review of submittal, verification of products, field measurement, field construction criteria, coordination of information within submittal with requirements of the Work and the Contract Documents, coordination with all trades, and verification that product will fit in space provided.

2. Transmittal Form: In the transmittal form forwarding each specific submittal to the ENGINEER include the following information as a minimum.

a. Date of submittal and dates of previous submittals containing the same material.

b. Project title and number.

c. Submittal and transmittal number.

d. Contract identification.

e. Names of:

(1) Contractor
(2) Supplier
(3) Manufacturer

f. Identification of equipment and material with equipment identification numbers, model numbers, and Specification section number.

g. Variations from Contract Documents and any limitations which may impact the Work.

h. Drawing sheet and detail number as appropriate.

D. Resubmittal Preparation:

1. Comply with the requirements described in Submittal Preparation. In addition:

a. Identify on transmittal form that submittal is a resubmission.

b. Make any corrections or changes in submittals required by ENGINEER's notations on returned submittal.

(1) Respond to ENGINEER's notations:

a) On the transmittal or on a separate page attached to CONTRACTOR's resubmission transmittal, answer or acknowledge in writing all notations or questions indicated by ENGINEER on ENGINEER's transmittal form returning review submission to CONTRACTOR.

b) Identify each response by question or notation number established by ENGINEER.

c) If CONTRACTOR does not respond to each notation or question, resubmission will be returned without action by ENGINEER until CONTRACTOR provides a written response to all ENGINEER's notations or questions.

(2) CONTRACTOR initiated revisions or variations:

a) On transmittal form identify variations or revisions from previously reviewed submittal, other than those called for by ENGINEER.

b) ENGINEER's responsibility for variations or revisions is established in the General Conditions.

1.4 SPECIFIC SUBMITTAL REQUIREMENTS

A. Specific submittals required for individual elements of work are specified in the individual Specification sections. Except as otherwise indicated in Specification sections, comply with requirements specified herein for each indicated type of submittal.

B. Requests for Substitution or "Or Equal"

1. Collect data for items to be submitted for review as substitution into one submittal for each item of material or equipment in accordance with the General Conditions.

2. Submit with other scheduled submittals for the material or equipment allowing time for ENGINEER to evaluate the additional information required to be submitted.

3. If CONTRACTOR requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, schedule substitution submittal request in Submittal schedule and submit as scheduled.

C. Shop Drawings:

1. Check all drawings, data and samples before submitting to the ENGINEER for review. Each and every copy of the drawings and data shall bear CONTRACTOR’s stamp showing that they have been so checked. Shop drawings submitted to the ENGINEER without the CONTRACTOR’s stamp will be returned to the CONTRACTOR for conformance with this requirement. All shop drawings shall be submitted through the CONTRACTOR, including those from any subcontractors.

2. Submit newly prepared information, with graphic information at accurate scale. Indicate name of manufacturer or supplier (firm name). Show dimensions and clearly note which are based on field measurement; identify materials and products which are included in the Work; identify revisions. Indicate compliance with standards and notation of coordination requirements with other work. Highlight, encircle or otherwise indicate variations from Contract Documents or previous submittals.

3. Include on each drawing or page:

a. Submittal date and revision dates.

b. Project name, division number and descriptions.

c. Detailed specifications section number and page number.

d. Identification of equipment, product or material.

e. Name of CONTRACTOR and Subcontractor.

f. Name of Supplier and Manufacturer.

g. Relation to adjacent structure or material.

h. Field dimensions, clearly identified.

i. Standards or Industry Specification references.

j. Identification of deviations from the Contract Documents.

k. CONTRACTOR's stamp, initialed or signed, dated and certifying to review of submittal, certification of field measurements and compliance with Contract.

l. Physical location and location relative to other connected or attached material at which the equipment or materials are to be installed.

4. Provide 8-inch by 3-inch blank space for CONTRACTOR and ENGINEER stamps.

5. Submittals:

a. Submit 1 PDF.

6. Distribution:

a. Do not proceed with installation of materials, products or systems until copy of applicable product data showing only approved information is in possession of installer.

b. Maintain one set of product data (for each submittal) at Project site.

c. Mark 5 additional copies with the date of approval and forward to the Engineer for use in field and for Owner's records.

D. Product Data:

1. Preparation:

a. Collect required data into single submittal for each element of work or system. Where product data has been printed to include information on several similar products, some of which are not required for use on Project or are not included in submittal, mark copies to clearly show such information is not applicable.

b. Where product data must be specially prepared for required products, materials or systems, because standard printed data are not suitable for use, submit data as a Shop Drawing and not as product data.

2. Submittals:

a. Submittal is for information and record, and to determine that products, materials, and systems comply with Contract Documents. Submittal is final when returned by ENGINEER marked "Approved" or "Approved as Noted".

b. Submit 1 PDF.

3. Distribution:

a. Do not proceed with installation of materials, products or systems until copy of applicable product data showing only approval information is in possession of installer.

b. Maintain one set of product data (for each submittal) at Project site, available for reference by ENGINEER and others.

c. Make 3 additional copies with the date of approval and forward to the Engineer for use in field and for Owner records.

E. Samples:

1. Preparation:

a. Where possible, provide samples that are physically identical with proposed materials or products to be incorporated into the Work. Where variations in color, pattern or texture are inherent in material or product represented by sample, submit multiple units (not less than 3 units) showing approximate limits of variations.

b. Provide full set of optional samples where ENGINEER's selection required. Prepare samples to match ENGINEER's selection where so indicated.

c. Include information with each sample to show generic description, source or product name and manufacturer, limitations, and compliance with standards.

d. Submit samples for ENGINEER's visual review of general generic kind, color, pattern, texture, and for final check of coordination of these characteristics with other related elements of work.

2. Submittals:

a. At CONTRACTOR's option, and depending upon nature of anticipated response from ENGINEER, initial submittal of samples may be either preliminary or final submittal.

b. A preliminary submittal, consisting of a single set of samples, is required where specifications indicate ENGINEER's selection of color, pattern, texture or similar characteristics from manufacturer's range of standard choices is necessary. Preliminary submittals will be reviewed and returned with ENGINEER's "Action" marking.

c. Final Submittals: Submit 3 sets of samples in final submittal, 1 set will be returned.

3. Distribution:

a. Maintain returned final set of samples at Project site, in suitable condition and available for quality control comparisons throughout course of performing work.

b. Returned samples intended or permitted to be incorporated in the Work are indicated in Specification sections, and shall be in undamaged condition at time of use.

F. Mock-Ups:

1. Mock-ups and similar samples specified in Specification sections are recognized as special type of samples. Comply with samples submittal requirements to greatest extent possible. Process transmittal forms to provide record of activity.

G. Miscellaneous Submittals:

1. Inspection and Test Reports:

a. Classify each inspection and test report as being either "Shop Drawings" or "product data", depending on whether report is specially prepared for

Project or standard publication of workmanship control testing at point of production. Process inspection and test reports accordingly.

2. Guarantees, Warranties, Maintenance Agreements, and Workmanship Bonds:

   a. Refer to Specification sections for specific requirements. Submittal is final when returned by ENGINEER marked "Approved" or "Approved as Noted".

   b. In addition to copies desired for CONTRACTOR's use, furnish 2 executed copies. Provide 2 additional copies where required for maintenance data.

3. Survey Data:

   a. Refer to Specification sections for specific requirements on property surveys, building or structure condition surveys, field measurements, quantitative records of actual Work, damage surveys, photographs, and similar data required by Specification sections. Copies will not be returned.

      (1) Survey Copies: Furnish 2 copies.

      (2) Provide 10 copies of final property survey (if any).

      (3) Condition Surveys: Furnish 2 copies.

4. Certifications:

   a. Refer to Specification sections for specific requirement on submittal of certifications. Submit 7 copies. Certifications are submitted for review of conformance with specified requirements and information. Submittal is final when returned by ENGINEER marked "Approved".

5. Closeout Submittals:

   a. Refer to Specification Section 01 77 00 for specific requirements on submittal of closeout information, materials, tools, and similar items.

      (1) Record Documents: Section 01 77 00.

      (2) Materials and Tools: Spare parts, extra and overrun stock, maintenance tools and devices, keys, and similar physical units to be submitted.

      (3) Operating and maintenance data.

H. Operation and Maintenance Manuals:

1. Submit Operation and Maintenance Manuals in accordance with Section 01 78 23.

I. General Distribution:

1. Unless required elsewhere, provide distribution of submittals to subcontractors, suppliers, governing authorities, and others as necessary for proper performance of work.

1.5 ACTION ON SUBMITTALS

A. ENGINEER's Action:

1. General:

a. Except for submittals for record and similar purposes, where action and return on submittals are required or requested, ENGINEER will review each submittal, mark with appropriate action, and return. Where submittal must be held for coordination, ENGINEER will also advise CONTRACTOR without delay.

b. ENGINEER will stamp each submittal with uniform, self-explanatory action stamp, appropriately marked with submittal action.

B. Action Stamp:

1. Furnish as Submitted (FAS):

a. Final Unrestricted Release: Where submittals are marked "Furnish as Submitted", Work covered by submittal may proceed provided that it complies with the Contract Documents. Acceptance of Work will depend upon that compliance.

2. Furnish as Corrected (FAC):

a. When submittals are marked "Furnish as Corrected", Work covered by submittal may proceed provided that it complies with both Engineer’s notations and corrections and with the Contract Documents. Acceptance of Work will depend on that compliance. Re-submittal is not required, except where Engineer’s notations require it.

3. Revise and Resubmit (R&R):

a. When submittals are marked “Revise and Resubmit”, do not proceed with Work covered by submittal. Do not permit Work covered by submittal to be used at Project site or elsewhere where Work is in progress.

b. Revise submittal or prepare new submittal in accordance with Engineer's notations and corrections and Part 1.03.D. of this section. A complete resubmittal shall be prepared. Submission of partial resubmittals is not acceptable. Resubmit submittal without delay. Repeat if necessary to obtain different action marking.

4. Receipt Acknowledged (RA):

a. Information included in submittal conforms to the applicable requirements of the Contract Documents and is acceptable. No further action by Contractor is required relative to this submittal, and the Work covered by the submittal may proceed, and products with submittals with this disposition may be shipped or operated, as applicable.

b. Information included in submittal is for Project record purposes and does not require Engineer’s review or approval.

5. Rejected (R):

a. Information included in submittal does not conform to the applicable requirements of the Contract Documents and is unacceptable. Contractor shall submit products and materials as specified in the Contract Documents or provide required information for substitution as specified in the Contract Documents for consideration by Engineer.

1.6 SUBMITTAL IDENTIFICATION SYSTEM

A. Submittal Identification System: Use the following submittal identification system, consisting of submittal number and review cycle number.

1. Submittal Number: Shall be separate and unique number correlating to each individual submittal required. Assign submittal numbers as follows:

a. First part of submittal number shall be the applicable Specification Section number, followed by a hyphen.

b. Second part of submittal number shall be a three-digit number (sequentially numbered from 001 through 999) assigned to each separate and unique submittal furnished under the associated Specifications Section.

c. Typical submittal number for the third submittal furnished for Section 40 05 19, Ductile Iron Pipe, would be “40 05 19-003”.

2. Review Cycle Number: Shall be a letter designation indicating the initial submittal or re-submittal associated with each submittal number:

a. “A” = Initial (first) submittal.

b. “B” = Second submittal (e.g., first re-submittal).

c. “C” = Third submittal (e.g., second re-submittal).

3. Examples:

	Submittal Identification	
Example Description	**Submittal No.**	**Review Cycle**
Initial (first) review cycle of the third submittal provided under Section 40 05 19, Ductile Iron Pipe	40 05 10-003-	A
Second review cycle (first re-submittal) of third submittal provided under Section 40 05 19, Ductile Iron Pipe	40 05 10-003-	B

1.6 RE-SUBMITTAL REVIEW

A. Cost of Subsequent Reviews: Shop Drawings and Operation and Maintenance Manuals submitted for each item will be reviewed no more than twice at the OWNER's expense. All subsequent reviews will be performed at times convenient to the ENGINEER and at the CONTRACTOR's expense based on the ENGINEER's then prevailing rates including all direct and indirect costs and fees. Reimburse the OWNER for all such fees invoiced to the OWNER by the ENGINEER.

B. Time Extension: Any need for more than one resubmission, or any other delay in ENGINEER's review of submittals, will not entitle CONTRACTOR to extension of the Contract Time.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 42 00

REFERENCE STANDARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Abbreviations and Symbols

B. Reference Standards

C. Definitions

1.2 RELATED SECTIONS

A. Information provided in this section is used where applicable in individual Specification Sections, Divisions 2 through 46.

1.3 REFERENCE ABBREVIATIONS

A. Reference to a technical society, trade association or standards setting organization, may be made in the Specifications by abbreviations in accordance with the following list:

AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ACI	American Concrete Institute
ADC	Air Diffusion Council
AFBMA	Anti-friction Bearing Manufacturers Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	Association of Home Appliance Manufacturers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
APA	American Plywood Association
ARI	American Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers

ASTM	American Society for Testing and Materials
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders' Hardware Manufacturers Association
BIA	Brick Institute of American
CABO	Council of American Building Officials
CAGI	Compressed Air and Gas Institute
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers Association of America
CRD	U.S. Corps of Engineers Specifications
CRSI	Concrete Reinforcing Steel Institute
CTI	Cooling Tower Institute
DHI	Door and Hardware Institute
DOH	Department of Health
DOT	Department of Transportation
Fed. Spec.	Federal Specifications
FGMA	Flat Glass Marketing Association
FM	Factory Mutual
HMI	Hoist Manufacturing Institute
HPMA	See HPVA
HPVA	Hardwood Plywood Veneer Association
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IFI	Industrial Fasteners Institute
MIL	Military Specifications
MSS	Manufacturer's Standardization Society
NAAMM	National Association of Architectural Metal Manufacturers
NACM	National Association of Chain Manufacturers
NBS	National Bureau of Standards, See NIST
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NFPA	National Fluid Power Association
NIST	National Institute of Standards and Technology
NLMA	National Lumber Manufacturers Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Act
PCI	Prestressed Concrete Institute
PDI	Plumbing and Drainage Institute
SAE	Society of Automotive Engineers
SCPRF	Structural Clay Products Research Foundation
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SPI	Society of the Plastics Industry

SSPC	Steel Structures Painting Council
STI	Steel Tank Institute
TCA	Tile Council of American
TIMA	Thermal Insulation Manufacturers' Association
UL	Underwriters' Laboratories, Inc.
USBR	U. S. Bureau of Reclamation
USBS	U. S. Bureau of Standards, See NIST

1.4 REFERENCE STANDARDS

A. Without limiting the generality of other requirements of the specifications, all work specified herein shall conform to or exceed the requirements of all applicable codes.

B. References herein to "Building Code" shall mean the Florida Building Code (FBC). The latest edition of the code as approved and used by the local agency as of the date of the opening of bids, as adopted by the agency having jurisdiction, shall apply to the Work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

C. In case of conflict between codes, reference standards, Drawings and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and directions prior to ordering or providing any materials or labor. The Contractor shall follow the most stringent requirements.

D. Applicable Standard Specifications: The Contractor shall construct the Work specified herein in accordance with the requirements of the Contract Documents and the referenced portions of those referenced codes, standards, and Specifications listed herein.

E. References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

F. References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

G. Latest Edition: Construe references to furnishing materials or testing, which conform to the standards of a particular technical society, organization, or body, to mean the latest standard, code, or specification of that body, adopted and published as of the date of bidding this Contract. Standards referred to herein are made a part of these Specifications to the extent which is indicated or intended.

H. Precedence: The duties and responsibilities of the OWNER, CONTRACTOR or ENGINEER, or any of their consultants, agents or employees are set forth in the Contract Documents and are not changed or altered by any provision of any referenced standard specifications, manuals or code, whether such standard manual

or code is or is not specifically incorporated by reference in the Contract Documents. Any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority, to undertake responsibility contrary to the powers of the ENGINEER as set forth in the Contract Documents cannot be assigned to the ENGINEER or any of the ENGINEER's consultants, agents or employees.

1.5 DEFINITIONS

A. In these Contract Documents the words furnish, install and provide are defined as follows:

1. Furnish (Materials): to supply and deliver to the project ready for installation and in operable condition.

2. Install (services or labor): to place in final position, complete, anchored, connected in operable condition.

3. Provide: to furnish and install complete. Includes the supply of specified services. When neither furnish, install or provide is stated, provided is implied.

B. Titles of Sections and Paragraphs: Captions accompanying specification sections and paragraphs are for convenience of reference only, and do not form a part of the Specifications.

C. Applicable Publications: Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is specified, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date of the opening of bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the Drawings shall be waived because of any provision of, or omission from, said standards or requirements.

D. Specialists, Assignments: In certain instances, Specification text requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such assignments shall be recognized as special requirements over which the Contractor has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the Work; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of contract requirements remains with the Contractor.

1.6 LCU APPROVED MATERIALS LIST

A. The CONTRACTOR shall refer to the most recent Approved Materials List, as of the date of the advertisement for these contract documents.

B. The Approved Materials List located on LCU website constitutes a part of these contract documents.

1.7 LCU STANDARD DETAILS

A. The CONSTRACTOR shall refer to the most resent LCU Standard Details, as of the date of the advertisement for these contract documents.

B. The Standard Details located on LCU website constitutes a part of these contract documents.

1.8 LCU DESIGN MANUAL

A. The CONSTRACTOR shall refer to the most resent LCU Design Manual, as of the date of the advertisement for these contract documents.

B. The Design Manual located on LCU website constitutes a part of these contract documents.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 42 13

ABBREVIATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Abbreviations

B. Standards for Abbreviations

1.2 RELATED SECTIONS

A. Abbreviations provided in this section are used where applicable in individual Specification Sections, Divisions 2 through 46.

1.3 ABBREVIATIONS

A. Abbreviations which may be used in Divisions 1 through 16 for units of measure are as follows:

alternating current ..... ac
American wire gauge ..... AWG
ampere(s) ..... amp
ampere-hour(s) ..... AH
annual ..... ann
Ampere Interrupting Capacity ..... AIC
atmosphere(s) ..... atm
average ..... avg

biochemical oxygen demand ..... BOD
Board Foot ..... FBM
brake horsepower ..... bhp
Brinell Hardness ..... BH
British thermal unit(s) ..... Btu

calorie (s) ..... cal
carbonaceous biochemical oxygen demand ..... CBOD
Celsius (centigrade) C
Center to Center ..... C to C
centimeter(s) ..... cm
chemical oxygen demand ..... COD
coefficient, valve flow ..... C_v
cubic ..... cu
cubic centimeter(s) cc
cubic feet per day ..... cfd
cubic feet per hour ..... cfh
cubic feet per minute ..... cfm
cubic feet per minute, standard conditions ..... scfm
cubic feet per second ..... cfs
cubic foot (feet) ..... cu ft
cubic inch(es) ..... cu in
cubic yard(s) ..... cu yd

decibels ..... dB
decibels (A scale) ..... dBa
degree(s) ..... deg
dewpoint temperature ..... dpt
diameter ..... dia
direct current ..... dc
dissolved oxygen ..... DO
dissolved solids ..... DS
dry-bulb temperature ..... dbt

efficiency ..... eff
elevation ..... el

entering water temperature.....ewt
entering air temperature ..... eat
equivalent direct radiation..... edr

face area ..... fa
face to face..... f to f
Fahrenheit ..... F
feet per day..... fpd
feet per hour ..... fph
feet per minute..... fpm
feet per second..... fps
foot (feet) ..... ft
foot-candle..... fc
foot-pound ..... ft-lb
foot-pounds per minute..... ft-lb/min
foot-pounds per second .....ft-lb/sec
formazin turbidity unit(s) ..... FTU
frequency..... freq

gallon(s)..... gal
gallons per day ..... gpd
gallons per day per
cubic foot ..... gpd/cu ft
gallons per day per
square foot..... gpd/sq ft
gallons per hour..... gph
gallons per minute ..... gpm
gallons per second ..... gps
gas chromatography and
mass spectrometry ..... GC-MS
gauge ..... ga
grain(s) ..... gr
gram(s) ..... g
grams per cubic centimeter .....gm/cc

Heat Transfer Coefficient.....U
height..... hgt
Hertz..... Hz
horsepower..... hp
horsepower-hour .....hp-hr
hour(s) ..... hr
humidity, relative..... rh
hydrogen ion concentration .....pH

inch(es)..... in
inches per second .....ips
inside diameter .....ID

Jackson turbidity unit(s) ..... JTU

kelvin..... K
kiloamperes..... kA
kilogram(s) ..... kg
kilometer(s) ..... km
kilovar (kilovolt-amperes
reactive) ..... kvar
kilovolt(s)..... kV
kilovolt-ampere(s)..... kVA
kilowatt(s).....kW
kilowatt-hour(s) .....kWh

linear foot (feet)..... lin ft
liter(s).....L

megavolt-ampere(s)..... MVA
meter(s).....m
micrograms per liter ..... ug/L
miles per hour .....mph
milliampere(s) ..... mA
milligram(s) ..... mg
milligrams per liter..... mg/L
milliliter(s)..... mL
millimeter(s) ..... mm
million gallons ..... MG
million gallons per day..... mgd
millisecond(s) ..... ms
millivolt(s)..... mV
minute(s)..... min

mixed liquor suspended
solids..... MLSS

nephelometric turbidity
unit..... NTU
net positive suction head.....NPSH
noise criteria.....nc
noise reduction coefficient.....NRC
number.....no

ounce(s).....oz
outside air .....oa
outside diameter ..... OD

parts per billion..... ppb
parts per million..... ppm
percent..... pct

phase (electrical) .... ph
pound(s) ..... lb
pounds per cubic foot ..... pcf
pounds per cubic foot
per hour ..... pcf/hr
pounds per day ..... lbs/day
pounds per day per
cubic foot ..... lbs/day/cu ft
pounds per day per
square foot..... lbs/day/sq ft
pounds per square foot..... psf
pounds per square foot
per hour ..... psf/hr
pounds per square inch ..... psi
pounds per square inch
absolute ..... psia
pounds per square inch
gauge ..... psig
power factor ..... PF
pressure drop or
difference ..... dp
pressure, dynamic
(velocity) ..... vp
pressure, vapor..... vap pr

quart(s) ..... qt

Rankine ..... R
relative humidity..... rh
resistance ..... res
return air ..... ra
revolution(s)..... rev
revolutions per minute ..... rpm
revolutions per second..... rps
root mean squared..... rms

safety factor ..... sf
second(s)..... sec
shading coefficient..... SC
sludge density index ..... SDI

Sound Transmission
Coefficient..... STC
specific gravity ..... sp gr
specific volume ..... Sp Vol
sp ht at constant pressure ..... Cp
square ..... sq
square centimeter(s)..... sq cm
square foot (feet)..... sq ft
square inch (es) ..... sq in
square meter(s)..... sq m
square yard(s) ..... sq yd
standard ..... std
static pressure..... st pr
supply air..... . . sa
suspended solids ..... SS

temperature..... temp
temperature difference ..... TD
temperature entering..... TE
temperature leaving ..... TL
thousand Btu per hour..... Mbh
thousand circular mils ..... kcmil
thousand cubic feet ..... Mcf
threshold limit value ..... TLV
tons of refrigeration ..... tons
torque..... TRQ
total dissolved solids ..... TDS
total dynamic head ..... TDH
total kjeldahl nitrogen ..... TKN
total oxygen demand..... TOD
total pressure ..... TP
total solids ..... TS
total suspended solids..... TSS
total volatile solids ..... TVS

vacuum ..... vac
viscosity ..... visc
volatile organic chemical ..... VOC
volatile solids..... VS
volatile suspended solids ..... VSS
volt(s) V
volts-ampere(s) ..... VA
volume ..... vol

watt(s) ..... W
watthour(s) ..... Wh
watt-hour demand ..... WHD
watt-hour demand meter ..... WHDM
week(s) ..... wk
weight ..... wt
wet-bulb ..... WB
wet bulb temperature ..... WBT

yard(s)..... yd
year(s)..... yr

1.4 STANDARD FOR ABBREVIATIONS

A. Use ASME Y1.1-1989, "Abbreviations for use on Drawings and in Text" for abbreviations for units of measure not included in Paragraph 1.3.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 43 00

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittals

B. Inspection Services

C. Inspection of Materials

D. Quality Control

E. Costs of Inspection

F. Acceptance Tests

G. Failure to Comply with Contract

1.2 RELATED SECTIONS

A. Section 01 33 00 - Submittals: Specific Submittal Requirements

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Certificate Submittals: Furnish the ENGINEER authoritative evidence in the form of Certificates of Manufacture that the materials and equipment to be used in the Work have been manufactured and tested in conformity with the Contract Documents. Include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

1.4 INSPECTION SERVICES

A. OWNER's Access: At all times during the progress of the Work and until the date of final completion, afford the OWNER and ENGINEER every reasonable, safe, and proper facility for inspecting the Work at the site. The observation and inspection of any work will not relieve the CONTRACTOR of any obligations to perform proper and satisfactory work as specified. Replace work rejected due to faulty design, inferior, or defective materials, poor workmanship, improper installation, excessive wear, or nonconformity with the requirements of the Contract Documents, with satisfactory

work at no additional cost to the OWNER. Replace as directed, finished or unfinished work found not to be in strict accordance with the Contract, even though such work may have been previously approved and payment made therefor.

B. Rejection: The OWNER and the OWNER's Authorized Representatives have the right to reject materials and workmanship which are defective or require correction. Promptly remove rejected work and materials from the site.

C. Inferior Work Discoveries: Failure or neglect on the part of the OWNER or the OWNER's Authorized Representatives to condemn or reject bad or inferior work or materials does not imply an acceptance of such work or materials. Neither is it to be construed as barring the OWNER or the OWNER's Authorized Representatives at any subsequent time from recovering damages or a sum of money needed to build anew all portions of the Work in which inferior work or improper materials were used.

D. Removal for Examination: Should it be considered necessary or advisable by the OWNER or the OWNER's Authorized Representatives, at any time before final acceptance of the Work, to make examinations of portions of the Work already completed, by removing or tearing out such portions, promptly furnish all necessary facilities, labor, and material, to make such an examination. If such Work is found to be defective in any respect, defray all expenses of such examination and of satisfactory reconstruction. If, however, such work is found to meet the requirements of the Contract, the cost of examination and restoration of the Work will be considered a change in the Work to be paid for in accordance with applicable provisions of the Contract.

E. Operation Responsibility: Assume full responsibility for the proper operation of equipment during tests and instruction periods. Make no claim for damage which may occur to equipment prior to the time when the OWNER accepts the Work.

F. Rejection Prior to Warranty Expiration: If at anytime prior to the expiration of any applicable warranties or guarantees, equipment is rejected by the OWNER, repay to the OWNER all sums of money received for the rejected equipment on progress certificates or otherwise on account of the Contract lump sum prices, and upon the receipt of the sum of money, OWNER will execute and deliver a bill of sale of all its rights, title, and interest in and to the rejected equipment. Do not remove the equipment from the premises of the OWNER until the OWNER obtains from other sources, equipment to take the place of that rejected. The OWNER hereby agrees to obtain other equipment within a reasonable time and the CONTRACTOR agrees that the OWNER may use the equipment furnished by the CONTRACTOR without rental or other charge until the other new equipment is obtained.

1.5 INSPECTION OF MATERIALS

A. Premanufacture Notification: Give notice in writing to the ENGINEER sufficiently in advance of the commencement of manufacture or preparation of materials especially manufactured or prepared for use in or as part of the permanent construction. When required, notice to include a request for inspection, the date of commencement, and

the expected date of completion of the manufacture or preparation of materials. Upon receipt of such notice, ENGINEER will arrange to have a representative present at such times during the manufacture or testing as may be necessary to inspect the materials, or will notify CONTRACTOR that the inspection will be made at a point other than the point of manufacture or testing, or that the inspection will be waived. Comply with these provisions before shipping any materials. Such inspection will not constitute a release from the responsibility for furnishing materials meeting the requirements of the Contract Documents.

B. Testing Standards: Tests of electrical and mechanical equipment and appliances shall be conducted in accordance with recognized, applicable test codes except as may otherwise be stated herein.

1.6 QUALITY CONTROL

A. Testing

1. Field and Laboratory

a. Provide personnel to assist the ENGINEER in performing the following periodic observation and associated services.

(1) Soils: Observe and test excavations, placement and compaction of soils. Determine suitability of excavated material. Observe subgrade soils and foundations.

(2) Concrete: Observe forms and reinforcement; observe concrete placement; witness air entrainment tests, facilitate concrete cylinder preparation and assist with other tests performed by ENGINEER.

(3) Masonry: Sample and test mortar, bricks, blocks and grout; inspect brick and block samples and sample panels; inspect placement of reinforcement and grouting.

b. When specified in Divisions 2 through 16 of the Contract Documents, provide an independent laboratory testing facility to perform required testing. Qualify the laboratory as having performed previous satisfactory work. Prior to use, submit to the ENGINEER for approval.

c. Cooperate with the ENGINEER and laboratory testing representatives. Provide at least 24 hours notice prior to when specified testing is required. Provide labor and materials, and necessary facilities at the site as required by the ENGINEER and the testing laboratory.

d. Provide an independent testing agency, a member of the National Electrical Testing Association, to perform inspections and tests specified in Division 16 of these Specifications.

2. Equipment: Coordinate and demonstrate test procedures as specified in the Contract Documents or as otherwise required during the formal tests.

3. Electrical Equipment and Other Testing: Conform to test procedures and requirements specified in the appropriate Specification Section.

B. Reports

1. Certified Test Reports: Where transcripts or certified test reports are required by the Contract Documents, meet the following requirements:

a. Before delivery of materials or equipment submit and obtain approval of the ENGINEER for all required transcripts, certified test reports, certified copies of the reports of all tests required in referenced specifications or specified in the Contract Documents. Perform all testing in an approved independent laboratory or the manufacturer's laboratory. Submit for approval reports of shop equipment tests within thirty days of testing. Transcripts or test reports are to be accompanied by a notarized certificate in the form of a letter from the manufacturer or supplier certifying that tested material or equipment meets the specified requirements and the same type, quality, manufacture and make as specified. The certificate shall be signed by an officer of the manufacturer or the manufacturer's plant manager.

2. Certificate of Compliance: At the option of the ENGINEER, or where not otherwise specified, submit for approval a notarized Certificate of Compliance. The Certificates may be in the form of a letter stating the following:

a. Manufacturer has performed all required tests

b. Materials to be supplied meet all test requirements

c. Tests were performed not more than one year prior to submittal of the certificate

d. Materials and equipment subjected to the tests are of the same quality, manufacture and make as those specified

e. Identification of the materials

1.7 COSTS OF INSPECTION

A. OWNER's Obligation: Initial inspection and testing of materials furnished under this Contract will be performed by the OWNER or his authorized Representatives or inspection bureaus without cost to the CONTRACTOR, unless otherwise expressly specified. If subsequent testing is necessary due to failure of the initial tests or

because of rejection for noncompliance, reimburse the OWNER for expenditures incurred in making such tests.

B. CONTRACTOR's Obligation: Include in the Contract Price, the cost of all shop and field tests of equipment and other tests specifically called for in the Contract Documents.

C. Reimbursements to OWNER:

1. Materials and equipment submitted by the CONTRACTOR as the equivalent to those specifically named in the Contract may be tested by the OWNER for compliance. Reimburse the OWNER for expenditures incurred in making such tests on materials and equipment which are rejected for noncompliance.

2. Reimburse OWNER for the costs of any jobsite inspection between the hours of 7:00 p.m. and 6:00 a.m.

3. Reimburse OWNER for all costs associated with Witness Tests which exceed 5 Calendar Days per kind of equipment.

1.8 ACCEPTANCE TESTS

A. Preliminary Field Tests: As soon as conditions permit, furnish all labor and materials and services to perform preliminary field tests of all equipment provided under this Contract. If the preliminary field tests disclose that any equipment furnished and installed under this Contract does not meet the requirements of the Contract Documents, make all changes, adjustments and replacements required prior to the acceptance tests.

B. Final Field Tests: Upon completion of the Work and prior to final payment, subject all equipment, piping and appliances installed under this Contract to specified acceptance tests to demonstrate compliance with the Contract Documents.

1. Furnish all labor, fuel, energy, water and other materials, equipment, instruments and services necessary for all acceptance tests.

2. Conduct field tests in the presence of the ENGINEER. Perform the field tests to demonstrate that under all conditions of operation each equipment item:

a. Has not been damaged by transportation or installation
b. Has been properly installed
c. Has been properly lubricated
d. Has no electrical or mechanical defects
e. Is in proper alignment
f. Has been properly connected
g. Is free of overheating of any parts
h. Is free of all objectionable vibration

i. Is free of overloading of any parts
j. Operates as intended

3. Operate work or portions of work for a minimum of 100 hours or 14 days continuous service, whichever comes first. For those items of equipment which would normally operate on wastewater or sludge, plant effluent may be used if available when authorized by ENGINEER. If water cannot properly exercise equipment, conduct 100-hour test after plant startup. Conduct test on those systems which require load produced by weather (heating or cooling) exercise only when weather will produce proper load.

C. Failure of Tests: If the acceptance tests reveal defects in material or equipment, or if the material or equipment in any way fails to comply with the requirements of the Contract Documents, then promptly correct such deficiencies. Failure or refusal to correct the deficiencies, or if the improved materials or equipment, when tested again, fail to meet the guarantees or specified requirements, the OWNER, notwithstanding its partial payment for work and materials or equipment, may reject said materials or equipment and may order the CONTRACTOR to remove the defective work from the site at no addition to the Contract Price, and replace it with material or equipment which meets the Contract Documents.

1.9 FAILURE TO COMPLY WITH CONTRACT

A. Unacceptable Materials: If it is ascertained by testing or inspection that the material or equipment does not comply with the Contract, do not deliver said material or equipment, or if delivered remove it promptly from the site or from the Work and replace it with acceptable material without additional cost to the OWNER. Fulfill all obligations under the terms and conditions of the Contract even though the OWNER or the OWNER's Authorized Representatives fail to ascertain noncompliance or notify the CONTRACTOR of noncompliance.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 55 26

TRAFFIC REGULATION

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. General Requirements

B. Traffic Control

1.2 RELATED SECTIONS

A. None

1.3 GENERAL REQUIREMENTS

A. All projects and work on highways, roads, and streets, shall have a traffic control plan (TCP), as required by Florida Statute and Federal regulations. All work shall be executed under the established plan and Department approved procedures. The TCP is the result of considerations and investigations made in the development of a comprehensive plan for accommodating vehicular and pedestrian traffic through the construction zone.

B. The complexity of the TCP varies with the complexity of the traffic problems associated with a project. Many situations can be covered adequately with reference to specific sections from the Manual on Uniform Traffic Control Devices (MUTCD), the Traffic Control Devices Handbook (TCDH), or Roadway and Traffic Design Standard Series 600.

C. The CONTRACTOR shall be responsible for providing safe and expeditious movement of traffic through construction zones. A construction zone is defined as the immediate areas of actual construction and all abutting areas which are used by the CONTRACTOR and which interfere with the driving or walking public.

D. Remove temporary equipment and facilities when no longer required, restore grounds to original, or to specified conditions.

E. Before starting work, the CONTRACTOR shall submit to the Lee County Department of Transportation, with copy to the ENGINEER, a detailed schedule of his operations a minimum of fourteen (14) days prior to beginning work for approval. This shall include, but not be limited to, type and extent of temporary paving, and drawings and lists describing materials and traffic control methods to be used. Approval shall not relieve the CONTRACTOR of his obligation to provide a safe and proper crossing.

1.4 TRAFFIC CONTROL

A. The necessary precautions shall include, but not be limited to, such items as proper construction warning signs, signals, lighting devices, marking, barricades, channelization, and hand signaling devices. The CONTRACTOR shall be responsible for installation and maintenance of all devices and requirements for the duration of the Construction period.

B. The CONTRACTOR shall provide at least 72 hours notification to the State, County, or municipal Department of Transportation of the necessity to close any portion of a roadway carrying vehicles or pedestrians so that the final approval of such closings can be obtained at least 48 hours in advanced. At no time will more than one (1) lane of roadway be closed to vehicles and pedestrians. With any such closings adequate provision shall be made for the safe expeditious movement of each.

C. The CONTRACTOR shall also be responsible for notifying Police, Fire, and other Emergency Departments whenever construction is within roadways and of the alternate routes. Monthly status reports shall be provided to these Departments, as a minimum.

D. The CONTRACTOR shall be responsible for removal, relocation, or replacement of any traffic control device in the construction area which exists as port of the normal pre-construction traffic control scheme. Any such actions shall be performed by the CONTRACTOR under the supervision, and in accordance with the Specifications, of the Owner, unless otherwise specified.

E. The CONTRACTOR shall immediately notify the Owner of any vehicular or pedestrian safety or efficiency problems incurred as a result of the construction of the project.

F. The CONTRACTOR shall be responsible for notifying all residents of any road construction and limited access at least 72 hours in advance.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01 57 00

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General Requirements

B. Temporary Utilities

C. Temporary Construction

D. Barricades and Enclosures

E. Fences

F. Security

G. Temporary Controls

H. Traffic Regulation

I. Field Offices and Sheds

1.2 GENERAL REQUIREMENTS

A. Plant and Facilities: Furnish, install, maintain and remove all false work, scaffolding, ladders, hoistways, braces, pumping plants, shields, trestles, roadways, sheeting, centering forms, barricades, drains, flumes, and the like, any of which may be needed in the construction of any part of the Work and which are not herein described or specified in detail. The CONTRACTOR shall accept responsibility for the safety and efficiency of such works and for any damage that may result from their failure or from their improper construction, maintenance or operation.

B. First Aid: Maintain a readily accessible, completely equipped first aid kit at each location where work is in progress.

C. Safety Responsibility: Accept sole responsibility for safety and security at the site. Indemnify and hold harmless the OWNER and the OWNER's Authorized Representatives, including the ENGINEER, for any safety violation, or noncompliance with governing bodies and their regulations, and for accidents, deaths, injuries, or damage at the site during occupancy or partial occupancy of the site by CONTRACTOR's forces while performing any part of the Work.

D. Hazard Communication: Furnish two copies of the CONTRACTOR's Hazard Communication Program required under OSHA regulations before beginning on site activities. Furnish two copies of amendments to Hazard Communications Program as they are prepared.

1.3 TEMPORARY UTILITIES

A. General: It shall be Contractor’s responsibility to provide temporary utilities that are adequate for the performance of the Work under this Contract within the time specified.

1. All temporary utilities shall be kept in satisfactory operating condition, capable of safely and efficiently performing the required function, and are subject to inspection and approval by Owner at any time for the duration of the Contract. All Work hereunder shall conform to the applicable requirements of the OSHA Standards for Construction.

2. The Contractor shall coordinate and install all temporary services in accordance with the requirements of the utility companies having jurisdiction and as required by applicable codes and regulations.

3. All costs in connection with the temporary services including, but not limited to, installation, utility company service charges, maintenance, relocation and removal shall be borne by the Contractor at no additional cost to the Owner.

B. Water: Provide all necessary and required water without additional cost, unless otherwise specified. If necessary, provide and lay water lines to the place of use; secure all necessary permits; pay for all taps to water mains and hydrants and for all water used at the established rates.

1. For continuous potable water use, potable water may be obtained through connection to an existing potable water line, with the Owner’s approval. However, the Contractor shall install a temporary water meter obtained from the Owner. Contractor shall pay all connection fees, service fees, taxes, and consumption costs. Consumption costs shall be based on monthly readings of the water meter. Charges shall be paid directly to Owner on the water account established by the Contractor.

2. Water Connections: Contractor shall not make connection to or draw water from any fire hydrant or pipeline without first obtaining permission of Owner. For each such connection made, Contractor shall first attach to the fire hydrant or pipeline a valve, backflow preventer, and a meter as obtained from the Owner to set up a new water supply account.

C. Light and Power: Provide without additional cost to the OWNER temporary lighting and power facilities required for the proper construction and inspection of

the Work. If, in the ENGINEER's opinion, these facilities are inadequate, do NOT proceed with any portion of the Work affected thereby. Maintain temporary lighting and power until the Work is accepted.

1. Source: Power shall be obtained through temporary power meter(s) from the local power company and CONTRACTOR shall pay all connection fees, service fees, taxes, and consumption costs based on monthly meter readings by the power company.

2. Construction Lighting: All WORK conducted at night or under conditions of insufficient day light shall be suitably lighted to ensure proper WORK and to afford adequate facilities for inspection and safe working conditions.

3. Approval of Electrical Connection: All temporary connections for electricity shall be subject to approval by Owner and the power company representative and shall be removed in like manner at Contractor's expense prior to final acceptance of the WORK.

4. Separation of Circuits: Unless otherwise permitted by the ENGINEER, separate lighting circuits from power circuits.

5. Construction Wiring: All wiring for temporary electric light and power shall be properly installed and maintained and securely fastened in place. All electrica facilities shall conform to the requirements of Subpart K of the OSHA Standards for Construction.

D. Heat: Provide temporary heat, whenever required, for work being performed during cold weather to prevent freezing of concrete, water pipes, and other damage to the Work or existing facilities.

E. Sanitary Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of employees. Use of Owner facilities for general construction personnel is not allowed. Portable toilets which do not have hand washing facilities located within the unit shall have an operable hand sanitizer dispenser containing sanitation liquid affixed to the inside of the unit or immediately adjacent to the unit. Toilets at construction job sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Regulations for Construction. Each contractor shall rigorously prohibit the committing of nuisances within, on, or about the work. CONTRACTOR shall pay all associated installation, removal, and periodic cleanout fees for portable units installed.

F. Connections to Existing Utilities:

1. Unless otherwise specified or indicated, make all necessary connections to existing facilities including structures, drain lines, and utilities such as water,

sewer, gas, telephone, and electricity. In each case, obtain permission from the OWNER or the owning utility prior to undertaking connections. Protect facilities against deleterious substances and damage.

2. Thoroughly plan in advance all connections to existing facilities. Have on hand at the time of undertaking the connections, all material, labor and required equipment. Proceed continuously to complete connections in minimum time. Arrange for the operation of valves or other appurtenances on existing utilities, under the direct supervision of the owning utility.

1.4 TEMPORARY CONSTRUCTION

A. Bridges: Design and place suitable temporary bridges where necessary for the maintenance of vehicular and pedestrian traffic. Assume responsibility for the sufficiency and safety of all such temporary work or bridges and for any damage which may result from their failure or their improper construction, maintenance, or operation. Indemnify and save harmless the OWNER and the OWNER's representatives from all claims, suits or actions, and damages or costs of every description arising by reason of failure to comply with the above provisions.

1.5 BARRICADES AND ENCLOSURES

A. Protection of Workmen and Public: Effect and maintain at all times during the prosecution of the Work, barriers and lights necessary for the protection of Workmen and the Public. Provide suitable barricades, lights, "danger" or "caution" or "street closed" signs and watchmen at all places where the Work causes obstructions to normal traffic, excavation sites, or constitutes in any way a hazard to the public.

B. Barricades and Lights:

1. Protect all streets, roads, highways, excavations and other public thoroughfares which are closed to traffic; use effective barricades which display acceptable warning signs. Locate barricades at the nearest public highway or street on each side of the blocked section.

2. Statutory Requirements: Install and maintain all barricades, signs, lights, and other protective devices within highway rights-of-way in strict conformity with applicable statutory requirements by the authority having jurisdiction.

1.6 FENCES

A. Existing Fences: Obtain written permission from the OWNER prior to relocating or dismantling fences which interfere with construction operations. Reach agreements with the fence owner as to the period the fence may be left relocated or dismantled. Install adequate gates where fencing must be maintained. Keep gates closed and locked at all times when not in use.

B. Restoration: Restore all fences to their original or better condition and to their original location on completion of the Work.

1.7 SECURITY

A. Preservation of Property:

1. Preserve from damage, all property along the line of the Work, in the vicinity of or in any way affected by the Work, the removal or destruction of which is not called for by the Drawings. Preserve from damage, public utilities, trees, lawn areas, building monuments, fences, pipe and underground structures, and public streets. Note: Normal wear and tear of streets resulting from legitimate use by the CONTRACTOR are not considered as damage. Whenever damages occur to such property, immediately restore to its original condition. Costs for such repairs are incidental to the Contract.

2. In case of failure on the part of the CONTRACTOR to restore property or make good on damage or injury, the OWNER may, upon 24 hours written notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary, and the cost thereof will be deducted from any moneys due or which may become due the CONTRACTOR under this Contract. If removal, repair or replacement of public or private property is made necessary by alteration of grade or alignment authorized by the OWNER and not contemplated by the Contract Documents, the CONTRACTOR will be compensated, in accordance with the General Conditions, provided that such property has not been damaged through fault of the CONTRACTOR or the CONTRACTOR's employees.

B. Public Utility Installations and Structures:

1. Public utility installations and structures include all poles, tracks, pipes, wires, conduits, vaults, manholes, and other appurtenances and facilities, whether owned or controlled by public bodies or privately-owned individuals, firms or corporations, used to serve the public with transportation, gas, electricity, telephone, storm and sanitary sewers, water, or other public or private utility services. Facilities appurtenant to public or private property which may be affected by the Work are deemed included hereunder.

2. The Contract Documents contain data relative to existing public utility installations and structures above and below the ground surface. Existing public utility installations and structures are indicated on the Drawings only to the extent such information was made available to, or found by, the ENGINEER in preparing the Drawings. These data are not guaranteed for completeness or accuracy, and the CONTRACTOR is responsible for making necessary investigations to become fully informed as to the character, condition, and extent of all public utility installations and structures that may be encountered and that may affect the construction operations.

3. Contact utility locating service sufficiently in advance of the start of construction to avoid damage to the utilities and delays to the completion date.

4. Remove, replace, relocate, repair, rebuild, and secure any public utility installations and structures damaged as a direct or indirect result of the Work under this Contract. Costs for such work are incidental to the Contract. Be responsible and liable for any consequential damages done to or suffered by any public utility installations or structures. Assume and accept responsibility for any injury, damage, or loss which may result from or be consequent to interference with, or interruption or discontinuance of, any public utility service.

5. Repair or replace any water, electric, sewer, gas, irrigation, or other service connection damaged during the Work with no addition to the Contract price.

6. At all times in performance of the Work, employ proven methods and exercise reasonable care and skill to avoid unnecessary delay, injury, damage, or destruction to public utility installations and structures. Avoid unnecessary interference with, or interruption of, public utility services. Cooperate fully with the owners thereof to that end.

7. Give written notice to the owners of all public utility installations and structures affected by proposed construction operations, sufficiently in advance of breaking ground in any area or on any unit of the Work, to obtain their permission before disrupting the lines and to allow them to take measures necessary to protect their interests. Advise the Chiefs of Police, Fire and Rescue Services of any excavation in public streets or the temporary shut-off of any water main. Provide at least 24 hours notice to all affected property owners whenever service connections are taken out of service.

C. Miscellaneous Structures: Assume and accept responsibility for all injuries or damage to culverts, building foundations and walls, retaining walls, or other structures of any kind met with during the prosecution of the Work. Assume and accept liability for damages to public or private property resulting therefrom. Adequately protect against freezing all pipes carrying liquid.

D. Protection of Trees and Lawn Areas:

1. Protect with boxes, trees and shrubs, except those ordered to be removed. Do not place excavated material so as to cause injury to such trees or shrubs. Replace trees or shrubs destroyed by accident or negligence of the CONTRACTOR or CONTRACTOR's employees with new stock of similar size and age, at the proper season, at no additional cost to the OWNER.

2. Leave lawn areas in as good condition as before the start of the Work. Restore areas where sod has been removed by seeding or sodding.

1.8 TEMPORARY CONTROLS

A. During Construction:

1. Keep the site of the Work and adjacent premises free from construction materials, debris, and rubbish. Remove this material from any portion of the site if such material, debris, or rubbish constitutes a nuisance or is objectionable.

2. Remove from the site all surplus materials and temporary structures when they are no longer needed.

3. Neatly stack construction materials such as concrete forms and scaffolding when not in use. Promptly remove splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from surfaces to prevent marring or other damage.

4. Properly store volatile wastes in covered metal containers and remove from the site daily.

5. Do not bury or burn on the site or dispose of into storm drains, sanitary sewers, streams, or waterways, any waste material. Remove all wastes from the site and dispose of in a manner complying with applicable ordinances and laws.

B. Smoke Prevention:

1. Strictly observe all air pollution control regulations.

2. Open fires will be allowed only if permitted under current ordinances.

C. Noises:

1. Maintain acceptable noise levels in the vicinity of the Work. Limit noise production to acceptable levels by using special mufflers, barriers, enclosures, equipment positioning, and other approved methods.

2. Supply written notification to the OWNER sufficiently in advance of the start of any work which violates this provision. Proceed only when all applicable authorizations and variances have been obtained in writing.

D. Hours of Operation:

1. Refer to the summary of work section 01 11 00 for hours of operation.

2. Do not carry out nonemergency work, including equipment moves, on Sundays without prior written authorization by the OWNER. No work shall be performed on holidays or weekends unless otherwise specified or approved.

E. Dust Control:

1. Take measures to prevent unnecessary dust. Keep earth surfaces exposed to dusting moist with water or a chemical dust suppressant. Cover materials in piles or while in transit to prevent blowing or spreading dust.

2. Adequately protect buildings or operating facilities which may be affected adversely by dust. Protect machinery, motors, instrument panels, or similar equipment by suitable dust screens. Include proper ventilation with dust screens.

F. Temporary Drainage Provisions:

1. Provide for the drainage of stormwater and any water applied or discharged on the site in performance of the Work. Provide adequate drainage facilities to prevent damage to the Work, the site, and adjacent property.

2. Supplement existing drainage channels and conduits as necessary to carry all increased runoff from construction operations. Construct dikes as necessary to divert increased runoff from entering adjacent property (except in natural channels), to protect the OWNER's facilities and the Work, and to direct water to drainage channels or conduits. Provide ponding as necessary to prevent downstream flooding.

3. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

G. Pollution: Prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris, and other substances resulting from construction activities. Do not permit sanitary wastes to enter any drain or watercourse other than sanitary sewers. Do not permit sediment, debris, or other substances to enter sanitary sewers. Take reasonable measures to prevent such materials from entering any drain or watercourse.

1.9 TRAFFIC REGULATION

A. Parking: Provide and maintain suitable parking areas for the use of all construction workers and others performing work or furnishing services in connection with the Contract, to avoid any need for parking personal vehicles where they may interfere with public traffic or construction activities.

B. Access: Conduct Work to interfere as little as possible with public travel, whether vehicular or pedestrian. Provide and maintain suitable and safe bridges, detours, or other temporary expedients for the accommodation of public and private travel. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, give reasonable notice to owners of private drives

before interfering with them. Such maintenance of traffic will not be required when the CONTRACTOR has obtained permission from the owner or tenant of private property, or from the authority having jurisdiction over the public property involved, to obstruct traffic at the designated point.

1.10 FIELD OFFICES AND SHEDS

A. CONTRACTOR's Office: Erect, furnish, and maintain a field office with a telephone. Have an authorized agent present at this office at all times while the Work is in progress. Keep readily accessible copies of the Contract Documents, required record documents, and the latest approved shop drawings at this field office.

B. Material Sheds and Temporary Structures: Provide material sheds and other temporary structures of sturdy construction and neat appearance.

C. Location: Coordinate location of field offices, material sheds and temporary structures with ENGINEER and OWNER.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 INSTALLATION

A. Install temporary facilities in neat, orderly, manner, and make structurally, mechanically, and electrically sound throughout.

B. Location of temporary utilities and temporary facilities:

1. Locate temporary systems for proper function and service.

2. Temporary systems shall not interfere with or provide hazards or nuisances to the work under this and other contracts, movement of personnel, traffic areas, materials handling, hoisting systems, storage areas, finishes, and work of utility companies.

a. Do not install temporary utilities on the ground, with the exception of temporary extension cords, hoses, and similar systems in place for short durations.

b. Modify and extend temporary systems as required by progress of the work.

3.2 MAINTENANCE

A. Maintain temporary systems to provide safe, continuous service as required.

B. Properly supervise operation of temporary systems:

1. Enforce compliance with Laws and Regulations.

2. Enforce safe practices.

3. Prevent abuse of services.

4. Prevent nuisances and hazards caused by temporary systems and their use.

5. Prevent damage to finishes.

6. Ensure that temporary systems and equipment do not interrupt continuous progress of construction.

C. At end of each work day, check temporary systems and verify that sufficient consumables are available to maintain operation until work is resumed at the Site. Provide additional consumables if the supply on hand is insufficient.

D. Contractor shall replace broken and burned out lamps, blown fuses, and damaged wiring and appurtenances as required to maintain adequate and safe operating conditions.

E. Contractor shall permit subcontractors and others at a mutually agreed arrangement to use temporary electrical system that meet the following requirements:

1. Equipment are suitable for 120 V, single phase, 60 Hz operation.

2. Operating input does not exceed 1,500 volt-amperes.

3. Single piece of equipment connected to one outlet.

4. Contractor shall restrict use of equipment as required to prevent overloading circuits.

3.3 CLOSEOUT ACTIVITIES

A. Completely remove temporary utilities, facilities, equipment, and materials when no longer required. Repair damage caused by temporary systems and their removal and restore the Site to condition required by the Contract Documents; if restoration of damaged areas is not specified, restore to preconstruction condition.

B. Contractor is responsible for and shall return to original condition those portions of permanent electric system used in completing the Work.

C. Where temporary utilities are disconnected from existing utility, provide suitable, watertight or gastight (as applicable) cap or blind flange, as applicable, on service line, in accordance with requirements of utility owner.

D. When permanent utilities and systems that were used for temporary utilities, upon Substantial Completion replace all consumables such as filters and light bulbs and parts used during the Work.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 61 00

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description

B. Substitutions

C. Manufacturer's Written Instructions

D. Transportation and Handling

E. Storage, Protection and Maintenance

F. Manufacturer's Field Quality Control Services

G. Startup

H. Post Startup Services

I. Special Tools and Lubricating Equipment

J. Lubrication

1.2 DESCRIPTION

A. Proposed Manufacturers List: Within 15 calendar days of the date of the Notice to Proceed, submit to the ENGINEER a list of the names of proposed manufacturers, materialmen, suppliers and subcontractors, obtain approval of this list by OWNER prior to submission of any working drawings. Upon request submit evidence to ENGINEER that each proposed manufacturer has manufactured a similar product to the one specified and that it has previously been used for a like purpose for a sufficient length of time to demonstrate its satisfactory performance.

B. Furnish and install Material and Equipment which meets the following:

1. Conforms to applicable specifications and standards.

2. Complies with size, make, type, and quality specified or as specifically approved, in writing, by ENGINEER.

3. Will fit into the space provided with sufficient room for operation and maintenance access and for properly connecting piping, ducts and services, as applicable. Make the clear spaces that will be available for operation and maintenance access and connections equal to or greater than those shown and meeting all the manufacturers' requirements. Make all provisions for installing equipment furnished at no increase in Contract Price.

4. Manufactured and fabricated in accordance with the following:

   a. Design, fabricate, and assemble in accordance with best engineering and shop practices.

   b. Manufacture like parts of duplicate units to standard sizes and gauges, to be interchangeable.

   c. Provide two or more items of same kind identical, by same manufacturer.

   d. Provide materials and equipment suitable for service conditions.

   e. Adhere to equipment capabilities, sizes, and dimensions shown or specified unless variations are specifically approved, in writing, in accordance with the Contract Documents.

   f. Adapt equipment to best economy in power consumption and maintenance. Proportion parts and components for stresses that may occur during continuous or intermittent operation, and for any additional stresses that may occur during fabrication or installation.

   g. Working parts are readily accessible for inspection and repair, easily duplicated and replaced.

5. Use material or equipment only for the purpose for which it is designed or specified.

1.3 SUBSTITUTIONS

A. Substitutions:

1. CONTRACTOR's requests for changes in equipment and materials from those required by the Contract Documents are considered requests for substitutions and are subject to CONTRACTOR's representations and review provisions of the Contract Documents when one of following conditions are satisfied:

   a. Where request is directly related to an "or equal" clause or other language of same effect in Specifications.

b. Where required equipment or material cannot be provided within Contract Time, but not as result of CONTRACTOR's failure to pursue Work promptly or to coordinate various activities properly.

c. Where required equipment or material cannot be provided in manner compatible with other materials of Work, or cannot be properly coordinated therewith.

2. CONTRACTOR'S Options:

a. Where more than one choice is available as options for CONTRACTOR's selection of equipment or material, select option compatible with other equipment and materials already selected (which may have been from among options for other equipment and materials).

b. Where compliance with specified standard, code or regulation is required, select from among products which comply with requirements of those standards, codes, and regulations.

c. "Or Equal": For equipment or materials specified by naming one or more equipment manufacturer and "or equal", submit request for substitution for any equipment or manufacturer not specifically named.

B. Conditions Which are Not Substitution:

1. Requirements for substitutions do not apply to CONTRACTOR options on materials and equipment provided for in the Specifications.

2. Revisions to Contract Documents, where requested by OWNER or ENGINEER, are "changes" not "substitutions".

3. CONTRACTOR's determination of and compliance with governing regulations and orders issued by governing authorities do not constitute substitutions and do not constitute basis for a Change Order, except as provided for in Contract Documents.

C. Or Equal" Items: Whenever a particular brand or make of material, equipment, or other item is specified, or is indicated on the Drawings, it is for the purpose of establishing a standard of quality, design, and type desired and to supplement the detailed specifications. Any other brand or make which, in the opinion of the Engineer, is equivalent to that specified or indicated may be offered as a substitute subject to the following provisions:

1. Contractor shall submit for each proposed substitution sufficient details, complete descriptive literature, and performance data together with samples of the materials, where feasible, to enable the Engineer to determine if the proposed substitution is equal.

2. Contractor shall submit certified tests, where applicable, by an independent laboratory attesting that the proposed substitution is equal.

3. A list of installations where the proposed substitution is equal.

4. Where the acceptance of a substitution requires revision or redesign of any part of the Work, all such revision and redesign, and all new Drawings and details required therefore, shall be provided by the Contractor at his own cost and expense, and shall be subject to review of the Engineer.

5. In all cases the Engineer shall be the sole judge as to whether a proposed substitution is to be accepted. The Contractor shall abide by the Engineer's decision when proposed substitute items are judged to be unacceptable and shall in such instances furnish the item, or substitute, as specified. No substitute items shall be used in the Work without written acceptance of the Engineer.

6. Acceptance of any proposed substitution shall in no way release the Contractor from any of the provisions of the Contract Documents.

7. The Owner may require, at the Contractor’s expense, a special performance guarantee or other surety with respect to any substitute.

1.4 MANUFACTURER'S WRITTEN INSTRUCTIONS

A. Instruction Distribution: When the Contract Documents require that installation, storage, maintenance and handling of equipment and materials comply with manufacturer's written instruction's, obtain and distribute printed copies of such instructions to parties involved in installation, including six copies to ENGINEER.

1. Maintain one set of complete instructions at jobsite during storage and installation, and until completion of work.

B. Manufacturer's Requirements: Store, maintain, handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's written instructions and in conformity with Specifications.

1. Should job conditions or specified requirements conflict with manufacturer's instructions, consult ENGINEER for further instructions.

2. Do not proceed with work without written instructions.

C. Performance Procedures: Perform work in accordance with manufacturer's written instructions. Do not omit preparatory steps or installation procedures, unless specifically modified or exempted by Contract Documents.

1.5 TRANSPORTATION AND HANDLING

A. Coordination with Schedule: Arrange deliveries of materials and equipment in accordance with Construction Progress Schedules to minimize long-term storage of products at site and overcrowding of construction spaces. In particular, the Contractor shall provide delivery/installation coordination to ensure minimum holding or storage times for products recognized to be flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other sources of loss. Arrange deliveries of materials and equipment. Coordinate to avoid conflict with work and conditions at site.

B. Immediately upon delivery, inspect shipments to determine compliance with requirements of Contract Documents and approved submittals and that material and equipment are protected and undamaged.

C. Handling: Provide equipment and personnel to handle material and equipment by methods recommended by manufacturer to prevent soiling or damage to materials and equipment or packaging.

D. The Contractor shall provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

E. The Contractor shall transport, deliver, and handle products in accordance with supplier's written recommendations and by means and methods that will prevent damage, deterioration, and loss including theft

1.6 STORAGE, PROTECTION, AND MAINTENANCE

A. On-site storage areas and buildings:

1. Conform storage buildings to requirements of Section 01 57 00.

2. Coordinate location of storage areas with ENGINEER and OWNER.

3. Arrange on site storage areas for proper protection and segregation of stored materials and equipment with proper drainage. Provide for safe travel around storage areas and safe access to stored materials and equipment.

4. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.

5. Store materials such as pipe, reinforcing and structural steel, and equipment on pallets, blocks or racks, off ground.

6. PVC Pipe may be damaged by prolonged exposure to direct sunlight and the CONTRACTOR shall take necessary precautions during storage and installation

to avoid this damage. Pipe shall be stored under cover and installed with sufficient backfill to shield it from the sun.

7. Store fabricated materials and equipment above ground, on blocking or skids, to prevent soiling or staining. Cover materials and equipment which are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

B. Interior Storage:

1. Store materials and equipment in accordance with manufacturer's instructions, with seals and labels intact and legible.

2. Store materials and equipment, subject to damage by elements, in weathertight enclosures.

3. Maintain temperature and humidity within ranges required by manufacturer's instructions.

C. Accessible Storage: Arrange storage in a manner to provide easy access for inspection and inventory. Make periodic inspections of stored materials or equipment to assure that materials or equipment are maintained under specified conditions and free from damage or deterioration.

1. Perform maintenance on stored materials of equipment in accordance with manufacturer's instructions, in presence of OWNER or ENGINEER.

2. Submit a report of completed maintenance to ENGINEER with each Application for Payment.

3. Failure to perform maintenance, to notify ENGINEER of intent to perform maintenance or to submit maintenance report may result in rejection of material or equipment.

D. OWNER's Responsibility: OWNER assumes no responsibility for materials or equipment stored in buildings or on-site. CONTRACTOR assumes full responsibility for damage due to storage of materials or equipment.

E. CONTRACTOR's Responsibility: CONTRACTOR assumes full responsibility for protection of completed construction. Repair and restore damage to completed Work equal to its original condition.

F. Special Equipment: Use only rubber-tired wheelbarrows, buggies, trucks, or dollies to wheel loads over finished floors, regardless if the floor has been protected or not. This applies to finished floors and to exposed concrete floors as well as those covered with composition tile or other applied surfacing.

G. Surface Damage: Where structural concrete is also the finished surface, take care to avoid marking or damaging surface.

1.7 MANUFACTURER'S FIELD QUALITY CONTROL SERVICES

A. General:

1. Provide manufacturer's field services in accordance with this subsection for those tasks specified in other sections.

2. Provide training as specified in Section 01 79 00.

3. Include and pay all costs for suppliers' and manufacturers' services, including, but not limited to, those specified.

B. Installation Instruction: Provide instruction by competent and experienced technical representatives of equipment manufacturers or system suppliers as necessary to resolve assembly or installation procedures which are attributable to, or associated with, the equipment furnished.

C. Installation Inspection, Adjustments and Startup Participation:

1. Provide competent and experienced technical representatives of equipment manufacturers or system suppliers to inspect the completed installation as follows.

a. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions which may cause damage.

b. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

c. Verify that wiring and support components for equipment are complete.

d. Verify that equipment or system is installed in accordance with the manufacturer's recommendations, approved shop drawings and the Contract Documents.

e. Verify that nothing in the installation voids any warranty.

2. Provide manufacturer's representatives to perform initial equipment and system adjustment and calibration conforming to the manufacturer's recommendations and instructions, approved shop drawings and the Contract Documents.

3. Obtain ENGINEER's approval before start-up of equipment. Execute start-up under supervision of applicable manufacturer's representative in accordance with manufacturers' instructions.

4. Furnish ENGINEER with three copies of the following. When training is specified, furnish the copies at least 24 hours prior to training.

   a. "Certificate of Installation, Inspection and Start-up Services" by manufacturers' representatives for each piece of equipment and each system specified, certifying:

      (1) That equipment is installed in accordance with the manufacturers' recommendations, approved shop drawings and the Contract Documents.

      (2) That nothing in the installation voids any warranty.

      (3) That equipment has been operated in the presence of the manufacturer's representative.

      (4) That equipment, as installed, is ready to be operated by others.

   b. Detailed report by manufacturers' representatives, for review by ENGINEER of the installation, inspection and start-up services performed, including:

      (1) Description of calibration and adjustments if made; if not in Operation and Maintenance Manuals, attach copy.

      (2) Description of any parts replaced and why replaced.

      (3) Type, brand name, and quantity of lubrication used, if any.

      (4) General condition of equipment.

      (5) Description of problems encountered, and corrective action taken.

      (6) Any special instructions left with CONTRACTOR or ENGINEER.

D. Field Test Participation: Provide competent and experienced technical representatives of all equipment manufacturers and system suppliers as necessary to participate in field testing of the equipment specified in Section 01 43 00.

E. Trouble-Free Operation: Provide competent and experienced technical representatives of all equipment manufacturers and system suppliers as necessary to place the equipment in trouble-free operation after completion of start-up and field tests.

1.8 START UP

A. The Contractor shall provide operating personnel for the duration of the startup. The Contractor shall also provide all water, power, chemicals and other consumables required. Additionally, the Contractor shall provide the effective coordination of all parties necessary for the successful startup, including suppliers, subcontractors, the Engineer, and the Owner.

B. It is not the intent of the Engineer to instruct the Contractor in the startup of the facilities; however, the Engineer will be available prior to and during startup to provide technical support to the Contractor.

C. The Contractor shall be required to startup the equipment, under direction of the Engineer, and operate it for a continuous one-day (24 hours) period at design conditions, except where more stringent requirements are included in the individual equipment specifications. The Contractor shall be available at all times during this period to provide necessary maintenance support services as may be deemed necessary by the Engineer.

D. Not less than two months prior to startup, the Contractor shall submit to the Engineer for review, a detailed schedule of operations which will be necessary to effect a successful initial operation and sustained period of operation for the duration of the required startup period.

E. The startup shall not be commenced until all required leakage tests, disinfection, and equipment tests, as applicable, have been completed to the satisfaction of the Engineer.

F. All defects in materials or workmanship which appear during this startup period shall be immediately corrected by the Contractor. Time lost for equipment repairs, wiring corrections, control point settings, or other reasons which actually interrupt the startup may, at the discretion of the Engineer, be justifiable cause for extending the startup test duration.

G. During the startup, the Contractor shall provide the services of authorized representatives of the suppliers, in addition to those services required under operations testing, as necessary, to correct faulty equipment operation.

H. During the startup, the Contractor shall keep records of the operations, in accordance with the instructions of the Engineer.

1.9 POST START-UP SERVICES

A. General: Provide Post Start-up Services in accordance with this subsection for equipment specified in other sections.

B. Site Visit: Provide the services of an authorized service representative for each equipment manufacturer or system supplier to make a final site visit after the equipment or system has been in operation for at least 6 months, but no longer than 11 months. Furnish assistance to OWNER's operating personnel in making adjustments and calibrations required to determine that the equipment and system is operating in conformance with design, manufacturer's, and specification requirements. Instruct the personnel in a review of proper operation and maintenance procedures.

C. Certificate: Furnish "Certificate of Post Start-up Services" cosigned by ENGINEER and the manufacturer's representative, certifying that this service has been performed.

1.10 SPECIAL TOOLS AND LUBRICATING EQUIPMENT

A. General: Furnish, per manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics.)

B. Time of Delivery: Deliver special tools and lubricating equipment to OWNER when unit is placed into operation and after operating personnel have been properly instructed in operation, repair, and maintenance of equipment.

C. Quality: Provide tools and lubricating equipment of a quality meeting equipment manufacturer's requirements.

1.11 LUBRICATION

A. General: Where lubrication is required for proper operation of equipment, incorporate in the equipment the necessary and proper provisions in accordance with manufacturer's requirements. Where possible, make lubrication automated and positive.

B. Oil Reservoirs: Where oil is used, supply reservoir of sufficient capacity to lubricate unit for a 24-hour period.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General Requirements

B. Scheduling of Shutdown

1.2 RELATED SECTIONS

A. None

1.3 GENERAL REQUIREMENTS

A. CONTRACTOR shall be responsible for all cutting, fitting and patching, including attendant excavation and backfill, required to complete the work or to:

1. Make its several parts fit together properly.
2. Uncover portions of the work to provide for installation of ill-timed work.
3. Remove and replace defective work.
4. Remove and replace work not conforming to requirements of Contract Documents.
5. Remove samples of installed work as specified for testing.
6. Provide routine penetrations of non-structural surfaces for installation of piping and electrical conduit.

B. Coordination: Perform all cutting, fitting or patching of the Work that may be required to make the several parts thereof join in accordance with the Contract Documents. Perform restoration with competent workmen skilled in the trade.

C. Improperly Timed Work: Perform all cutting and patching required to install improperly timed work, to remove samples of installed materials for testing, and to provide for alteration of existing facilities or for the installation of new Work in the existing construction.

D. Limitations: Except when the cutting or removal of existing construction is specified or indicated, do not undertake any cutting or demolition which may affect the structural stability of the Work or existing facilities without the ENGINEER's concurrence.

1.4 SUBMITTALS

A. Submit a written request to the ENGINEER well in advance of executing any cutting or alteration which affects:
   1. Work of the OWNER or any separate contractor.
   2. Structural value or integrity of any element of the project or work.
   3. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
   4. Efficiency, operational life, maintenance or safety of operational elements.
   5. Visual qualities of sight-exposed elements.

B. Request shall include:
   1. Identification of the work.
   2. Description of affected work.
   3. The necessity for cutting, alteration or excavation.
   4. Effect on work of OWNER or any separate contract, or on structural or weatherproof integrity of work.
   5. Description of proposed work:
      a. Scope of cutting, patching, alteration, or excavation.
      b. Trades who will execute the work.
      c. Products proposed to be used.
      d. Extent of refinishing to be done.
   6. Alternatives to cutting and patching.
   7. Cost proposal, when applicable.
   8. Written permission of any separate contractor whose work will be affected.

C. SUBMIT WRITTEN NOTICE TO THE ENGINEER DESIGNATING THE DATE AND THE TIME THE WORK WILL BE UNCOVERED.

1.5 SCHEDULING OF SHUTDOWN

A. Connections to Existing Facilities: If any connections, replacement, or other work requiring the shutdown of an existing facility is necessary, schedule such work at times when the impact on the OWNER's normal operation is minimal. Overtime, night and weekend work without additional compensation from the OWNER, may be required to make these connections, especially if the connections are made at times other than those specified.

B. Request for Shutdowns: Submit a written request for each shutdown to the OWNER and the ENGINEER sufficiently in advance of any required shutdown.

PART 2 PRODUCTS

2.1 MATERIALS

A. Comply with specifications and standards for each specific product involved.

PART 3 EXECUTION

3.1 INSPECTION

A. Inspect existing conditions of projects, including elements subject to damage or to movement during cutting and patching.

B. After uncovering work, inspect conditions affecting installation of products, or performance of the work.

C. Report unsatisfactory or questionable conditions to the ENGINEER in writing; do not proceed with work until the ENGINEER has provided further instructions.

3.2 PREPARATION

A. Provide adequate temporary support as necessary to assure structural value or integrity or affected portion of work.

B. Provide devices and methods to protect other portions of project from damage.

C. Provide protection from elements for that portion of the project which may be exposed by cutting and patching work, and maintain excavations free from water.

D. Material Removal: Cut and remove all materials to the extent shown or as required to complete the Work. Remove materials in a careful manner with no damage to adjacent facilities. Remove materials which are not salvageable from the site.

3.3 PERFORMANCE

A. Execute cutting and demolition by methods which will prevent damage to other work, and will provide proper surfaces to receive installation of repairs.

B. Execute excavating and backfilling by methods which will prevent settlement or damage to other work.

C. Employ original installer or fabricator to perform cutting and patching for:
1. Weather-exposed or moisture-resistant elements.
2. Sight-exposed finished surfaces.

D. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances, and finishes.

E. Restore work which has been cut or removed; install new products to provide completed work in accord with requirements of contract documents.

F. Fit work airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

G. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes:
   1. For continuous surfaces, refinish to nearest intersection.
   2. For an assembly, refinish entire unit.

3.4 PAVEMENT RESTORATION

A. The restoration of existing street paving, including underdrains, if any are encountered, where damaged, shall be restored by the Contractor and shall be replaced or rebuilt using the same type of construction as was in the original. The Contractor shall be responsible for restoring all such work, including subgrade, base courses, curb and gutter or other appurtenances where present. The Contractor shall obtain and pay for at his own expense such local or other governmental permits as may be necessary for the opening of streets and shall satisfy himself as to any requirements other than those herein set forth which may affect the type, quality and manner of carrying on the restoration of surfaces by reason of jurisdiction of such governmental bodies.

B. This section does not describe the construction of new road surfaces or the complete resurfacing of existing pavements.

C. In all cases, the Contractor will be required to maintain, without additional compensation, all permanent replacement of street paving, done by him under this Contract for a period of 12 months after the acceptance of the Contract, including the removal and replacement of such work wherever surface depressions or underlying cavities result from settlement of trench backfill.

D. The Contractor shall do all the final resurfacing or repaving of streets or roads, over the excavations that he has made and he shall be responsible for relaying paving surfaces of roads that have failed or been damaged, at any time before the termination of the maintenance period on account of work done by him and he shall resurface or repave over any tunnel jacking, or boring excavation that shall settle or break the surface, shall be repaved to the satisfaction of the Owner and at the Contractor's sole expense. Backfilling of trenches and the preparation of subgrades shall conform to the requirements of excavation and backfilling of pipeline trenches.

E. Where pipeline construction crosses paved streets, the Contractor may elect, at no additional cost to the Owner, to place the pipe by the jacking or boring or tunneling method in lieu of cutting and patching of the paved surfaces.

END OF SECTION

SECTION 01 74 00

CLEANING

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. General Requirements

B. Disposal Requirements

1.2 GENERAL REQUIREMENTS

A. Execute cleaning during progress of the work and at completion of the work.

1.3 DISPOSAL REQUIREMENTS

A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 DURING CONSTRUCTION

A. Execute daily cleaning to keep the work, the site, and adjacent properties free from accumulations of waste materials, rubbish, and windblown debris, resulting from construction operations.

B. Provide onsite containers for the collection of waste materials, debris and rubbish. All waste materials including containers, food debris and other miscellaneous materials must be disposed of daily in onsite containers.

C. Remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

3.2 FINAL CLEANING

A. Requirements: At the completion of work and immediately prior to final inspection, clean the entire project as follows:

1. Thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. Leave the structures and site in a complete and finished condition to the satisfaction of the ENGINEER.

2. Direct all subcontractors to similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their contracts.

3. Remove all temporary structures and all debris, including dirt, sand, gravel, rubbish and waste material.

4. Should the CONTRACTOR not remove rubbish or debris or not clean the buildings and site as specified above, the OWNER reserves the right to have the cleaning done at the expense of the CONTRACTOR.

B. Employ experienced workers, or professional cleaners, for final cleaning.

C. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

D. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.

E. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces. Polish surfaces so designated to shine finish.

F. Repair, patch, and touch up marred surfaces to specified finish, to match adjacent surfaces.

G. Replace air-handling filters if units were operated during construction.

H. Clean ducts, blowers, and coils, if air-handling units were operated without filters during construction.

I. Vacuum clean all interior spaces, including inside cabinets.

J. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.

K. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly-painted surfaces.

L. Clean interior of all panel cabinets, pull boxes, and other equipment enclosures.

M. Wash and wipe clean all lighting fixtures, lamps, and other electrical equipment which may have become soiled during installation.

N. Perform touch-up painting.

O. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

P. Remove erection plant, tools, temporary structures and other materials.

Q. Remove and dispose of all water, dirt, rubbish or any other foreign substances.

3.3 FINAL INSPECTION

A. After cleaning is complete the final inspection may be scheduled. The inspection will be done with the OWNER and ENGINEER.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 01 77 00

CONTRACT CLOSE OUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Warranties and Bonds

B. Record Drawings

C. Special Tools

1.2 WARRANTIES AND BONDS

A. Prior to final payment deliver to the OWNER the original and one copy of all bonds, warranties, guarantees and similar documents, including those customarily provided by manufacturers and suppliers which cover a period greater than the one year correction period. Show OWNER as beneficiary of these documents.

1.3 RECORD DRAWINGS

A. General Requirements:

1. At the start of the Project, label each record document to be submitted as, “PROJECT RECORD” using legible, printed letters. Letters on record copy of the Drawings shall be two inches high.

2. Keep record documents current. Make entries on record documents within two working days of receipt of information required to record the change.

3. Do not permanently conceal the Work until required information has been recorded.

4. Accuracy of record documents shall be such that future searches for items shown on the record documents may rely reasonably on information obtained from Engineer-accepted record documents.

5. Marking of Entries:
   a. Use erasable, colored pencils (not ink or indelible pencil) for marking changes, revisions, additions, and deletions to record documents.

   b. Clearly describe the change by graphic line and make notations as required. Use straight-edge to mark straight lines. Writing shall be

legible and sufficiently dark to allow scanning of record documents into legible electronic files.

c. Date all entries on record documents.

d. Call attention to changes by drawing a “cloud” around the change(s) indicated.

e. Mark initial revisions in red. In the event of overlapping changes, use different colors for subsequent changes.

6. All as-built conditions must be noted as follows:

a. Buried valves, fittings, plugs and caps, taps for disinfection and testing, and air release valve assemblies. Locate by survey using state plane coordinate system for horizontal location and by elevation to top of fitting or valve.

b. Invert elevation of all gravity stubouts for future connections, including terminal point.

c. Limits, dimensions, and depth of concrete encasing, encasing pipe and sheeting.

d. Horizontal and vertical locations of other public and private utilities when they are encountered during construction.

e. Indicate size, type, depth, location, and limits of any pipe that is abandoned as part of the work or any existing pipe that is crossed by new piping as part of the work. Include type of abandonment (i.e. end plug, mortar filled, etc.) for abandoned pipe.

f. Certified survey of the location of all new structures in relation to the property boundaries and other existing structures. Indicate location of all underground pipe and duct bank at point of connection to structures. Locate from corner or centerline of structure.

g. Storm Drains, Inlets, and Structures: Location for all catchbasins, manholes, and other structures. Elevations of grates, throats, weirs, and orifices. Invert elevations for all pipes and structures. Pipe size, type, material, slope, and distance between structures.

h. Roadway: Elevations of all roadway vertical control points and terminations of curb returns.

B. Recording Changes to Drawings:

1. Record changes on copy of the Drawings. Submittal of Contractor-originated or -produced drawings as a substitute for recording changes on the Drawings is unacceptable.

2. Record changes on plans, sections, schematics, and details as required for clarity, making reference dimensions and elevations (to Project datum) for complete record documentation.

3. Record actual construction including, as applicable:

a. Depths of various elements of foundation relative to Project datum.

b. High and low pipeline points, service taps, restrained joints, and fire hydrants.

c. Pipe diameter and material, including services.

d. Beginning and end points where pipe joints are significantly deviated to avoid a conflict, including the depth of cover.

e. Gravity Sewers: Station number of all manholes and services (i.e. wyes, etc.). Elevations for top of manholes and pipe inverts. Pipe size, type, slope, and distance between manholes.

f. Plants/Pump Stations: All of the items below ground level including electrical ducts, etc.

g. Field changes of dimensions, arrangements, and details.

h. Changes made in accordance with Change Orders, Work Change Directives, and Field Orders.

i. Changes in details on the Drawings. Submit additional details prepared by Contractor when required to document changes.

C. Recording Changes for Schematic Layouts:

1. In some cases, on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items are shown schematically and are not intended to portray physical layout. For such cases, the final physical arrangement shall be determined by Contractor subject to acceptance by Engineer.

2. Record on record documents all revisions to schematics on Drawings, including: piping schematics, ducting schematics, process and instrumentation diagrams, control and circuitry diagrams, electrical one-line diagrams, motor control center layouts, and other schematics when included in the Contract. Record actual locations of equipment, lighting fixtures, in-place grounding system, and other pertinent data.

3. When dimensioned plans and dimensioned sections on the Drawings show the Work schematically, indicate on the record documents, by dimensions accurate to within one inch in the field, centerline location of items of Work such as conduit, piping, ducts, and similar items.

4. Clearly identify the Work item by accurate notations such as “cast iron drain”, “rigid electrical conduit”, “copper waterline”, and similar descriptions.

5. Show by symbol or note the vertical location of Work item; for example, “embedded in slab”, “under slab”, “in ceiling plenum”, “exposed”, and similar designations. For piping not embedded, also provide elevation dimension relative to Project datum.

6. Descriptions shall be sufficiently detailed to be related to Specifications.
7. Engineer may furnish written waiver of requirements relative to schematic layouts shown on plans and sections when, in Engineer’s judgment, dimensioned layouts of Work shown schematically will serve no useful purpose. Do not rely on waiver(s) being issued.

D. Requirements for Supplemental Drawings:

1. In some cases, drawings produced during construction by Engineer or Contractor supplement the Drawings and shall be included with record documents submitted by Contractor. Supplemental record drawings shall include drawings provided with Change Orders, Work Change Directives, and Field Orders and that cannot be incorporated into the Drawings due to space limitations.

2. Supplemental drawings provided with record drawings shall be integrated with the Drawings and include necessary cross-references between drawings. Supplemental record drawings shall be on sheets the same size as the Drawings.

3. When supplemental drawings developed by Contractor using computer-aided drafting/design (CADD) software are to be included in record drawings, submit electronic files for such drawings in AutoCAD (latest version) as part of record drawing submittal.

E. Recording Changes to Specifications and Addenda

1. Mark each Section to record:

   a. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually provided.

   b. Changes made by Addendum, Change Orders, Work Change Directives, and Field Orders.

1.4 SPECIAL TOOLS

A. Special tools are considered to be those tools which, because of their limited use, are not normally available but which are necessary for maintenance of particular equipment.

B. For each type of equipment provided under this CONTRACT, furnish a complete set of all special tools including grease guns and other lubricating devices, which may be needed for the adjustment, operation, maintenance, and disassembly of such equipment. Furnish only tools of high grade, smooth forged alloy tool steel. Manufacture grease guns of the lever type.

C. Furnish and erect one or more neat and substantial steel wall cases or cabinets with flat key locks and clips or hooks to hold each special tool in a convenient arrangement.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Description

B. Quality Assurance

C. Submittals

D. Format and Contents

1.2 DESCRIPTION

A. Scope: Furnish to the ENGINEER 2 copies and a PDF of an Operation and Maintenance Manual for all equipment and associated control systems furnished and installed.

1.3 QUALITY ASSURANCE

A. Reference Codes and Specifications: No current government or commercial specifications or documents apply.

1.4 SUBMITTALS

A. Prior to the Work Reaching 50 Percent Completion, electronically submit to the ENGINEER for approval the manual with all specified material. Submit the approval copy with the partial payment request for the specified completion. Within 30 days after the ENGINEER's approval of the submittal, furnish to the ENGINEER the 2 hard copies of the manual. Provide space in the manual for additional material. Submit any missing material for the manual prior to requesting certification of substantial completion.

1.5 FORMAT AND CONTENTS

A. Prepare and arrange each copy of the manual as follows:

1. One copy of an equipment data summary (see sample form) for each item of equipment.

2. One copy of an equipment preventive maintenance data summary (see sample form) for each item of equipment.

3. One copy of the manufacturer's operating and maintenance instructions. Operating instructions include equipment start-up, normal operation, shutdown, emergency operation and troubleshooting. Maintenance instructions include equipment installation, calibration and adjustment, preventive and repair maintenance, lubrication, troubleshooting, parts list and recommended spare parts.

4. List of electrical relay settings and control and alarm contact settings.

5. Electrical interconnection wiring diagram for equipment furnished including all control and lighting systems.

6. Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for operation.

7. Lubrication schedules, including the lubricant SAE grade and type, temperature range of lubricants, and frequency of required lubrication.

8. Preventive maintenance procedures and schedules.

9. Parts lists by generic title and identification number complete with exploded views of each assembly.

10. Disassembly and reassembly instructions.

11. Name and location of nearest supplier and spare parts warehouse.

12. Recommended troubleshooting and start-up procedures.

13. Reproducible prints of the record drawings, including diagrams and schematics, as required under the electrical and instrumentation portions of these specifications (if any).

14. Furnish all O&M Manual material on 8-1/2 by 11 commercially printed or typed forms or an acceptable alternative format.

B. Electronic File Copies: Electronic submittals shall be pdf format and shall be book marked and word searchable.

C. Digital O&M Manual: Contractor’s instrumentation subcontractor responsible for programming shall combine the electronic files for all equipment to create the on-line O&M manual. Provide six copies of the combined digital O&M manual file on six separate flash drives/external hard drives.

D. Organize each manual into sections paralleling the equipment specifications. Identify each section using heavy section dividers with reinforced holes and numbered plastic index tabs. Use 3-ring, hard-back binders Type No. VS11 as manufactured by K&M Company, Torrence, CA, or equal. Punch all loose data for binding. Arrange composition and printing so that punching does not obliterate any data. Print on the cover and binding edge of each manual the project title, and manual title, as furnished and approved by the ENGINEER.

E. Leave all operating and maintenance material that comes bound by the equipment manufacturer in its original bound state. Cross-reference the appropriate sections of the CONTRACTOR's O&M manual to the manufacturers' bound manuals.

F. Information not applicable to the specific piece of equipment installed on this project shall be struck from the Manual by the Contractor. Information provided shall include a source of replacement parts and names of service representatives, including addresses and telephone numbers.

G. When written instructions include shop drawings and other information previously reviewed by the Engineer, only those editions which were accepted by the Engineer, and which accurately depict the equipment installed, shall be incorporated in the O&M Manual.

H. Label binders Volume 1, 2, and so on, where more than one binder is required. Include the table of contents for the entire set, identified by volume number, in each binder.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

Lee County Utilities

Corkscrew Production Well Panel Replacement

Equipment Data Summary

Equipment Name: Specification Reference:

Manufacturer:

Name:

Address:

Telephone:

Number Supplied: Location/Service:

Model No: Serial No:

Type:

Size/Speed/Capacity/Range (as applicable):

Power Requirement (Phase/Volts/Hertz):

Local Representative:

Name:

Address:

Telephone:

NOTES:

Lee County Utilities

Corkscrew Production Well Panel Replacement

Preventive Maintenance Summary

Equipment Name: Location:

Manufacturer:

Name:

Address:

Telephone:

Model No: Serial No:

Maintenance Task	Lubricant/Part	D W M Q SA A	O&M Manual Reference

NOTES:

*D-Daily W-Weekly M-Monthly Q-Quarterly SA-Semi-Annual A-Annual

SECTION 01 78 36

WARRANTIES AND BONDS

PART 1 GENERAL

1.1 REQUIREMENTS INCLUDED

A. Compile specified warranties and bonds.

B. Co-execute submittals when so specified.

C. Review submittals to verify compliance with Contract Documents.

D. Submit to the ENGINEER for review and transmittal to OWNER.

1.2 SUBMITTAL REQUIREMENTS

A. Assemble warranties, bonds and service and maintenance contracts, executed by each of the respective manufacturers, suppliers, and subcontractors.

B. Two original signed copies are required.

C. Table of Contents. Neatly typed in orderly sequence. Provide complete information for each items.

1. Product or work item.
2. Firm, with name of principal, address and telephone number.
3. Scope.
4. Date of beginning warranty, bond or service and maintenance contract.
5. Duration of warranty, bond or service maintenance contract.
6. Provide information for OWNER's personnel:
    a. Proper procedure in case of failure.
    b. Instances which might affect the validity of warranty or bond.
7. CONTRACTOR, name of responsible principal, address and telephone number.

1.3 FORM OF SUBMITTALS

A. Prepare in duplicate packets.

B. Format:

1. Size 8-1/2" x 11", punch sheets for standard 3-post binder.
    a. Fold larger sheets to fit into binders.

2. Cover: Identify each packet with typed or printed title “WARRANTIES AND BONDS” list:
   a. Title of Project
   b. Name of CONTRACTOR

C. Binders: Commercial quality, three-post binder, with durable and cleanable plastic covers and maximum post width of 2 inches.

1.4 WARRANTY SUBMITTAL REQUIREMENTS

A. For all major pieces of equipment, submit a warranty from the equipment manufacturer. The manufacturer’s warranty period shall be concurrent with the CONTRACTOR’s for one (1) year, unless otherwise specified, commencing at the time of substantial completion.

B. The CONTRACTOR shall be responsible for obtaining certificates for equipment warranty for all major equipment specified under Division 26 and which has a 1 HP motor or which lists for more than $1,000. The ENGINEER reserves the right to request warranties for equipment not classified as major. The CONTRACTOR shall still warrant equipment not considered to be “major” in the CONTRACTOR’s one-year warranty period even though certificates of warranty may not be required.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 79 00

TRAINING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Training

1.2 TRAINING

A. Training: Provide the services of knowledgeable, technically competent, factory trained specialists to instruct Plant and Maintenance personnel in the operation and maintenance of the equipment and system components listed in Paragraph B. The OWNER will furnish training classroom space.

1. Coordinate services with the OWNER, with a minimum of 30 days prior notice.

2. Provide a combination of classroom and "hands-on" instruction designed to completely familiarize operating and maintenance personnel with the systems theory, standard operating procedures, safety features and emergency procedures, and general maintenance of all components.

3. Conduct all training at the Plant during regular hours, 8am-1pm, on weekdays.

B. Provide training for the following:

Specification	Equipment Name	Minimum Hours
26 29 23	Variable Frequency Drive	2 per session
26 23 00	Switchgear	3 Days
26 24 19	Motor Control Centers	2 Days

C. Length of Training: The minimum lengths of training sessions are listed in Paragraph B. above.

D. Credentials: Submit for approval, credentials of equipment manufacturer representatives who are to be course instructors at least 14 days prior to a proposed training session.

E. Scheduling: Submit training outline and other information described in paragraphs G through K for approval at least 14 days prior to the proposed date for the training

sessions. Verify scheduling with the OWNER at least 14 days prior to the training sessions.

F. Number of Copies: For each training class, provide instructional material for at least ten attendees plus five extra copies, plus duplicate copies of all audio-visual aids utilized during each training course. Minimum of 12 participants total.

G. Training Outline Submission: Provide a proposed training outline including the topics presented in Paragraph K. Identify specific components and procedures in the proposed training outline.

H. Training Topic Detail: Detail specific training topics. Describe "hands-on" demonstrations planned for the training. Reference training aids to be utilized in the training (i.e. video tapes, slides, transparencies) and attach where applicable.

I. Training Handouts: Attach training handouts to the proposed training outline.

J. Training Segment Duration: Indicate the duration of each training segment.

K. Training Outline:

1. Equipment Operation

    a. Describe equipment's operating (process) function.

    b. Describe equipment's fundamental operating principles and dynamics.

    c. Identify equipment's mechanical, electrical and electronic components and features.

    d. Identify all support equipment associated with the operation of the subject equipment.

2. Detailed Component Description

    a. Identify and describe in detail each component's function.

    b. Where applicable, group related components into subsystems.

    c. Identify, and describe in detail, equipment safety features and control interlocks.

3. Equipment Preventive Maintenance

   a. Describe preventive maintenance inspection procedures required to perform and inspect the equipment in operation, and spot potential trouble symptoms (anticipate breakdowns).

   b. Outline recommended routine lubrication and adjustments (preventive maintenance).

4. Equipment Troubleshooting

   a. Define recommended systematic troubleshooting procedures.

   b. Provide component specific troubleshooting checklists.

   c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.

5. Equipment Corrective Maintenance

   a. Describe recommended equipment preparation requirements.

   b. Identify and describe the use of special tools required for maintenance of the equipment.

   c. Describe component removal/installation and disassembly/ assembly procedures.

   d. Perform at least two "hands-on" demonstrations of common corrective maintenance repairs.

   e. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

   f. Define recommended torqueing, mounting, calibration, and alignment procedures and settings, as appropriate.

   g. Describe recommended procedures to check/test equipment following corrective repair.

L. Certificate: Provide "Certificate of Instructional Services" signed by ENGINEER and equipment representative, verifying that training has been accomplished to satisfaction of all parties. Use form provided in this section, and furnish ENGINEER with three copies.

M. Substantial Completion: Training provided by manufacturers' representative, ENGINEER and OWNER does not constitute substantial completion.

N. Equipment Use: Use of equipment for training will not void manufacturers' or contract warranties.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 HANDS-ON DEMONSTRATION

A. Contractor's instructor shall provide "hands-on" demonstration of operations and maintenance of equipment and materials for each training session.

B. Contractor shall furnish tools and appurtenances required for demonstrations.

3.2 CERTIFICATE OF INSTRUCTIONAL SERVICES

CERTIFICATE OF INSTRUCTIONAL SERVICES

Project_____

Equipment_____

Specification.Section_____

Contract_____

I hereby certify the equipment Manufacturers' Representative has instructed OWNER's personnel in startup operation and maintenance of this equipment as required in the Contract Documents.

MANUFACTURER'S REPRESENTATIVE

Signature _____

Name: (print) _____

Title: _____

Representing _____

CONTRACTOR

Signature _____ Date _____

Name (print) _____

Title _____

ENGINEER

Signature _____ Date _____

Name (print) _____

Title _____

COMMENTS:

Complete and submit three copies of this form to ENGINEER upon completion of training as required by Specification Section 01 79 00.

END OF SECTION

(NO TEXT FOR THIS PAGE)

DIVISION 02 – EXISTING CONDITIONS

SECTION 02 21 13

LINES AND GRADES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General

B. Surveys

C. Datum Plane

D. Protection of Survey Data

1.2 GENERAL

A. Construct all work in accordance with the lines and grades shown on the Drawings. Assume full responsibility for keeping all alignment and grade.

1.3 SURVEYS

A. Reference Points: The OWNER will provide reference points for the work as described in the General Conditions. Base horizontal and vertical control points will be designated by the ENGINEER and used as datum for the Work. Perform all additional survey, layout, and measurement work.

1. Keep Engineer informed, sufficiently in advance, of the times and places at which work is to be performed so that base horizontal and vertical control points may be established, and any checking deemed necessary by Engineer may be done, with minimum inconvenience to the Engineer and at no delay to Contractor. It is the intention not to impede the Work for the establishment of control points and the checking of lines and grades set by the Contractor. However, when necessary, suspend working operations for such reasonable time as the Engineer may require for this purpose. Costs associated with such suspension are deemed to be included in the Contract Price, and no time extension or additional costs will be allowed.

2. Provide an experienced survey crew including an instrument operator, competent assistants, and any instruments, tools, stakes, and other materials required to complete the survey, layout, and measurement of work performed by the CONTRACTOR.

1.4 DATUM PLANE

A. All elevations indicated or specified refer to the North American Vertical Datum Plane, 1988 General Adjustment, of the United States Coast and Geodetic Survey and are expressed in feet and decimal parts thereof, or in feet and inches.

1.5 PROTECTION OF SURVEY DATA

A. General: Safeguard all points, stakes, grade marks, known property corners, monuments, and bench marks made or established for the Work. Reestablish them if disturbed and bear the entire expense of checking reestablished marks and rectifying work improperly installed.

B. Records: Keep neat and legible notes of measurements and calculations made in connection with the layout of the Work. Furnish copies of such data to the ENGINEER for use in checking the CONTRACTOR's layout. Data considered of value to the OWNER will be transmitted to the OWNER by the ENGINEER with other records on completion of the Work.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 02 40 00

DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: All work necessary for the removal and disposal of buildings, structures, foundations, piping, equipment and roadways, or any part thereof including masonry, steel, reinforced concrete, plain concrete, electrical facilities, and any other material or equipment shown or specified to be removed.

B. Basic Procedures and Schedule: Carry out demolition so that adjacent structures, which are to remain, are not endangered. Schedule the work so as not to interfere with the day to day operation of the existing facilities. Do not block doorways or passageways in existing facilities.

C. Additional Requirements: Provide dust control and make provisions for safety.

1.2 SUBMITTALS

A. Provide all submittals, including the following, as specified in Division 1.

B. Site Inspection: Visit the site and inspect all existing structures. Observe and record any defects which may exist in buildings or structures adjacent to but not directly affected by the demolition work. Provide the OWNER with a copy of this inspection record and obtain the OWNER's approval prior to commencing the demolition.

1.3 QUALITY ASSURANCE

A. Limits: Exercise care to break concrete sufficiently for removal in reasonably small masses. Where only parts of a structure are to be removed, cut the concrete along limiting lines with a suitable saw so that damage to the remaining structure is held to a minimum.

1.4 TITLE TO EQUIPMENT AND MATERIALS

A. Contractor shall have no right or title to any of the equipment, materials, or other items to be removed from the existing buildings or structures unless and until said equipment, materials and other items have been removed from the premises. The Contractor shall not sell or assign or attempt to sell or assign any interest in the said equipment, materials, or other items until the said equipment, materials or other items have been removed.

B. Contractor shall have no claim against the Owner because of the absence of such fixtures and materials.

1.5 CONDITION OF STRUCTURES AND EQUIPMENT

A. The Owner does not assume responsibility for the actual condition of structures and equipment to be demolished and removed.

B. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner so far as practical.

C. The information regarding the existing structures and equipment shown on the Drawings is based on visual inspection and a walk through survey only. Neither the Engineer nor the Owner will be responsible for interpretations or conclusions drawn therefrom by the Contractor.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 DEMOLITION AND REMOVALS

A. The removal of all equipment and piping, and all materials from the demolition of buildings and structure shall, when released by the Owner and Engineer, shall be done by the Contractor, and shall become the Contractor's property, unless otherwise noted, for disposition in any manner not contrary to the Contract requirements and shall be removed from the site to the Contractor's own place of disposal.

B. The electrical subcontractor specifically, shall de energize all panelboards, lighting fixtures, switches, circuit breakers, electrical conduits, motors, limit switches, pressure switches, instrumentation such as flow, level and/or other meters, wiring, and similar power equipment prior to removal. Any electric panels or equipment which are to be retained shall be relocated or isolated by the electrical subcontractor specifically, prior to the removal of the equipment specified herein.

C. The Contractor shall proceed with the removal of the equipment, piping and appurtenances in a sequence designed to maintain the plant in continuous operation and shall proceed only after approval of the Engineer.

D. Any equipment piping and appurtenances removed without proper authorization, which are necessary for the operation of the existing facilities shall be replaced to the satisfaction of the Engineer at no cost to the Owner.

E. Excavation caused by demolition shall be backfilled with fill free from rubbish and debris. Select fill or structural fill shall be used where specifically required on Contract Drawings.

F. Burning of any debris resulting from the demolition will not be permitted at the site.

G. Where parts of existing structures are to remain in service, demolish the portions to be removed, repair damage, and leave the structure in proper condition for the intended use. Remove concrete and masonry to the lines designated by drilling, chipping, or other suitable methods. Leave the resulting surfaces reasonably true and even, with sharp straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended. Where existing reinforcing bars are to extend into new construction, remove the concrete so that the reinforcing is clean and undamaged. Cut off other reinforcing 1/2-inch below the surface and fill with epoxy resin binder flush with the surface.

H. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of the adjoining and/or nearby structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.

3.2 PROTECTION

A. Demolition and removal work shall be performed by competent experienced workmen for the various type of demolition and removal work and shall be carried out through to completion with due regard to the safety of Owner employees, workmen on site and the public. The work shall be performed with as little nuisance as possible.

B. The work shall comply with the applicable provisions and recommendations of OSHA, all governing codes, and as hereinafter specified.

C. The Contractor shall make such investigations, explorations, and probes as are necessary to ascertain any required protective measures before proceeding with demolition and removal. The Contractor shall give particular attention to shoring and bracing requirements to prevent any damage to new or existing construction.

D. The Contractor shall provide, erect, and maintain catch platforms, lights, barriers, weather protection, warning signs and other items as required for proper protection of the public, occupants of the building, workmen engaged in demolition operations, and adjacent construction.

E. The Contractor shall provide and maintain weather protection at exterior openings to fully protect the interior premises against damage from the elements until such openings are closed by new construction.

F. The Contractor shall provide and maintain temporary protection of the existing structure designated to remain where demolition, removal and new work is being done, connections made, materials handled, or equipment moved.

G. The Contractor shall take necessary precautions to prevent dust from rising by wetting demolished masonry, concrete, plaster, and similar debris. Unaltered portions of the existing buildings affected by the operations under this Section shall be protected by dust proof partitions and other adequate means.

H. The Contractor shall provide adequate fire protection in accordance with local Fire Department requirements.

I. The Contractor shall not close or obstruct walkways, passageways, or stairways and shall not store or place materials in passageways, stairs, or other means of egress. The Contractor shall conduct operations with minimum traffic interference.

J. The Contractor shall be responsible for any damage to the existing structure or contents by reason of the insufficiency of protection provided.

3.3 WORKMANSHIP

A. The demolition and removal work shall be performed as described in the Contract Documents. The work required shall be done with care, and shall include all required shoring, bracing, etc. The Contractor shall be responsible for any damage which may be caused by demolition and removal work to any part or parts of existing structures or items designated for reuse or to remain. The Contractor shall perform patching, restoration, and new work in accordance with applicable Technical Sections of the Specifications and in accordance with the details shown on the Drawings. Prior to starting of work, the Contractor shall provide a detailed description of methods and equipment to be used for each operation and the sequence thereof for review by the Engineer.

B. All supports, pedestals and anchors shall be removed with the equipment and piping unless otherwise specified or required. Concrete bases, anchor bolts and other supports shall be removed to approximately 1 inch below the surrounding finished area and the recesses shall be patched to match the adjacent areas. Superstructure wall and roof openings shall be closed, and damaged surfaces shall be patched to match the adjacent areas, as specified under applicable Sections of these Specifications, as shown on the Drawings, or as directed by the Engineer. Wall sleeves and castings shall be plugged or blanked off, all openings in concrete shall be closed in a manner meeting the requirements of the appropriate Sections of these Specifications, as shown on the Drawings, and as directed and approved by the Engineer.

C. Materials or items designated to remain the property of the Owner shall be as hereinafter tabulated. Such items shall be removed with care and stored at a location at the site to be designated by the Owner.

D. Where equipment is shown or specified to be removed and relocated, the Contractor shall not proceed with removal of this equipment without specific prior approval of the Engineer. Upon approval, and prior to commencing removal operations, the equipment shall be operated in the presence of representatives of the Contractor, Owner and Engineer. Such items shall be removed with care, under the supervision of the trade responsible for reinstallation and I. protected and stored until required. Material or items damaged during removal shall be replaced with similar new material or item. Any equipment that is removed without proper authorization and is required for plant operation shall be replaced at no cost to the Owner.

E. Wherever piping is to be removed for disposition, the piping shall be drained by the Contractor and adjacent pipe and headers that are to remain in service shall be blanked off or plugged and then anchored in an approved manner.

F. Materials or items demolished and not designated to become the property of the Owner or to be reinstalled shall become the property of the Contractor and shall be removed from the property and legally disposed of.

G. The Contractor shall execute the work in a careful and orderly manner, with the least possible disturbance to the public and to the occupants of the building.

H. In general, masonry shall be demolished in small sections, and where necessary to prevent collapse of any construction, the Contractor shall install temporary shores, struts, and bracing.

I. Where alterations occur, or new and old work join, the Contractor shall cut, remove, patch, repair or refinish the adjacent surfaces to the extent required by the construction conditions, to leave the altered work in as good a condition as existed prior to the start of the work. The materials and workmanship employed in the alterations, unless otherwise shown on the Drawing or specified, shall comply with that of the various respective trades which normally perform the items of work.

J. The Contractor shall finish adjacent existing surfaces to new work to match the specified finish for new work. The Contractor shall clean existing surfaces of dirt, grease, loose paint, etc., before refinishing.

K. The Contractor shall cut out embedded anchorage and attachment items as required to properly provide for patching and repair of the respective finishes.

L. The Contractor shall confine cutting of existing roof areas designated to remain to the limits required for the proper installation of the new work. The Contractor shall cut and

remove insulation, etc., and provide temporary weather tight protection as required until new roofing and flashings are installed.

M. The Contractor shall remove temporary work, such as enclosures, signs, guards, and the like when such temporary work is no longer required or when directed at the completion of the work.

3.4 MAINTENANCE

A. The Contractor shall maintain the buildings, structures, and public properties free from accumulations of waste, debris, and rubbish, caused by the demolition and removal operations.

B. The Contractor shall provide on site dump containers for collection of waste materials, debris, and rubbish, and shall wet down dry materials to lay down and prevent blowing dust.

C. At reasonable intervals during the progress of the demolition and removal work or as directed by the Engineer, the Contractor shall clean the site and properties, and dispose of waste materials, debris, and rubbish.

3.5 EQUIPMENT AND MATERIALS RETAINED BY OWNER

A. All debris resulting from the demolition and removal work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed. All other material shall be disposed of off-site by the Contractor at his expense.

END OF SECTION

(NO TEXT FOR THIS PAGE)

DIVISION 03 – CONCRETE

SECTION 031000

CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1. SUMMARY

   a. Section Includes:

      1) Form-facing material for cast-in-place concrete.
      2) Shoring, bracing, and anchoring.

2. PREINSTALLATION MEETINGS

   a. Preinstallation Conference: Conduct conference at Project site.

3. ACTION SUBMITTALS

   a. Product Data: For each of the following:

      1) Exposed surface form-facing material.
      2) Concealed surface form-facing material.
      3) Form ties.
      4) Waterstops.
      5) Form-release agent.

   b. Shop Drawings: Prepared, signed and sealed by a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

      1) For exposed vertical concrete walls, indicate dimensions and form tie locations.
      2) Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.

         a Location of construction joints is subject to approval of the Architect.

      3) Indicate location of waterstops.

4. INFORMATIONAL SUBMITTALS

   a. Field quality-control reports.

PART 2 PRODUCTS

1. PERFORMANCE REQUIREMENTS

   a. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

      1) Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
      2) Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

2. FORM-FACING MATERIALS

   a. As-Cast Surface Form-Facing Material:

      1) Provide continuous, true, and smooth concrete surfaces.
      2) Furnish in largest practicable sizes to minimize number of joints.
      3) Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:

         a Plywood, metal, or other approved panel materials.
         b Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1.

   b. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

      1) Provide lumber dressed on at least two edges and one side for tight fit.

3. WATERSTOPS

   a. Flexible Rubber Waterstops: U.S. Army Corps of Engineers CRD-C 513 for embedding in concrete to prevent passage of fluids through joints, with factory fabricate corners, intersections, and directional changes.

      1) Profile: Flat dumbbell with center bulb or ribbed with center bulb.
      2) Dimensions: Minimum 6 inches by 3/8 inch thick; nontapered.

   b. Flexible PVC Waterstops: U.S. Army Corps of Engineers CRD-C 572 for embedding in concrete to prevent passage of fluids through joints, with factory fabricate corners, intersections, and directional changes.

      1) Profile: Flat dumbbell with center bulb or ribbed with center bulb.
      2) Dimensions: Minimum 6 inches by 3/8 inch thick; nontapered.

c. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

d. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

4. RELATED MATERIALS

a. Reglets: Fabricate reglets of not less than 0.022-inch-thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

b. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034-inch-thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

c. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

d. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

e. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1) Formulate form-release agent with rust inhibitor for steel form-facing materials.
2) Form release agent for form liners shall be acceptable to form liner manufacturer.

f. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1) Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.

PART 3 EXECUTION

1. INSTALLATION OF FORMWORK

a. Comply with ACI 301.

b. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.

c. Limit concrete surface irregularities as follows:

1) Surface Finish-2.0: ACI 117 Class B, 1/4 inch.

d. Construct forms tight enough to prevent loss of concrete mortar.

1) Minimize joints.
2) Exposed Concrete: Symmetrically align joints in forms.

e. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1) Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2) Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3) Install keyways, reglets, recesses, and other accessories, for easy removal.

f. Do not use rust-stained, steel, form-facing material.

g. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1) Provide and secure units to support screed strips.
2) Use strike-off templates or compacting-type screeds.

h. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1) Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2) Locate temporary openings in forms at inconspicuous locations.

i. Chamfer exterior corners and edges of permanently exposed concrete.

j. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

k. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1) Determine sizes and locations from trades providing such items.
2) Obtain written approval of Architect prior to forming openings not indicated on Drawings.

l. Construction and Movement Joints:

1) Construct joints true to line with faces perpendicular to surface plane of concrete.
2) Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3) Place joints perpendicular to main reinforcement.
4) Locate joints for beams, slabs, joists, and girders in the middle third of spans.

a Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5) Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

6) Space vertical joints in walls as indicated on Drawings.

a Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

m. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1) Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2) Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

n. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

o. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

p. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

2. INSTALLATION OF EMBEDDED ITEMS

a. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

1) Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2) Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3) Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
4) Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5) Clean embedded items immediately prior to concrete placement.

3. INSTALLATION OF WATERSTOPS

a. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.

1) Install in longest lengths practicable.
2) Locate waterstops in center of joint unless otherwise indicated on Drawings.
3) Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 033000 "Cast-In-Place Concrete."
4) Secure waterstops in correct position at 12 inches on center.
5) Field fabricate joints in accordance with manufacturer's instructions using heat welding.

a Miter corners, intersections, and directional changes in waterstops.
b Align center bulbs.

6) Clean waterstops immediately prior to placement of concrete.
7) Support and protect exposed waterstops during progress of the Work.

b. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.

1) Install in longest lengths practicable.
2) Locate waterstops in center of joint unless otherwise indicated on Drawings.
3) Protect exposed waterstops during progress of the Work.

4. SHORING AND RESHORING INSTALLATION

a. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

b. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

5. FIELD QUALITY CONTROL

a. Special Inspections: Owner may engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

b. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

c. Inspections:

1) Inspect formwork for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 032000

CONCRETE REINFORCING

PART 1 GENERAL

1. SUMMARY

   a. Section Includes:

      1) Steel reinforcement bars.
      2) Welded-wire reinforcement.

2. PREINSTALLATION MEETINGS

   a. Preinstallation Conference: Conduct conference at Project site.

3. ACTION SUBMITTALS

   a. Product Data: For the following:

      1) Each type of steel reinforcement.
      2) Bar supports.
      3) Mechanical splice couplers.

   b. Shop Drawings: Comply with ACI SP-066:

      1) Include placing drawings that detail fabrication, bending, and placement.
      2) Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

   c. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

      1) Location of construction joints is subject to approval of the Architect.

4. INFORMATIONAL SUBMITTALS

   a. Welding certificates.

      1) Reinforcement to Be Welded: Welding procedure specification in accordance with AWS D1.4

   b. Material Certificates: For each of the following, signed by manufacturers:

1) Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

c. Material Test Reports: For the following, from a qualified testing agency:

1) Steel Reinforcement:

a For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706.

2) Mechanical splice couplers.

d. Field quality-control reports.

5. QUALITY ASSURANCE

a. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

PART 2 PRODUCTS

1. STEEL REINFORCEMENT

a. Reinforcing Bars: ASTM A615, Grade 60, deformed.

b. Low-Alloy Steel Reinforcing Bars: ASTM A706, deformed.

c. Headed-Steel Reinforcing Bars: ASTM A970.

d. Galvanized Reinforcing Bars:

1) Steel Bars: ASTM A615, Grade 60, deformed bars.
2) Zinc Coating: ASTM A767, Class I zinc coated after fabrication and bending.

e. Epoxy-Coated Reinforcing Bars:

1) Steel Bars: ASTM A615, Grade 60, deformed bars.
2) Epoxy Coating: ASTM A775 or ASTM A934 with less than 2 percent damaged coating in each 12-inch bar length.

f. Plain-Steel Welded-Wire Reinforcement: ASTM A1064, plain, fabricated from as-drawn steel wire into flat sheets.

g. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064, flat sheet.

h. Galvanized-Steel Welded-Wire Reinforcement: ASTM A1064, plain, fabricated from galvanized-steel wire into flat sheets.

2. REINFORCEMENT ACCESSORIES

a. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1) Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
b For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.
c For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
d For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

b. Mechanical Splice Couplers: ACI 318 Type 1, same material of reinforcing bar being spliced; tension-compression type.

c. Steel Tie Wire: ASTM A1064, annealed steel, not less than 0.0508 inch in diameter.

1) Finish: Galvanized or ASTM A884, Class A, Type 1, epoxy coated, with less than 2 percent damaged coating in each 12-inch wire length.

d. Stainless Steel Tie Wire: ASTM A1022, not less than 0.0508 inch in diameter.

3. FABRICATING REINFORCEMENT

a. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 EXECUTION

1. PREPARATION

a. Protection of In-Place Conditions:

1) Do not cut or puncture vapor retarder.
2) Repair damage and reseal vapor retarder before placing concrete.

b. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

2. INSTALLATION OF STEEL REINFORCEMENT

a. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

b. Accurately position, support, and secure reinforcement against displacement.

1) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2) Do not tack weld crossing reinforcing bars.

c. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

d. Provide concrete coverage in accordance with ACI 318.

e. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

f. Splices: Lap splices as indicated on Drawings.

1) Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2) Stagger splices in accordance with ACI 318.
3) Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4) Weld reinforcing bars in accordance with AWS D1.4, where indicated on Drawings.

g. Install welded-wire reinforcement in longest practicable lengths.

1) Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

a For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches.

2) Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3) Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4) Lace overlaps with wire.

3. JOINTS

a. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1) Place joints perpendicular to main reinforcement.
2) Continue reinforcement across construction joints unless otherwise indicated.
3) Do not continue reinforcement through sides of strip placements of floors and slabs.

4. INSTALLATION TOLERANCES

a. Comply with ACI 117.

5. FIELD QUALITY CONTROL

a. Special Inspections: Owner may engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

b. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

c. Inspections:

1) Steel-reinforcement placement.
2) Steel-reinforcement mechanical splice couplers.
3) Steel-reinforcement welding.

END OF SECTION 032000

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1. SUMMARY

   a. Section Includes:

      1) Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

   b. Related Requirements:

      1) Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
      2) Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.

2. DEFINITIONS

   a. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, and other pozzolans materials subject to compliance with requirements.

   b. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

3. PREINSTALLATION MEETINGS

   a. Preinstallation Conference: Conduct conference at Project site.

4. ACTION SUBMITTALS

   a. Product Data: For each of the following.

      1) Portland cement.
      2) Fly ash.
      3) Slag cement.
      4) Aggregates.
      5) Admixtures:
      6) Vapor retarders.
      7) Liquid floor treatments.
      8) Curing materials.
      9) Joint fillers.

   b. Design Mixtures: For each concrete mixture, include the following:

1) Mixture identification.
2) Minimum 28-day compressive strength.
3) Durability exposure class.
4) Maximum w/cm.
5) Calculated equilibrium unit weight, for lightweight concrete.
6) Slump limit.
7) Air content.
8) Nominal maximum aggregate size.
9) Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10) Intended placement method.
11) Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

c. Shop Drawings:

1) Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

a Location of construction joints is subject to approval of the Architect.

d. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1) Concrete Class designation.
2) Location within Project.
3) Exposure Class designation.
4) Formed Surface Finish designation and final finish.
5) Final finish for floors.
6) Curing process.
7) Floor treatment if any.

5. INFORMATIONAL SUBMITTALS

a. Material Certificates: For each of the following, signed by manufacturers:

1) Cementitious materials.
2) Admixtures.
3) Curing compounds.
4) Vapor retarders.
5) Joint-filler strips.

b. Material Test Reports: For the following, from a qualified testing agency:

1) Portland cement.
2) Fly ash.
3) Slag cement.
4) Aggregates.
5) Admixtures:

c. Preconstruction Test Reports: For each mix design.

d. Field quality-control reports.

6. QUALITY ASSURANCE

a. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.

7. PRECONSTRUCTION TESTING

a. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1) Include the following information in each test report:

a Admixture dosage rates.
b Slump.
c Air content.
d Seven-day compressive strength.
e 28-day compressive strength.

8. DELIVERY, STORAGE, AND HANDLING

a. Comply with ASTM C94 and ACI 301.

9. FIELD CONDITIONS

a. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1.

PART 2 PRODUCTS

1. CONCRETE, GENERAL

a. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2. CONCRETE MATERIALS

a. Cementitious Materials:

1) Portland Cement: ASTM C150, Type I/II, gray.
2) Fly Ash: ASTM C618, Class C or F.
3) Slag Cement: ASTM C989, Grade 100 or 120.

b. Normal-Weight Aggregates: ASTM C33, coarse aggregate or better, graded. Provide aggregates from a single source.

1) Maximum Coarse-Aggregate Size: 3/4-inch nominal.
2) Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

c. Air-Entraining Admixture: ASTM C260.

d. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1) Water-Reducing Admixture: ASTM C494, Type A.
2) Retarding Admixture: ASTM C494, Type B.
3) Water-Reducing and -Retarding Admixture: ASTM C494, Type D.
4) High-Range, Water-Reducing Admixture: ASTM C494, Type F.
5) High-Range, Water-Reducing and -Retarding Admixture: ASTM C494, Type G.
6) Plasticizing and Retarding Admixture: ASTM C1017, Type II.

e. Water and Water Used to Make Ice: ASTM C94, potable.

3. VAPOR RETARDERS

a. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

4. LIQUID FLOOR TREATMENTS

a. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

5. CURING MATERIALS

a. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

b. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

c. Water: Potable.

d. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

e. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B.

f. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

6. RELATED MATERIALS

a. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.

b. Floor Slab Protective Covering: Eight-feet-wide cellulose fabric.

7. CONCRETE MIXTURES, GENERAL

a. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

1) Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

b. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1) Fly Ash or Other Pozzolans: 25 percent by mass.
2) Slag Cement: 50 percent by mass.
3) Total of Fly Ash or Other Pozzolans, Slag Cement: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass.
4) Total of Fly Ash or Other Pozzolans: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass.

c. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1) Use water-reducing admixture in concrete, as required, for placement and workability.
2) Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3) Use water-reducing admixture in pumped concrete and concrete with a w/cm below 0.50.

8. CONCRETE MIXTURES

a. Normal-weight concrete used for footings:
1) Minimum Compressive Strength: 3000 psi at 28 days.
2) Minimum Cementitious Materials Content: 470 lb/cu. yd.
3) Maximum w/cm: 0.58.
4) Slump Limit: 5 inches, plus or minus 1 inch before adding high-range water-reducing admixture at Project site.
5) Air Content: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

b. Normal-weight concrete used for walls and slabs:
1) Minimum Compressive Strength: 4000 psi strength at 28 days.
2) Minimum Cementitious Materials Content: 550 lb/cu. Yd
3) Maximum w/cm: 0.44.
4) Slump Limit: 4 inches, plus or minus 1 inch before adding high-range water-reducing admixture at Project site.

5) Air Content: 4.0 percent, plus or minus 1.0 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

9. CONCRETE MIXING

a. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94 and ASTM C1116, and furnish batch ticket information.

PART 3 EXECUTION

1. INSTALLATION OF EMBEDDED ITEMS

a. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1) Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2) Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
3) Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels and other conditions.

2. INSTALLATION OF VAPOR RETARDER

a. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1) Install vapor retarder with longest dimension parallel with direction of concrete pour.
2) Face laps away from exposed direction of concrete pour.
3) Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
4) Lap joints 6 inches and seal with manufacturer's recommended tape.
5) Seal penetrations in accordance with vapor retarder manufacturer's instructions.
6) Protect vapor retarder during placement of reinforcement and concrete.

a Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

3. JOINTS

a. Construct joints true to line, with faces perpendicular to surface plane of concrete.

b. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1) Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2) Place joints perpendicular to main reinforcement.

a Continue reinforcement across construction joints unless otherwise indicated.

3) Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4) Locate horizontal joints in walls and columns at underside of floors and at the top of footings or floor slabs.
5) Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.

c. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1) Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2) Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

d. Isolation Joints in Slabs-on-Ground: Install joint-filler strips at slab junctions with vertical surfaces, as indicated.

1) Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2) Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

e. Doweled Joints:

1) Install dowel bars and support assemblies at joints where indicated on Drawings.
2) Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

4. CONCRETE PLACEMENT

a. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1) Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2) Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

b. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

c. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.

1) Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

d. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

1) Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

e. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1) If a section cannot be placed continuously, provide construction joints as indicated.
2) Deposit concrete to avoid segregation.
3) Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4) Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

a Do not use vibrators to transport concrete inside forms.
b Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
c Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
d At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

f. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1) Do not place concrete floors and slabs in a checkerboard sequence.
2) Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3) Maintain reinforcement in position on chairs during concrete placement.
4) Screed slab surfaces with a straightedge and strike off to correct elevations.
5) Level concrete, cut high areas, and fill low areas.
6) Slope surfaces uniformly to drains where required.
7) Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8) Do not further disturb slab surfaces before starting finishing operations.

5. FINISHING FORMED SURFACES

a. As-Cast Surface Finishes:

1) ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

a Patch voids larger than 3/4 inch wide or 1/2 inch deep.
b Remove projections larger than 1/4 inch.
c Patch tie holes.
d Surface Tolerance: ACI 117 Class B.
e Locations: Apply to concrete surfaces exposed to public view.

b. Related Unformed Surfaces:

1) At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2) Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

6. FINISHING FLOORS AND SLABS

a. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

b. Float Finish:

1) When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2) Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3) Apply float finish to surfaces to receive trowel finish.

c. Trowel Finish:

1) After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2) Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3) Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4) Do not add water to concrete surface.
5) Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6) Apply a trowel finish to surfaces exposed to view.
7) Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch and also no more than 1/16 inch in 2 feet.

d. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated on Drawings. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1) Coordinate required final finish with Architect before application.
2) Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

e. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1) Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2) Coordinate required final finish with Architect before application.

7. INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

a. Filling In:

1) Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2) Mix, place, and cure concrete, as specified, to blend with in-place construction.
3) Provide other miscellaneous concrete filling indicated or required to complete the Work.

b. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

c. Equipment Bases and Foundations:

1) Coordinate sizes and locations of concrete bases with actual equipment provided.
2) Construct concrete bases inches high unless otherwise indicated on Drawings, and extend base not less than 12 inches in each direction beyond the maximum dimensions of supported equipment, unless otherwise indicated on Drawings.
3) Minimum Compressive Strength: 4000 psi at 28 days.
4) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6) Prior to pouring concrete, place and secure anchorage devices.

a Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
b Install anchor bolts to elevations required for proper attachment to supported equipment.

8. CONCRETE CURING

a. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1) Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
2) Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305.1, before and during finishing operations.

b. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1) Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2) Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3) If forms remain during curing period, moist cure after loosening forms.
4) If removing forms before end of curing period, continue curing for remainder of curing period, as follows:

a Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
b Continuous Sprinkling: Maintain concrete surface continuously wet.
c Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
d Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
e Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

1 Recoat areas subject to heavy rainfall within three hours after initial application.
2 Maintain continuity of coating and repair damage during curing period.

c. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1) Begin curing immediately after finishing concrete.
2) Interior Concrete Floors:

a Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

1 Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

Lap edges and ends of absorptive cover not less than 12 inches.
Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2 Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
Cure for not less than seven days.

3 Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

Water.
Continuous water-fog spray.

b Floors to Receive Curing Compound:

1 Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2 Recoat areas subjected to heavy rainfall within three hours after initial application.
3 Maintain continuity of coating, and repair damage during curing period.
4 Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

c Floors to Receive Curing and Sealing Compound:

1 Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2 Recoat areas subjected to heavy rainfall within three hours after initial application.
3 Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

9. TOLERANCES

a. Conform to ACI 117.

10. APPLICATION OF LIQUID FLOOR TREATMENTS

a. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1) Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2) Do not apply to concrete that is less than seven-days old. Follow manufacturer’s printed instructions.

3) Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4) Rinse with water; remove excess material until surface is dry.
5) Apply a second coat in a similar manner if surface is rough or porous.

b. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

11. FIELD QUALITY CONTROL

a. Special Inspections: Owner may engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

b. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1) Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31.
2) Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3) Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

a Test reports shall include reporting requirements of ASTM C31, ASTM C39, and ACI 301, including the following as applicable to each test and inspection:

1 Project name.
2 Name of testing agency.
3 Names and certification numbers of field and laboratory technicians performing inspections and testing.
4 Name of concrete manufacturer.
5 Date and time of inspection, sampling, and field testing.
6 Date and time of concrete placement.
7 Location in Work of concrete represented by samples.
8 Date and time sample was obtained.
9 Truck and batch ticket numbers.
10 Design compressive strength at 28 days.
11 Concrete mixture designation, proportions, and materials.
12 Field test results.
13 Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
14 Type of fracture and compressive break strengths at seven days and 28 days.

c. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength,

aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

d. Inspections:

1) Headed bolts and studs.
2) Verification of use of required design mixture.
3) Concrete placement, including conveying and depositing.
4) Curing procedures and maintenance of curing temperature.
5) Verification of concrete strength before removal of shores and forms from beams and slabs.
6) Batch Plant Inspections: On a random basis, as determined by Architect.

e. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172 shall be performed in accordance with the following requirements:

1) Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

a When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2) Slump: ASTM C143:

a One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
b Perform additional tests when concrete consistency appears to change.

3) Air Content: ASTM C231 pressure method, for normal-weight concrete.

a One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4) Concrete Temperature: ASTM C1064:

a One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.

5) Unit Weight: ASTM C567 fresh unit weight of structural lightweight concrete.

a One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

6) Compression Test Specimens: ASTM C31:

a Cast and laboratory cure two sets of five 6-inch by 12-inch cylinder specimens for each composite sample.

7) Compressive-Strength Tests: ASTM C39.

a Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days. Keep the fifth cylinder as a spare.
b Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days. Keep the fifth cylinder as a spare.
c A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8) When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9) Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi..
10) Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
11) Additional Tests:

a Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
b Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Architect.

1 Acceptance criteria for concrete strength shall be in accordance with ACI 301, Section 1.6.6.3.

12) Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13) Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

12. PROTECTION

a. Protect concrete surfaces as follows:

1) Protect from petroleum stains.
2) Prohibit vehicles from interior concrete slabs.
3) Prohibit use of pipe-cutting machinery over concrete surfaces.
4) Prohibit use of acids or acidic detergents over concrete surfaces.
5) Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
6) Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033000

DIVISION 04 – MASONRY

SECTION 042200

CONCRETE UNIT MASONRY

PART 1 GENERAL

1. SUMMARY

   a. Section Includes:

      1) Concrete masonry units.
      2) Steel reinforcing bars.

2. DEFINITIONS

   a. CMU(s): Concrete masonry unit(s).

   b. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

3. ACTION SUBMITTALS

   a. Product Data: For each type of product.

   b. Shop Drawings: For reinforcing steel. Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.

   c. Samples: For each type and color of the following:

      1) CMU.
      2) Mortar.

4. INFORMATIONAL SUBMITTALS

   a. Material Certificates: For each type and size of product. For masonry units, include data on material properties and material test reports substantiating compliance with requirements.

   b. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

      1) Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109 for compressive strength, ASTM C1506 for water retention, and ASTM C91 for air content.
      2) Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

5. QUALITY ASSURANCE

a. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects.

1) Build sample panels for each type of typical exterior wall in sizes approximately 60 inches long by 48 inches high by full thickness.

6. FIELD CONDITIONS

a. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 PRODUCTS

1. UNIT MASONRY, GENERAL

a. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

b. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

c. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1) Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2. CONCRETE MASONRY UNITS

a. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1) Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

b. Integral Water Repellent: Provide units made with integral water repellent for exposed units.

c. Insulated CMUs: Where indicated, units shall contain rigid, specially shaped, molded-polystyrene insulation units complying with ASTM C578, Type I, designed for installing in cores of masonry units.

d. CMUs: ASTM C90.

1) Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.

2) Density Classification: Normal weight.

e. Concrete Building Brick: ASTM C55.

1) Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi.
2) Density Classification: Normal weight.

3. CONCRETE LINTELS

a. Concrete Lintels: ASTM C1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than that of CMUs.

4. MORTAR AND GROUT MATERIALS

a. Portland Cement: ASTM C150, Type I or II. Provide natural color or white cement as required to produce mortar color indicated.

b. Hydrated Lime: ASTM C207, Type S.

c. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

d. Masonry Cement: ASTM C91.

e. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979. Use only pigments with a record of satisfactory performance in masonry mortar.

f. Aggregate for Mortar: ASTM C144.

g. Aggregate for Grout: ASTM C404.

h. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

i. Water: Potable.

5. REINFORCEMENT

a. Uncoated-Steel Reinforcing Bars: ASTM A615 or ASTM A996, Grade 60.

b. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

c. Masonry-Joint Reinforcement, General: ASTM A951.

1) Interior Walls: Hot-dip galvanized, carbon steel.
2) Exterior Walls: Hot-dip galvanized carbon steel.
3) Wire Size for Side Rods: 0.187-inch diameter.
4) Wire Size for Cross Rods: 0.148-inch diameter.
5) Spacing of Cross Rods: Not more than 16 inches o.c.
6) Provide in lengths of not less than 10 feet, with prefabricated corner and tee units].

6. TIES AND ANCHORS

a. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1) Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82, with ASTM A153, Class B-2 coating.
2) Steel Sheet, Galvanized after Fabrication: ASTM A1008, Commercial Steel, with ASTM A153, Class B coating.
3) Steel Plates, Shapes, and Bars: ASTM A36.

b. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1) Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.105-inch-thick steel sheet, galvanized after fabrication.
2) Tie Section: Triangular-shaped wire tie made from 0.187-inch-diameter, hot-dip galvanized-steel wire.
3) Corrugated-Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.075-inch-thick steel sheet, galvanized after fabrication with dovetail tabs for inserting into dovetail slots in concrete.

c. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1) Corrosion Protection: Hot-dip galvanized to comply with ASTM A153.

7. EMBEDDED FLASHING MATERIALS

a. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1) Stainless Steel: ASTM A240 or ASTM A666, Type 304, 0.016 inch thick.
2) Copper: ASTM B370, Temper H00, cold-rolled copper sheet, 16-oz./sq. ft. weight or 0.0216 inch thick or ASTM B370, Temper H01, high-yield copper sheet, 12-oz./sq. ft. weight or 0.0162 inch thick.
3) Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.

4) Fabricate metal drip edges from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed].
5) Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
6) Fabricate metal expansion-joint strips from stainless steel or copper to shapes indicated.

b. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

8. MISCELLANEOUS MASONRY ACCESSORIES

a. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or PVC.

b. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 or PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

c. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226, Type I (No. 15 asphalt felt).

9. MASONRY-CELL FILL

a. Loose-Fill Insulation: Perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).

10. MORTAR AND GROUT MIXES

a. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1) Do not use calcium chloride in mortar or grout.
2) Use portland cement-lime or masonry cement mortar unless otherwise indicated.

b. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

c. Mortar for Unit Masonry: Comply with ASTM C270, Proportion or Property Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1) For masonry below grade or in contact with earth, use Type S.
2) For reinforced masonry, use Type S.
3) For mortar parge coats, use Type S or Type N.
4) For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type S.
5) For interior non-load-bearing partitions, use Type N.

d. Grout for Unit Masonry: Comply with ASTM C476.

1) Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2) Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
3) Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143.

PART 3 EXECUTION

1. INSTALLATION, GENERAL

a. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

2. TOLERANCES

a. Dimensions and Locations of Elements:

1) For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2) For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3) For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch total.

b. Lines and Levels:

1) For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
2) For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, or 1/2-inch maximum.
3) For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
4) For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, or 1/2-inch maximum.

5) For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, or 1/2-inch maximum.

c. Joints:

1) For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2) For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
3) For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3. LAYING MASONRY WALLS

a. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

b. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

c. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

d. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

e. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

f. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

4. MORTAR BEDDING AND JOINTING

a. Lay hollow CMUs as follows:

1) Bed face shells in mortar and make head joints of depth equal to bed joints.
2) Bed webs in mortar in all courses of piers, columns, and pilasters.
3) Bed webs in mortar in grouted masonry, including starting course on footings.
4) Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

b. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

c. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

d. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

5. MASONRY-CELL FILL

a. Pour loose-fill insulation into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than 20 feet.

6. MASONRY-JOINT REINFORCEMENT

a. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1) Space reinforcement not more than 16 inches o.c.
2) Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3) Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.

b. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

c. Provide continuity at wall intersections by using prefabricated T-shaped units.

d. Provide continuity at corners by using prefabricated L-shaped units.

7. ANCHORING MASONRY TO CONCRETE

a. Anchor masonry to concrete, where masonry abuts or faces concrete, to comply with the following:

1) Provide an open space not less than 1/2 inch wide between masonry and concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2) Anchor masonry with anchors embedded in masonry joints and attached to structure.
3) Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

8. FLASHING

a. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.

b. Install flashing as follows unless otherwise indicated:

1) Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2) At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
3) Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
4) Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.

c. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

9. REINFORCED UNIT MASONRY

a. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1) Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2) Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

b. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

c. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1) Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2) Limit height of vertical grout pours to not more than 48 inches height.

10. FIELD QUALITY CONTROL

a. Testing and Inspecting: Owner may engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

b. Inspections: Special inspections according to Level C in TMS 402/ACI 530/ASCE 5.

1) Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2) Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3) Place grout only after inspectors have verified proportions of site-prepared grout.

c. Testing Prior to Construction: One set of tests.

d. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

e. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.

f. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.

g. Mortar Test (Property Specification): For each mix provided, according to ASTM C780. Test mortar for mortar air content and compressive strength.

h. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.

i. Prism Test: For each type of construction provided, according to ASTM C1314 at seven days and at 28 days.

11. PARGING

a. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.

b. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

c. Damp-cure parging for at least 24 hours and protect parging until cured.

12. REPAIRING, POINTING, AND CLEANING

a. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

b. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1) Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2) Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

13. MASONRY WASTE DISPOSAL

a. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1) Do not dispose of masonry waste as fill within 18 inches of finished grade.

b. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

c. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

DIVISION 05 – METALS

SECTION 051200

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1. SUMMARY

   a. Section Includes:

      1) Structural steel.
      2) Shear stud connectors.
      3) Shrinkage-resistant grout.

2. DEFINITIONS

   a. Structural Steel: Elements indicated on Drawings or required by the Project, and as described in ANSI/AISC 303.

3. ACTION SUBMITTALS

   a. Product Data:

      1) Structural-steel materials.
      2) High-strength, bolt-nut-washer assemblies.
      3) Shear stud connectors.
      4) Anchor rods.
      5) Threaded rods.
      6) Shop primer.
      7) Shrinkage-resistant grout.

   b. Shop Drawings: Show fabrication of structural-steel components.

4. INFORMATIONAL SUBMITTALS

   a. Welding certificates.

5. QUALITY ASSURANCE

   a. Fabricator Qualifications: A qualified Fabricator approved by the Owner.

   b. Installer Qualifications: A qualified Installer approved by the Owner.

   c. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1.

PART 2 PRODUCTS

1. PERFORMANCE REQUIREMENTS

   a. Comply with applicable provisions of the following specifications and documents:

      1) ANSI/AISC 303.
      2) ANSI/AISC 360.

   b. Connection Design Information:
      1) Fabricator shall select or complete connections in accordance with ANSI/AISC 303.

2. STRUCTURAL-STEEL MATERIALS

   a. W-Shapes: ASTM A992 or ASTM A572, Grade 50.

   b. Channels, Angles: ASTM A36 or ASTM A572, Grade 50.

   c. Plate and Bar: ASTM A36 or ASTM A572, Grade 50.

   d. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B or ASTM A500, Grade C structural tubing.

   e. Welding Electrodes: Comply with AWS requirements.

3. BOLTS AND CONNECTORS

   a. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125, Grade A325, ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436, hardened carbon-steel washers.

   b. Shear Stud Connectors: ASTM A108, headed-stud type.

4. RODS

   a. Unheaded Anchor Rods: ASTM F1554, Grade 36.

   b. Headed Anchor Rods: ASTM F1554, Grade 36.

   c. Threaded Rods: ASTM A36.

5. PRIMER

   a. Steel Primer:

      1) Fabricator's standard lead- and chromate-free, rust-inhibiting primer.

6. SHRINKAGE-RESISTANT GROUT

a. Metallic, Shrinkage-Resistant Grout: ASTM C1107.

b. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107.

7. FABRICATION

a. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

8. SHOP CONNECTIONS

a. High-Strength Bolts: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts".

b. Weld Connections: Comply with AWS D1.1.

9. GALVANIZING

a. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123.

10. SHOP PRIMING

a. Shop prime steel surfaces, except the following:

1) Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2) Surfaces to be field welded.
3) Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
4) Galvanized surfaces.
5) Surfaces enclosed in interior construction.

b. Surface Preparation of Steel: Clean surfaces to be painted in accordance with SSPC-SP 7.

c. Priming: Apply primer in accordance with manufacturer's written instructions.

11. SOURCE QUALITY CONTROL

a. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.

1) Welded Connections: Visually inspect shop-welded connections.

2) In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1.

PART 3 EXECUTION

1. EXAMINATION

   a. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

   b. Proceed with installation only after unsatisfactory conditions have been corrected.

2. ERECTION

   a. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

   b. Baseplates, Bearing Plates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

   c. Maintain erection tolerances of structural steel within ANSI/AISC 303.

3. FIELD CONNECTIONS

   a. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts".

   b. Weld Connections: Comply with AWS D1.1.

4. FIELD QUALITY CONTROL

   a. Special Inspections: Owner may engage a special inspector to perform the following special inspections:

      1) Verify structural-steel materials and inspect steel details.
      2) Verify weld materials and inspect welds.

   b. Testing Agency: Owner may engage a qualified testing agency to perform tests and inspections.

   c. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

      1) Bolted Connections: Inspect bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
      2) Welded Connections: Visually inspect field welds in accordance with AWS D1.1.

         a In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1.

END OF SECTION 051200

SECTION 053100

STEEL DECKING

PART 1 GENERAL

1. SUMMARY

   a. Section Includes:

      1) Roof deck.

2. ACTION SUBMITTALS

   a. Product Data: For the following:

      1) Roof deck.

   b. Shop Drawings:

      1) Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

3. INFORMATIONAL SUBMITTALS

   a. Welding certificates.

   b. Product Certificates: For each type of steel deck.

4. QUALITY ASSURANCE

   a. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

   b. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

PART 2 PRODUCTS

1. PERFORMANCE REQUIREMENTS

   a. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2. ROOF DECK

a. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1) Galvanized-Steel Sheet: ASTM A653, Structural Steel (SS), Grade 33, G90 zinc coating.
2) Galvanized and Shop-Primed Steel Sheet: ASTM A653, Structural Steel (SS), Grade 33, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

a Color: Manufacturer's standard Gray.

3) Deck Profile: Type WR, wide rib.
4) Profile Depth: 1-1/2 inches.
5) Design Uncoated-Steel Thickness: 0.0358 inch.

3. ACCESSORIES

a. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

b. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

c. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

d. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

e. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

f. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

g. Galvanizing Repair Paint: SSPC-Paint 20.

h. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 EXECUTION

1. INSTALLATION

a. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

b. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

c. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

d. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

e. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

f. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

g. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds or mechanical fasteners not more than 12 inches apart with at least one weld or fastener at each corner.

h. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

2. REPAIR

a. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

b. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

3. FIELD QUALITY CONTROL

a. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

b. Field welds will be subject to inspection.

c. Prepare test and inspection reports.

END OF SECTION 053100

SECTION 054400

COLD-FORMED METAL TRUSSES

PART 1 GENERAL

1. SUMMARY

   a. Section Includes:

      1) Roof trusses.

2. PREINSTALLATION MEETINGS

   a. Preinstallation Conference: Conduct conference at Project site.

3. ACTION SUBMITTALS

   a. Product Data: For the following:

      1) Cold-formed steel truss materials.
      2) Anchor bolts.
      3) Post-installed anchors.
      4) Power-actuated fasteners.
      5) Mechanical fasteners.

   b. Shop Drawings:

      1) Include layout, spacings, sizes, thicknesses, and types of cold-formed steel trusses; fabrication; and fastening and anchorage details, including mechanical fasteners.
      2) Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

   c. Delegated-Design Submittal: For cold-formed steel trusses.

4. INFORMATIONAL SUBMITTALS

   a. Welding certificates.

   b. Product test reports.

   c. Research Reports: For post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

   d. Field quality-control reports.

5. QUALITY ASSURANCE

a. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

b. Product Tests: Mill certificates or data from a qualified independent testing agency.

c. Welding Qualifications: Qualify procedures and personnel according to the following:

1) AWS D1.1, "Structural Welding Code - Steel."
2) AWS D1.3, "Structural Welding Code - Sheet Steel."

PART 2 PRODUCTS

1. PERFORMANCE REQUIREMENTS

a. Delegated Design: Engage a qualified professional engineer to design cold-formed steel trusses.

b. Structural Performance: Provide cold-formed steel trusses capable of withstanding design loads within limits and under conditions indicated.

1) Design Loads: As indicated on Drawings.
2) Deflection Limits: Design trusses to withstand design loads without deflections greater than the following:

a Roof Trusses: Vertical deflection of 1/360 of the span.

3) Design trusses to provide for movement of truss members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

c. Cold-Formed Steel Truss Standards: Unless more stringent requirements are indicated, trusses shall comply with the following:

1) Roof Systems: AISI S210.
2) Lateral Design: AISI S213.
3) Roof Trusses: AISI S214.

d. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2. COLD-FORMED STEEL TRUSS MATERIALS

a. Steel Sheet: ASTM A1003, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1) Grade: As required by structural performance.
2) Coating: G90 or equivalent.

3. ROOF TRUSSES

a. Roof Truss Members: Manufacturer's standard steel sections.

1) Connecting Flange Width: 1-5/8 inches, minimum at top and bottom chords connecting to sheathing or other directly fastened construction.
2) Minimum Base-Metal Thickness: 0.0358 inch.

4. TRUSS ACCESSORIES

a. Fabricate steel-truss accessories from steel sheet, ASTM A1003, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for truss members.

b. Provide accessories of manufacturer's standard thickness and configuration unless otherwise indicated.

5. ANCHORS, CLIPS, AND FASTENERS

a. Steel Shapes and Clips: ASTM A36, zinc coated by hot-dip process according to ASTM A123.

b. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153.

c. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC193, ICC-ES AC58 or ICC-ES AC308, as appropriate for the substrate.

1) Uses: Securing cold-formed steel trusses to structure.
2) Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, unless otherwise indicated.
3) Material for Exterior Locations: Stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

d. Power-Actuated Fasteners: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

e. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1) Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

6. MISCELLANEOUS MATERIALS

a. Galvanizing Repair Paint: SSPC-Paint 20.

b. Shims: Load-bearing, high-density multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as truss members supported by shims.

PART 3 EXECUTION

1. PREPARATION

a. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

b. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed steel trusses without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

2. INSTALLATION

a. Install bridging and brace cold-formed steel trusses according to AISI S200, AISI S202, AISI S214, and manufacturer's written instructions unless more stringent requirements are indicated.

1) Coordinate with wall framing to align webs of bottom chords and load-bearing studs or continuously reinforce track to transfer loads to structure.
2) Install continuous bridging and permanently brace trusses as indicated on Shop Drawings and designed according to CFSEI's Technical Note 551e, "Design Guide: Permanent Bracing of Cold-Formed Steel Trusses”.

b. Install cold-formed steel trusses and accessories true to line and location, and with connections securely fastened.

c. Install temporary bracing and supports to secure trusses and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to trusses are secured.

d. Truss Spacing: 48 inches.

3. ERECTION TOLERANCES

a. Install cold-formed steel trusses level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1) Space individual trusses no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

4. REPAIR

a. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel trusses with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

5. FIELD QUALITY CONTROL

a. Special Inspections: Owner may engage a qualified special inspector to perform inspections.

b. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

c. Cold-formed metal trusses will be considered defective if they do not pass tests and inspections.

d. Prepare test and inspection reports.

END OF SECTION 054400

SECTION 055000

METAL FABRICATIONS

PART 1 GENERAL

1. SUMMARY

   a. Section Includes:

      1) Miscellaneous steel framing.
      2) Metal ladders.
      3) Ladder safety cages.
      4) Metal floor plate and supports.
      5) Structural-steel door frames.
      6) Metal bollards.
      7) Loose bearing and leveling plates.

   b. Products furnished, but not installed, under this Section include the following:
      1) Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
      2) Steel weld plates and angles for casting into concrete.

2. ACTION SUBMITTALS

   a. Product Data: For the following:
      1) Fasteners.
      2) Shop primers.
      3) Manufactured metal ladders.
      4) Ladder safety cages.
      5) Metal bollards.

   b. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.]

   c. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

PART 2 PRODUCTS

1. PERFORMANCE REQUIREMENTS

   a. Delegated Design: Engage a qualified professional engineer to design ladders.

2. METALS

a. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

b. Steel Plates, Shapes, and Bars: ASTM A36.

c. Stainless Steel Bars and Shapes: ASTM A276, Type 316L.

d. Rolled-Steel Floor Plate: ASTM A786, rolled from plate complying with ASTM A36 or ASTM A283.

e. Rolled-Stainless Steel Floor Plate: ASTM A793.

f. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.

g. Steel Tubing: ASTM A500, cold-formed steel tubing.

h. Steel Pipe: ASTM A53, Standard Weight (Schedule 40) unless otherwise indicated.

i. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1) Size of Channels: 1-5/8 by 1-5/8 inches.
2) Material: Galvanized steel, ASTM A653, structural steel, Grade 33, with G90 coating; 0.108-inch nominal thickness.
3) Material: Cold-rolled steel, ASTM A1008, structural steel, Grade 33; 0.0966-inch minimum thickness; hot-dip galvanized after fabrication.

3. FASTENERS

a. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941 at exterior walls. Select fasteners for type, grade, and class required.

b. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47 malleable iron or ASTM A27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329.

c. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1) Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, unless otherwise indicated.
2) Material for Exterior Locations and Where Stainless Steel Is Indicated: Stainless steel bolts, ASTM F593, and nuts, ASTM F594.

d. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary

filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, as needed for fastening to inserts.

4. MISCELLANEOUS MATERIALS

a. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

b. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

c. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

d. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

e. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

f. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

g. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

h. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

5. FABRICATION, GENERAL

a. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

b. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

c. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

d. Form exposed work with accurate angles and surfaces and straight edges.

e. Weld corners and seams continuously to comply with the following:

1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2) Obtain fusion without undercut or overlap.

3) Remove welding flux immediately.
4) At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

f. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

g. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

h. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches from ends and corners of units and 24 inches o.c.

6. MISCELLANEOUS FRAMING AND SUPPORTS

a. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

7. METAL LADDERS

a. General:

1) Comply with ANSI A14.3.

b. Steel Ladders:

1) Space siderails 18 inches apart unless otherwise indicated.
2) Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
3) Rungs: 1-inch diameter, steel bars.
4) Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5) Provide nonslip surfaces on top of each rung.
6) Galvanize and prime ladders, including brackets.
7) Prime ladders, including brackets and fasteners, with zinc-rich primer.

8. LADDER SAFETY CAGES

a. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless steel fasteners.

b. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.

c. Galvanize ladder safety cages, including brackets and fasteners.

1) Prime ladder safety cages, including brackets and fasteners, with zinc-rich primer.

9. METAL FLOOR PLATE

a. Fabricate from rolled-stainless steel floor plate of thickness indicated below:

1) Thickness: 3/8 inch.

b. Provide steel or stainless steel angle supports as required.

c. Provide flush steel or stainless steel bar drop handles for lifting removable sections, one at each end of each section.

10. STRUCTURAL-STEEL DOOR FRAMES

a. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Reinforce frames and drill and tap as necessary to accept finish hardware.

1) Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

b. Galvanize steel frames.

c. Prime exterior steel frames with zinc-rich primer.

11. MISCELLANEOUS STEEL TRIM

a. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

b. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1) Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

c. Galvanize miscellaneous steel trim.

d. Prime miscellaneous steel trim with zinc-rich primer.

12. METAL BOLLARDS

a. Fabricate metal bollards from Schedule 80 steel pipe.

b. Prime steel bollards with zinc-rich primer.

13. LOOSE BEARING AND LEVELING PLATES

a. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

b. Galvanize bearing and leveling plates.

c. Prime plates with zinc-rich primer.

14. STEEL WELD PLATES AND ANGLES

a. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

15. GENERAL FINISH REQUIREMENTS

a. Finish metal fabrications after assembly.

16. STEEL AND IRON FINISHES

a. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153 for steel hardware and with ASTM A123 for other steel and iron products.

b. Shop prime steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1) Shop prime with universal shop primer.

c. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 3, "Power Tool Cleaning".

d. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 EXECUTION

1. INSTALLATION, GENERAL

a. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

b. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

c. Field Welding: Comply with the following requirements:

1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2) Obtain fusion without undercut or overlap.
3) Remove welding flux immediately.
4) At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

d. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

e. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

2. INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

a. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

b. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.

3. INSTALLATION OF METAL BOLLARDS

a. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

b. Anchor bollards in concrete in formed or core-drilled holes not less than 42 inches deep and 3/4 inch larger than OD of bollard. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

c. Fill bollards solidly with concrete, mounding top surface to shed water.

4. INSTALLATION OF BEARING AND LEVELING PLATES

a. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

b. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

5. REPAIRS

a. Touchup Painting:

1) Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

b. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

END OF SECTION 055000

DIVISION 09 – FINISHES

SECTION 09 96 35

IET COATING SYSTEM

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section provides details for furnishing and installing the Integrated Environmental Technologies (IET) coating system where shown on the drawings for protection of concrete structures against hydrogen sulfide corrosion. Coating materials shall be as manufactured by Integrated Environmental Technologies or approved equal. Installation shall be performed by workers experienced in the application of the coating to be used.

PART 2 PRODUCTS

2.1 IET COATING SYSTEM

A. The IET Coating System shall be as distributed by Integrated Environmental Technologies, Santa Barbara, CA, or equal.

B. Polymorphic Resin shall be a 100% solids, two-component, highly modified polyester resin system, exhibiting no adhesion-interfering shrinkage upon curing. Resin shall cure rapidly within fifteen minutes to one hour without the use of heat or cooling at surface temperatures ranging from –30 degrees Fahrenheit to over +150 degrees. Excellent resistance to a broad range of corrosive chemicals, including sulfuric acid created by hydrogen sulfide gas as well as other chemicals typically found in sanitary sewers, and impact and abrasion attack shall be provided.

PART 3 EXECUTION

3.1 IET COATING

A. All pipes in service shall be plugged or bypassed before any work is started on the structure. No debris is to be flushed down the line.

B. Anyone entering the structure must conform to all OSHA requirements for “Confined Space Entry” equipment and permitting.

C. Surface preparation shall meet the requirements of IET Systems Data Sheets on Concrete Preparation and interior surfaces of manhole shall be sound, porous, dry, and free of dust, dirt, oil, grease and other contaminants prior to application of lining.

D. Interior surface of structure must be pressure washed at 5,000 psi and must be abrasive-blasted with an approved abrasive material (see LCU Approved Materials List) to remove all loose patching, old coatings and any contamination in the concrete. No silica sand shall be used.

1. "New" structures shall be abrasive-blasted to remove all oils and patch mud and to open pin holes and expose aggregate.

2. "Rehab" structures shall be abrasive-blasted to remove all loose patching, old coatings, and any contamination that penetrated the concrete. The finished interior of the structure shall be gray. The exposed invert/floor shall also be coated. Where there is severe deterioration of the mortar, place new concrete to match the original interior dimensions after abrasive-blasting and removal of all loose material and by-products of corrosion. Restore invert/floor to the original elevation.

3. Vacuum to remove all abrasives and debris.

E. Repair all leaks by injecting grout using an approved grout (see LCU Approved Materials List). Hydraulic cement shall not be used to stop any water leaks.

F. Clean and remove dust material with pressure washing for maximum adhesion. Blow dry concrete at 250 cfm with 120 psi.

G. Apply IET Systems Coating by the use of the IET Systems Spray Unit and IET Systems Spincaster. Apply IET coating at least three different intervals – prime coat, intermediate coat and finish coat, per IET Systems manufacturer instructions and specifications. The total thickness of the IET coating shall be at least 125 mils.

H. Inspect lining system for holes, cracks and pinholes. Take particular care to check lining over brick, block, heavy spalled surfaces, and other very rough surfaces and locate holes in the lining caused by voids in bricks, block, concrete and structure joints. Fill voids and holes in accordance with the lining system manufacturer's instructions.

I. Provide at a minimum a five (5) year unlimited warranty on all workmanship and products. The work includes the surface preparation and application of the IET coating system, shall protect the structure for at least five (5) years from all leaks, and from failure due to corrosion from exposure to corrosive gases such as hydrogen sulfide.

END OF SECTION

DIVISION 23 – HVAC SYSTEMS

SECTION 23_05_00

COMMON WORK RESULTS FOR HVAC SYSTEMS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 ARTICLES INCLUDED

A. Definitions.

B. Permits, Fees and Notices.

C. Applicable Publications.

D. Code Compliance.

E. Scope of Work.

F. Record Drawings.

G. Intent of Drawings and Specifications.

H. Quality Assurance

I. Submittals.

J. Product Requirements, Equals and Substitutions.

K. Manufacturer’s Instructions.

L. Transportation and Handling.

M. Storage and Protection.

N. Cutting, Patching and Demolition.

O. Cleaning Up/Removal of Debris.

P. Starting of Mechanical Systems.

Q. Operating and Maintenance Manuals.

R. Training of Owners Operators.

S. Guarantee of Work.

T. System Testing.

1.3 ARTICLES

A. Definitions:

1. The term "As indicated" means as shown on drawings by notes, graphics or schedules, or written into other portions of contract documents. Terms such as "shown", "noted", "scheduled" and "specified" have same meaning as "indicated", and are used to assist the reader in locating particular information.
2. The term "Provide", means furnish and install as part of the work covered in Division 23.
3. The term "Furnish" means furnish only, for installation, as part of this contract, by other Divisions.
4. The term "Install only" means to install under the work of Division 23 equipment furnished by other Divisions, or by the Owner.
5. The term "Owner's Representative" when referenced herein shall be the Architect or the Engineer acting as his designated representative unless otherwise noted.
6. The term "design" as it pertains to the work of this division shall describe the basic intent, component sizing, component relationships and overall architecture of the plumbing system. The design is generally schematic in nature and will require specific detailing after the accepted products are determined.
7. The term "detail" as it pertains to the work of this division shall describe the work required by the contractor to assure a fully coordinated installation of the material and equipment supplied. When requested, the contractor shall produce detailed shop drawings or sketches indicating the actual placement of the equipment or material supplied; also including how the equipment or material interfaces with work of other sections or divisions within the contract documents.
8. The term "workman-like manner" as it pertains to the work of this division shall describe a neat well organized high quality installation system (duct, pipe, control wire or tube, conduit, etc.). Routing shall be well thought out providing adequate service clearance and maximum use of space. Equipment placement shall exhibit proper clearances for service. All lines (duct, pipe, control wire or tube, conduit, etc.) shall be run straight and true, parallel or perpendicular to building structure neatly supported.
9. For additional definitions refer to the Division 01 - General Requirements.

B. Permits, Fees and Notices: Comply with the Division 01 - General Requirements.

1. Submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

C. Applicable Publications:

1. Publications listed in each Section form a part of that Section to the extent referenced.
2. When a standard is specified by reference, comply with requirements of that standard, except when requirements are modified by the Contract Documents, or applicable codes establish stricter standards.
3. The Publication or Standard is the publication in effect as of the bid date, except when a specific date is listed.

D. Code Compliance:

1. Florida Building Code 7th Edition (2020) Building

2. Florida Building Code 7th Edition (2020) Energy Conservation
3. Florida Building Code 7h Edition (2020) Mechanical
4. Florida Building Code 7th Edition (2020) Existing Building
5. Florida Building Code 7th Edition (2020) Fuel Gas
6. Florida Building Code 7th Edition (2020) Accessibility
7. Florida Fire Prevention Code 7th Edition (2020)
8. NFPA 1 Fire Code, 2018 Edition
9. NFPA 13, 2016 Edition
10. NFPA 70, National Electric Code (NEC), 2017 Edition
11. NFPA 101 Life Safety Code, 2018 Edition

E. Scope of Work: The work to be performed under this Division consists of the satisfactory completion of all HVAC as indicated in the Contract Documents.

F. Record Drawings: Comply with the Division 01 - General Requirements.

1. Drawings - Legibly mark drawings to record actual construction:

   a. Depths of various elements of foundation in relation to finish first floor datum.
   b. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   c. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.
   d. Field changes of dimension and detail.
   e. Changes made by Addenda, Supplemental Instruction, Construction Change Directive, or Change Order.
   f. Details not on original Contract Drawings.

2. Specifications - Legibly mark each section to record:

   a. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
   b. Changes made by Supplemental Instruction, Construction Change Directive, or Change Order.

c. Addenda - Legibly mark or post in Drawings and Specifications all items as listed in Addenda.

3. At Substantial Completion, deliver Record Documents to Engineer for review prior to sending to the Owner's Representative.

G. Intent of Drawings and Specifications:

1. The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.
2. Existing conditions, dimensions, etcetera, depicted on the drawings are taken from the "as-built" drawings of the original construction supplemented by field observation. The contractor is cautioned to field verify all existing conditions, dimensions, etcetera, notifying the Owner's Representative of any discrepancies other than those minor in nature, for direction, prior to ordering or fabricating equipment or materials. Anything mentioned in the specifications and not shown on the drawings, or shown on the drawings and not mentioned in the specifications, shall be of like effect as if shown or mentioned in both. In case of difference between drawing and specifications, the more stringent shall govern, unless the discrepancy conflicts with applicable codes, wherein the code shall govern.
3. The drawings are diagrammatic, intending to show general arrangement, capacity and location of system components, and are not intended to be rigid in detail. Final placement of equipment, other system components, and coordination of all related trades shall be the contractor's responsibility.
4. Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets and fittings may not be shown but shall be provided at no additional change in contract cost.
5. In the event of a conflict, the Owner's Representative will render an interpretation in accordance with the Division 01 - General Requirements.

H. Quality Assurance:

1. All equipment furnished under this Division shall be listed and labeled by U.L., ETL or a nationally recognized testing laboratory (NRTL).
2. Material furnished under this Division shall be standard catalogued products of recognized manufacturers regularly engaged in the production of such material and shall be the latest design.
3. Materials shall be the best of their respective kinds. Materials shall be new except where the specifications permit reuse of certain existing materials.
4. Work provided for in these specifications shall be constructed and finished in every part in a workmanlike manner.
5. All items necessary for the completion of the work and the successful operation of a product shall be provided even though not fully specified or indicated on the drawings.
6. All work to be performed by qualified and experienced personnel specifically trained in their respective field.

7. All work of this division shall be carefully interfaced with the work of other divisions to assure a complete, functioning system or systems.

I. Submittals: Comply with the Division 01 - General Requirements.

1. Submittals shall initially be created and submitted in PDF format. Once approved Contractor shall print hard copies of approved submittals and provide Owner with hard copies.
2. Hard copies of submittals for Owner shall consist of a minimum of one view type 3-ring binder, white, sized to hold 8-1/2" x 11" sheets.

    a. Binder is to be adequately sized to comfortably hold required submittals. Minimum spline size to be 1", maximum spline size to be 3" (provide additional binders if 3" size is not sufficient to properly hold submittals).
    b. Binder cover and spline to have outer clear vinyl pockets. Provide correct designation of project in each pocket; see Binder Examples for Submittals included at end of this Section. Description sheet is to be white with black letters, minimum of 11" high and full width of pocket. Description is to describe project and match project drawing/project manual description. Description to include submittal type, i.e., "HVAC SUBMITTALS" for Power and Lighting.

3. In addition to all other submittal requirements elsewhere in the contract documents, the contractor shall comply with the following.
4. Submittal for acceptance is required only on those items specifically requested in the specification section that applies.
5. For products and equipment that do not require a submittal for acceptance, submit a separate letter for each specification section certifying that all products and equipment will be provided in compliance with the contract documents.
6. Designate in the construction schedule, or in a separate coordinated schedule, the dates for submission and the dates that the submittals will be needed in order to meet construction schedule. This schedule shall be submitted prior to or in conjunction with the first submittal. Processing of submittals may be delayed pending the receipt of this schedule at the reviewer’s discretion.
7. Submittal data shall be presented in a clear and thorough manner and referenced to the specification section.

    a. Where applicable, data shall be identified by reference to sheet and detail, schedule or room numbers, equipment or unit number as shown on Contract Drawings.

8. Prepare performance and product data as follows:

    a. Clearly mark each copy to identify pertinent products or models, delete non-pertinent data.
    b. Show performance characteristic and capacities.

c. Show dimensions and clearances required.
d. Show wiring or piping diagrams and controls.
e. Clearly list any deviation in the submittals from the requirements of the contract documents.
f. Include installation requirements.

9. Manufacturer's standard schematic drawings and diagrams:

   a. Modify drawings and diagrams to delete information not applicable to the work of this project.
   b. Supplement standard information to provide information specifically applicable to the work of this project.

10. Prohibition of Asbestos and PCB:

   a. The use of any process involving asbestos or PCB, and the installation of any product, insulation, compound of material containing or incorporating asbestos or PCB, is prohibited. The requirements of this specification for complete and operating mechanical systems shall be met without the use of asbestos or PCB.
   b. Prior to the Final Review field visit the Contractor shall certify in writing that the equipment and materials installed in this Project under this Division 23 contain no asbestos or PCB. Additionally, all manufacturers shall provide a statement with their submittal that indicates that their product contains no asbestos or PCB. This statement shall be signed by a duly authorized agent of the manufacturer.

11. Letter of Certification: Where a submittal is not required, provide letter certifying that the work will be completed in strict accordance of the specified requirements. In the event the contractor wishes to alter the requirements of the specification for whatever reason, this should be clearly explained in this letter noting that this alteration may require additional submittal requirements.
12. Schedules: Where schedules are called for, submit schedule indicating which products will be used and to what extent by system, location, size, etc.
13. Where samples are requested, samples shall be of sufficient size and quantity to clearly illustrate:

   a. Functional characteristics of the product, with integral related parts and attachment devices.
   b. Full range of color, texture and pattern.
   c. Where a mock-up is specified, erect at the Project site, in a location acceptable to the Owner's Representative. Size or area shall be that specified or as agreed upon during pre-construction or other job site meetings.
   d. Where mock-up is not a permanent part of the installation, remove mock-ups at conclusion of work or when acceptable to the Owner's Representative.

14. The Contractor shall:

    a. Review Shop Drawings, Product Data and Samples prior to submission.
    b. Determine and verify:

        1) Field measurements.
        2) Field construction criteria.
        3) Catalog numbers and similar data.
        4) Conformance with specifications.
        5) All submittals have been properly interfaced with the requirements of this and other divisions of work so as to assure a complete, functioning system in accordance with the contract documents.
        6) Provide ¼" drawings of ALL mechanical rooms, with dimensions clearly indicating equipment maintenance clearances and electrical NEC required clearances. NO mechanical room walls shall be built until the engineer and the owner have approved the shop drawings for the mechanical equipment and clearances.

    c. Coordinate each submittal with requirements of the work and of the Contract Documents.
    d. Clearly identify any deviations in the submittals from requirements of the Contract Documents. Any deviations not specifically disclosed in the submittal shall be solely at the risk of the Contractor, and shall be subject to discovery at any time. Any undisclosed deviations shall be corrected by the Contractor to comply with the requirements of the Contract Documents at no cost to the Owner regardless of the action code accorded the submittal by the Owner's Representative.
    e. Do not release equipment for shipment, begin fabrication or work on any items requiring submittals for acceptance until all submittals are returned with the Owner's Representative acceptance.
    f. Make submittals promptly, and in such sequence as to cause no delay in the work or in the work of any other contractor.

15. Number of Submittals: Comply with the Division 01 – General Requirements.
16. Submittals shall contain:

    a. The date of submission and the dates of any previous submissions.
    b. The Project title and number.
    c. Contract identification.
    d. The names and phone numbers including personal contact of:

        1) Contractor.
        2) Supplier.

3) Manufacturer.

e. Identification of the product, with the specification section number and contract document description clearly indicated.
f. Field dimensions, clearly identified as such.
g. Relation to adjacent or critical features of the work or materials.
h. Applicable standards.
i. Identification of deviations from Contract Documents.
j. Identification of revisions on re-submittals.
k. Contractor's stamp, initialed or signed, certifying to review of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of Contract Documents.
l. Each submittal shall be limited to a single specification section. Submittals shall not be grouped with other sections in common binders or under common control sheets except as defined in paragraph m. below. Each submittal shall have a cover/control sheet containing the information listed above (a thru k) and have a minimum of 8" x 3" clear space for the general contractors, engineers and architects review stamp.
m. Submittals not complying with these requirements may be returned with no action taken at the reviewer's discretion.

17. Re-submittals shall contain:

a. The date of re-submission and the dates of all previous submissions.
b. A copy of the Engineer's comments from the previous submittal.
c. An itemized response to each of the Engineer's comments specifically outlining the changes or corrections being made. As an example; this could be either noting the page(s) of the previous submission that are affected and what changes have been made or noting specific additional information being provided.
d. Submittals not complying with these requirements may be returned with no action taken at the reviewer's discretion.

18. The Owner's Representative will (if they so desire):

a. Review submittals promptly and where special attention is requested, review in accordance with the schedule required.
b. Review the submittal for general compliance with the contract documents. The contractor is responsible for quantities, dimensions, placement of the product, coordination with all other trades occupying the space, maintain service clearance, function and compliance with the written installation instructions.
c. Determine the appropriate action for the submittal. Action codes will be as follows:

ACTION	DESCRIPTION
No exceptions noted.	No exceptions taken.

Make corrections noted.	Re-submittal not required. Make corrections to exceptions noted.
Revised and re-submit	Make corrections to exceptions noted and re-submit.
Rejected	Not in compliance with the contract documents. Re-submit.
Submit Specific Item	Re-submit item as specified.
Review not required.	Not required for review. No action taken. Copy retained for reference.

d. The turn-around time will generally be within 14 calendar days on properly prepared submittals unless otherwise noted in Division 01 – General Requirements.
e. Review comments will generally be on a separate attached sheet.

19. Resubmission requirements for "as specified" products.

a. Make any corrections or changes in the submittals required by the Owner's Representative and resubmit until accepted.
b. A submittal shall only be reviewed a maximum of 3 times. If upon the second resubmission an accepted action cannot be rendered (No Exceptions Noted or Make Corrections as Noted), the contractor shall supply the basis of design product and bear all costs incurred by the Owner's Representative during the review process until an accepted submittal is achieved.

20. The Contractor shall maintain one copy of all accepted submittal data including letters of compliance in a job site file.

J. Product Requirements, Equals and Substitutions: Comply with the Division 01 - General Requirements.

1. In addition to all other requirements for submittals, equals and substitutions elsewhere in the contract documents, the contractor shall comply with the following.
2. Product Requirements:

a. The specifications sections under Article 2.1 "ACCEPTABLE MANUFACTURER", lists suppliers found acceptable for this project. The names listed are manufacturers who meet the minimum acceptable standards that this project dictates. The list is furnished as a guide. Even though a manufacturer is named, he must still provide the type and quality of equipment specified as well as equipment that will fit within the allotted space and within the design weight allowance, etc. Being named does not imply

permission for that manufacturer to provide an alternative product or design. Other manufacturers not named will be considered to be equal providing they furnish a product of the type and quality specified.

b. In certain cases, foundations and/or structural supports or electrical requirements for equipment specified in this Division are provided under other divisions of the specifications. Where an alternate acceptable manufacturer's product is provided, this contractor shall coordinate the revised requirements and include an allowance for any cost differential.

c. If the list, under Article 2.1 "ACCEPTABLE MANUFACTURERS" names only one manufacturer followed by "No Substitutions" that product shall be supplied.

3. Substitutions.

a. A substitution is defined as any product not meeting the requirements as outlined in PART 2 - PRODUCTS. A different design accomplishing the same result will be considered a substitution. The same design requiring a larger motor, or more space or a structural change to accommodate larger weight, etc., will be considered a substitution. If a manufacturer who is not listed as an "ACCEPTABLE MANUFACTURER" wants to have his product considered as an equal or as a substitution, he shall submit details to the Owner's Representative 10 days in advance of bid date and a decision will be rendered. If necessary, a clarification will be issued in the form of an Addendum. No substitution requests shall be considered after the Bid.

b. Submit a separate request for each product, supported with complete data, with drawings and samples as appropriate, including.

1) Comparison of the qualities of the proposed substitution with that specified in tabulated format.
2) Changes required in other elements of the work because of the substitution.
3) Effect on the construction schedule.
4) Cost, extra credit or statement of no change in contract price.
5) Any required license fees or royalties.
6) Availability of maintenance service, and source of replacement materials.

c. The Owner's Representative shall be the judge of the acceptability of the proposed substitution.

d. A request for a substitution constitutes that the Contractor:

1) Has investigated the proposed product and determined that it is equal to or superior in all respects to that specified.
2) Will provide the same warranties for the substitution as for

the product specified.

3) Will coordinate the installation of the substitution into the work, and make such other changes as may be required to make the work complete in all respects.
4) Waives all claims for additional costs, under his responsibility, which may subsequently become apparent.
5) Will absorb all costs incurred by the substitution when affecting other trades including but not limited to electrical, structural, architectural, etc.
6) Will absorb any cost incurred by the Owner's Representative in review of the substituted product if the acceptance of the substituted item creates the need for system modification and/or redesign, or if the substituting contractor exhibits negligence in his substituting procedure thus submitting inferior, misapplied or miss-sized equipment. In the event of additional engineering costs the billing structure shall be agreed upon prior to review by all involved parties.

4. Owner's Representative will review requests for substitutions with reasonable promptness, and will issue an addendum or notify Contractor, in writing, of the decision to accept or reject the requested substitution.
5. The Owner's Representative will review substitution submittals for compliance a maximum of two times. If the submittal or substituted product does not comply with the contract documents on the second submittal, the submittal and product will be rejected and the specified product will be required.
6. The contractor may request further review of the substitution after the second submittal rejection if the contractor agrees in writing to accept responsibility for the cost of additional review time and expenses by the Owner's Representative.
7. In the event a substitution is rejected, supply the products which constituted the basis of design at no change in the contract price.

K. Manufacturer's Instructions:

1. Installation of work shall comply with manufacturer's printed instructions.
2. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Owner's Representative for clarification. Do not proceed with work without clear instructions.

L. Transportation and Handling: Comply with the Division 01 - General Requirements.

1. Provide for expeditious transportation and delivery of products to project site undamaged, on a schedule to avoid delay of the work, or work of other contractors.
2. Provide equipment and personnel at the site, unload and handle products in a manner to avoid damage to products.

M. Storage and Protection:

1. Store products in accord with manufacturer's instructions, with seals and labels intact and legible.
2. Store products to prevent damage by the elements. Space temperature shall be controlled as required to prevent condensation and metal corrosion or damage to electrical or electronic parts are the result of condensation.
3. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration.
4. Provide protection as necessary to prevent damage after installation.
5. Products which suffer damage due to improper storage shall not be installed and if found in place, shall be removed and replaced at the contractors expense.

N. Cutting and Patching: Comply with the Division 01 - General Requirements.

1. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
2. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
3. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

O. Cleaning Up/Removal of Debris: Comply with the Division 01 - General Requirements.

1. Maintain a clean work area. Construction debris shall be immediately removed from all newly erected work.

P. Starting of Mechanical Systems:

1. Provide material and labor to perform start-up of each respective item of equipment and system prior to beginning of test, adjust and balance procedures.
2. Provide labor to assist the Owner's Representative in acceptance review.
3. Provide point by point system check-out. Submit results in tabulated form by system. Include this data as part of Operation and Maintenance Manuals.
4. Provide information and assistance and cooperate with test, adjust and balance services.
5. Comply strictly with manufacturer's recommended procedures in starting up mechanical systems.
6. Provide such periodic continuing adjustment services as necessary to ensure proper functioning of mechanical systems until acceptance and up to 1 full year after date of Owner acceptance.

Q. Operating and Maintenance Manuals: Comply with the Division 01 - General Requirements.

1. Quantity: Four (4) sets
2. Format: Adequately sized for contents, minimum 1" and maximum 3" spline size, hard cover, view type, 8-1/2" x 11 loose leaf binders. Binder covers to have outer clear vinyl pocket on front cover and spline. Provide correct project designation and contents description in each pocket. Use as many as required. Do not overload binders.
3. Content:

    a. Cover sheet.
    b. Table of contents (as follows):

        1) Description of systems.
        2) Design parameters.

    c. Point by Point System Check-out: Provide tabulated results indicating compliance with contract document requirements.

4. Detailed Preparation Requirements:

    a. The cover sheet shall list: project name, location, architect, structure engineer, mechanical engineer and electrical engineering firm name with address, telephone number and project manager’s name for this project.
    b. Each major heading in the table of contents shall have a large distinctive, clearly marked, non-erasable, plastic encased tab.
    c. The description of systems will be provided by the design engineer for insertion at the time of review and turn-over to owner. This description of systems will be an updated version of the narrative included in this section and will be an overview of the entire system. It will be the basis for the starting of the owner’s instruction program.
    d. Each section shall have the following sub-tabs. Sub-tabs shall be similar to the main tabs but of a different color.

        1) Specifications: The specification shall be copied and inserted complete with all addenda.
        2) Submittal: This section shall include all accepted submittal data. If submittal was not required, include technical data as specified.
        3) Installation Instructions: If the product, such as pipe, etc., does not have any written installation instructions, include a statement "Manufacturer's Written Installation Instructions not Available - Product Installed in Accordance with Specifications and Good Practice".
        4) Operation and Maintenance Instructions: These shall be the written manufacturer's data edited to omit reference to products or data not applicable to this installation.
        5) Parts List: These shall be edited to omit reference to items not applying to this installation.
        6) Equipment Supplier: This section shall include the name, address and telephone number of the manufacturer's

agent and/or service agency supplying or installing and starting up of the equipment.

7) System Description: This section shall include that portion of the overall description included in the beginning of the manual as it applies to each sub-section. In sections such as pipe, valves and fittings, a statement shall be included "Not Applicable to this Section." Data for this section will be added by the design engineer when the manuals are submitted for review and forwarded to the owner.

8) Controls Description: This will be included in each section covering controlled equipment. It will include the description from the approved temperature control submission, complete with schematic diagram showing piping arrangement and control location on 8-1/2 x 11 or 11 x 17 sheet. This data shall be provided by the temperature controls contractor in a form suitable for insertion by the mechanical contractor and for review by the design engineer.

9) Special Operating Instructions: This section shall include condensed instructions for start-up, shut-down, emergency operation, safety precautions and troubleshooting suggestions. Where control is clearly covered in controls description, it is not to be duplicated here.

10) Preventative Maintenance Instructions: This section shall include excerpts from the manufacturer's written instructions on weekly, monthly, quarterly, annually, etc. This summary shall be prepared by the mechanical contractor with help from the equipment supplier. It will be reviewed by the engineer prior to turning over to the owner.

R. Training of Owners Operators:

1. The owners shall be given comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of equipment.
2. The contractor shall be responsible for scheduling the training which shall start with classroom sessions followed by hands on training on each piece of equipment. Hands on training shall include start-up, operation in all modes possible, shut-down and any emergency procedures.
3. The manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions shall use the printed installation, operation and maintenance instruction material included in the O&M manuals and shall emphasize safe and proper operating requirements and preventative maintenance.

S. Guarantee of Work: Comply with Division 01 – General Requirements.

1. Where applicable, furnish manufacturer's written warranty for materials and equipment.

2. Insert warranties in appropriate locations in operating and maintenance manuals.
3. Materials and equipment having seasonal operation limitations shall be guaranteed for a minimum of one year from date of seasonally appropriate test, and acceptance in writing by the Owner, unless specific Division 23 specifications specify a longer period.

T. System Testing:

1. Provide all necessary labor, materials and equipment to successfully complete all system testing necessary for building occupancy and owner acceptance.
2. Provide all necessary labor, materials and equipment to assist contractors of other division to complete system testing necessary for building occupancy and owner acceptance, wherever an inter-relationship between Division 23 and the work of other divisions exists.
3. Tests shall be repeated as necessary until all occupancy and operation permits are granted and the owner accepts the project.

PART 2- **PRODUCTS** - Not Used

PART 3 - EXECUTION - Not Used

SECTION 23_05_10

BASIC MATERIALS AND METHODS OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Access doors.

B. Waterproofing and flashing. (Refer to Division 07)

C. Fire and smoke stopping. (Refer to Division 07)

D. Electrical requirements. (Refer to Division 26)

E. Painting. (Refer to Division 09)

F. Plumbing requirements. (Refer to Division 22)

G. Concrete work. (Refer to Division 03)

H. Fabricated steel supports.

I. Excavation, trenching and backfilling. (Refer to Division 33)

J. Placing of equipment.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this Section to the extent referenced.

1. American Institute of Steel Construction (AISC) Publications
2. American National Standards Institute (ANSI) Standards
3. American Society for Testing and Materials (ASTM) Publications
4. American Welding Society (AWS) Publications
5. Underwriters Laboratories, Inc. (UL) Standards

1.4 SUBMITTALS

A. General: Where submittals are required, comply with Division 01 requirements.

B. Shop Drawings: Submit drawings of fabricated steel supports where proposed supports are not in accordance with details on drawings, or where drawings do not detail supports. Submittal for acceptance is required.

C. Product Data: Submittal for other than fabricated steel supports is not required. Product data for the following shall be included in the operation and maintenance manuals. Submittal for acceptance is not required.

1. Access doors.
2. Waterproofing and flashing material.
3. Fire and smoke stopping material.

PART 2-PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Access Doors:

1. Acudor
2. Elmodor Manufacturing, Co.
3. Karp Metal Associates, Inc.
4. Larsen's Manufacturing Co.
5. Milcor

B. Waterproofing and Flashing: (Refer to Division 07 for requirements).

1. Stoneman Engineering and Manufacturing Co.
2. S.B.C. Industries.
3. Other suppliers acceptable.

C. Fire and Smoke Stopping Material: (Refer to Division 07 for requirements).

2.2 FABRICATION

A. Access doors:

1. Access doors: UL labeled where installed in fire rated walls, partitions, and ceilings. Door rating shall be not less than wall, partition, or ceiling rating.
2. Frames: 16 gauge steel, flush trim, with corners welded and ground smooth, masonry anchor strap for masonry walls, bolt holes for mounting in framed openings.
3. Non-fire rated doors: 13 gauge steel, concealed continuous piano hinge with dust flap, flush screwdriver operated lock with stainless steel cam and studs.
4. Fire rated doors: 20 gauge steel welded pan type, concealed continuous piano hinge with stainless steel pins, key-operated latch bolt, interior latch release, automatic door closer, automatic door latch when door closes. The door panel shall contain 2- inch thick insulation in sandwich type construction.
5. Finish of doors and frames: Prime coat of rust inhibitive baked enamel, except as specified otherwise.
6. Finish of doors and frames in wet areas, and in areas with surfaces subject to wet cleaning: No. 4 satin stainless steel.
7. Label access doors per NFPA 80-19.2.3.2. and NFPA 105-6.3.2.2.

B. Waterproofing and Flashing: All work is provided under Division 07.

C. Fire and Smoke Stopping: All work is provided under Division 07.

D. Electrical Requirements: Product description not applicable to this Section.

E. Painting: Product specified in Division 09 - Finishes.

F. Concrete Work:

1. Concrete is provided under DIVISION 03 - Concrete.
2. This contractor to provide detailed dimension drawings, including anchor bolt locations where required for all bases and pads required for equipment furnished under this Division.
3. Concrete for equipment bases and pads shall be 3000 p.s.i. design mix prepared in accord with ASTM C94. Cement shall be in accord with ASTM C150. Aggregate shall be fine sand in accord with ASTM C33. Water shall be clean, fresh, drinkable.

G. Fabricated Steel Supports:

1. Steel angles, channels, and plate shall be in accordance with ASTM A36.
2. Steel members, including fasteners, exposed to weather shall be galvanized.

H. Excavation, Trenching, and Backfilling: Product description not applicable

I. Placing of Equipment: Product description not applicable.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation of materials and equipment shall be in accord with the manufacturer's written instructions, except as specified.

3.2 INSTALLATION

A. Access Doors:

1. Furnish access doors for installation under Division 09 - Finishes.
2. Deliver access doors to the appropriate trade well in advance of the time they are needed so as to avoid unnecessary delay of the work.
3. Access doors shall be sized as indicated on drawings. If no size is given, provide access door of size suitable for servicing equipment or valve. Unless otherwise noted, the minimum size for an access door shall be 12" x 12".
4. Access doors shall be provided where indicated and if not indicated, where required.
5. Access doors shall be installed so as to allow full door swing.
6. Where full swing and access is not possible, removable doors shall be provided.
7. Access doors not required in lay-in-tile ceilings.

B. Waterproofing and Flashing: All penetrations of roof to be in accordance with requirements of Division 07.

C. Fire and Smoke Stopping: Fire and smoke stopping shall be provided in Division 07.

D. Electrical Requirements: Refer to Division 26 for electrical requirements.

E. Painting:

1. All equipment shall be furnished with a factory- applied galvanized, prime paint, or finish paint finish. Touch-up damaged surfaces of equipment immediately.
2. Paint for galvanized surfaces shall be in accordance with ASTM A780 using zinc rich compound.
3. Paint wooden mounting backboards with two coats of gray enamel prior to making attachments to the board.
4. For quality control refer to DIVISION 09 - FINISHES.
5. Remove all dirt, rust, scale, grease, pipe dope, solder flux, and welding slag from all surfaces to be painted.
6. Paint immediately, under this Division, all damaged galvanized surfaces. Paint galvanized metal surfaces behind grilles with two coats of flat black paint.
7. Apply rust inhibitive primer to ferrous surfaces of shop fabricated steel supports.
8. Paint immediately under this division all field and shop welded joints in piping or equipment supports with 2 coats of grey metal primer.
9. All exposed piping shall have a PVC jacket, per ANSI Standard with the following colors:

a.	Refrigerant Piping	White text on gray jacket
b.	Condensate piping	White text on purple jacket

F. Concrete Work:

1. Concrete pads and curbs for supports of equipment shall be a minimum of 4" high with chamfered edges and sized for approved equipment. Furnish drawings to Division 03 Contractor.
2. Surfaces of concrete shall be troweled smooth. When forms are removed, fill voids with cement and rub smooth with rubbing stone.
3. Do not pour concrete when ambient temperature is less than 40^{o}F, and falling.

G. Fabricated Steel Supports:

1. Because of the small scale of the drawings, details of equipment support are not always shown. It shall be the responsibility of the contractor to provide supports as required for safe and adequate support.

2. Fabricated steel supports and ladders may be shop or field-fabricated, and shall be in accord with details on drawings.
3. When details are not indicated, the contractor shall submit proposed support detail for review. The contractor shall bear all cost in producing this detail in the bid. This includes but is not limited to structural engineering support.
4. Steel members shall be saw cut, with corners ground smooth, and shall be assembled with welded or bolted connections at Contractor's option. Connections shall be in accord with specified AISC Publications.

H. Excavation, Trenching, and Backfilling:

1. Definitions:

a. Satisfactory material includes all materials except those classified "unsatisfactory", "unyielding" or "unstable".
b. Unsatisfactory material includes those materials containing roots, organic matter, trash, debris, frozen materials, stones larger than 3 inches in any dimension, and materials classified by ASTM D 2487 as OL, OH, and PT.
c. Unyielding material consists of rock and gravely soils with stones greater than 3 inches in any dimension, or as defined by the pipe or tank manufacturer, whichever is smaller.
d. Unstable material consists of material too wet to properly support the pipe or tank.
e. Select granular material consists of well- graded sand, gravel, crushed gravel, crushed stone, or crushed gravel, crushed stone, or crushed slag composed of hard, tough, and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve, and no less than 95 percent by weight passing the 1 inch sieve. The maximum allowable aggregate size shall be 3 inches, or the maximum size recommended by the pipe or tank manufacturer, whichever is smaller.

2. Excavation, trenching, and backfilling for site utility piping systems is specified in Division 31 – Earthwork.

I. Placing of Equipment:

1. Coordinate setting of equipment with the requirements of other trades so as to avoid conflicts and to insure compatibility. Equipment shall not block access for installation of other equipment.
2. All air handling units shall have code required and manufacturer required clearances around all equipment.
3. Set base mounted equipment on permanent and finished supports. Temporary support, if any, shall be removed prior to making final pipe, duct, or electrical connections to equipment.
4. Adjust suspended equipment to final elevation prior to making pipe, duct or electrical connections.
5. Exercise caution during equipment placing operations to insure that structure is not overloaded.
6. Do not move heavy equipment across floor or roof of insufficient load bearing

capacity to support such equipment. Provide bracing or shoring as required, or use crane to place equipment directly on permanent and finished support.

7. Secure all exterior mounted equipment to the structure adequately to resist overturning, uplift and sliding forces for basic wind speeds indicated for this location in Figure(s) 1609.3 (1), (2), (3), & (4) of the Florida Building Code 7th Edition (2020) – Building.
8. Guards shall be provided where appliances, equipment, fans or other components that require service are located within 10 feet of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches above the floor, roof or grade below. The guard shall extend not less than 30 inches beyond each end of such appliance, equipment, fan or component and the top of the guard shall be located not less than 42 inches above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 21-inch-diameter sphere and shall comply with the loading requirements for guards specified in the Florida Building Code 7th Edition (2020) – Building.

SECTION 23_05_18

CONTROL WIRING

PART 1- GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 26 for electrical wiring requirements.

1.2 WORK INCLUDED

A. Split Direct Expansion (DX) System Interlock Wiring.

1.3 DEFINITIONS

A. Control Wiring: All wiring, high or low voltage other than power wiring, required for the proper operation of the mechanical systems.

B. Power Wiring: All line voltage wiring to the mechanical equipment. Line voltage which also serves as a control circuit, such as a line voltage thermostat, or involves interlocking with a damper, shall be considered control wiring.

1.4 QUALITY ASSURANCE

A. All work will be in accordance with the requirements of the National Electrical Code.

1.5 SUBMITTALS

A. Submittals are not required.

PART 2- PRODUCTS

2.1 MATERIALS

A. All material used in the completion of the wiring under this section will comply with the requirements of Division 26 Electrical.

PART 3- EXECUTION

3.1 INSTALLATION

A. Cooperate completely with the contractor for Division 26.

B. Provide all conduit, wire, control enclosures, and accessories necessary to complete the control wiring as specified under WORK INCLUDED.

C. Because of variations in requirements from manufacturer to manufacturer, all details may not be included in the Contract Documents. This sub-contractor must obtain approved coordinated wiring diagrams before proceeding with the control wiring.

D. All control wiring shall be properly installed in an approved raceway system or when allowed, run exposed in concealed spaces. All control wiring run in exposed areas shall be in an approved raceway unless otherwise noted.

E. Control wire run exposed shall be neatly bundled and routed parallel and/or perpendicular to building structure or equipment casing. Routing of wire shall be so that it does not interfere, chafe or obstruct service or maintenance of the equipment served.

F. Exposed control wire shall be properly secured and/or supported within equipment enclosures. Secure cable on no greater than 18" centers.

G. All openings made for the passing of control wire shall be properly bushed to prevent chafing. The hole size shall be suitable for the quantity of wires or tubing passing through while allowing for ease of pulling and future expansion. Oversized holes beyond these requirements are not allowed.

H. Holes made within air handling equipment which may allow the transfer or bypassing of air shall be properly sealed after wire is pulled. Expanding foam sealant and proper backing material will be acceptable. Seal shall be suitable for maximum unit operating pressures.

I. Attachments of control devices, raceway and cable supports shall be made with proper attachments. Self-drilling screws which result in exposed end will not be acceptable. Bolts and nuts shall be used with bolt head exposed to view. All fasteners located where exposed to weather or moisture shall be stainless steel or cadmium plated.

J. Any opening, holes or cuts in equipment enclosures or building structure not used shall be neatly sealed. On equipment, the seal or patch shall be of similar material sealed and painted to match.

K. The control contractor shall clean all unused or scrap material from the equipment enclosure.

L. Identify all control wire by proper cable identification methods. Verify how cables shall be labeled with the Owner's Representative prior to the start of work. All termination shall be labeled and labels clearly visible.

M. All control devices, cabinets, equipment and raceways shall be labeled. Verify

how the hardware shall be labeled with the Owner's Representative prior to the start of work.

N. Splices in control wire are not allowed unless the length of run is too great to allow for a continuous run. When splices become necessary, they shall be solder connected with heat shrink tubing. When raceway is used, all splices shall be in junction boxes.

O. Control devices (i.e., flow switches), connected to cold equipment where the possibility of condensation may occur shall be vapor proof type. Properly seal the connecting conduit with spray type foam after the wires are pulled through. If this is not possible, a weatherproof junction box shall be close mounted to the device to allow for proper moisture sealing. Conduit connections shall be sealed with a silicon type caulk/sealant.

P. All control devices or wiring located exposed to weather or moisture shall be in an approved raceway system. This system shall be properly supported and sealed to prohibit moisture convection or transfer. Provide flexible conduit similar to seal tight for connection to all equipment. EMT and set screw fittings are not acceptable. All exterior raceway shall be IMC (Intermediate Metallic Conduit) or better with threaded fittings.

SECTION 23_05_53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Piping and equipment identification.

1.3 SUBMITTALS

A. Refer for Division 01 for submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Piping and Equipment Identification:

1. Communications Technology Corp.
2. Craftmark Identification Systems, Inc.
3. EMED Co., Inc.
4. Florida Marking Products, Inc.
5. Marking Services, Inc.
6. Seton Name Plate Corp.
7. W.H. Brady Co., Signmark Division

2.2 FABRICATION

A. Piping and Equipment Identification:

1. Provide a ceiling tag (on the ceiling grid) for all equipment, HVAC valves, fire dampers, smoke dampers, and fire/smoke dampers above the ceiling.
2. Pipe markers: Sub-surface printed plastic, with protective undercoating. Markers shall be permanently curled for snap-on installation for pipe sizes (including insulation) up to 6” diameter. For external diameters above 8”. Marker shall be secured using cable ties for indoor use and stainless steel banding or ultraviolet resistant plastic for exterior use. Markers for outdoor installation shall be over-laminated with Tedlar™ on polyester to prevent ultraviolet to avoid damage and fading. Markers shall identify the pipe contents and direction of flow through 360 degree visibility range. Marker size, letter size, letter color, wording and background color shall be in accord with ANSI A13.1 – Scheme for the Identification of Piping Systems. Based on Marking Services Inc. Model MS-970 Coiled Plastic Markers for indoor

use and Model MS-995 Maxilar Marker for exterior use.

3. The marker shall be 1/16 inch thick plastic with a satin surface and white core. Color of the marker shall match color of piping identification system. Lettering shall be engraved through the surface color to expose the core color. Plate size shall be ¾ inch by 2-1/2 inch, with 3/16 inch high lettering for ceiling grid labeling. Plate manufacturer shall furnish suitable adhesive for permanently attaching plate to ceiling grid.
4. Valve tags: Contractors Option:

    a. Indoor:

        1) 19 gauge brass, 1-1/2 inch round, with 1/4 inch high black pipe service letter abbreviation above 1/2 inch high black valve number. Pipe service letter abbreviation shall be in accord with legend on drawings. Valve tag attachment shall be 4 ply 0.018 copper wire meter seal or #6 solid brass bead chain with locking link. Based on Marking Services Inc.
        2) 1/16 inch thick plastic, 1-1/2" round, with ¼ inch high black pipe service abbreviation above 1/2 inch high black valve number. Pipe service letter abbreviation shall be in accord with legend on drawings. Color of valve tag shall match pipe marker color. Valve tag attachment shall be 4 ply 0.018 copper wire meter seal or #6 solid brass bead chain with locking link. Based on Marking Services Inc.

    b. Outdoor Service:

        1) 19 gauge brass, 1-1/2 inch round, with 1/4 inch high black pipe service letter abbreviation above 1/2 inch high black valve number. Pipe service letter abbreviation shall be in accord with legend on drawings. Valve tag attachment shall be 4 ply 0.018 copper wire meter seal or #6 solid brass bead chain with locking link. Based on Marking Services Inc.
        2) 19 gauge Type 304 stainless steel, 1-1/2" round, with ¼ inch high pipe service abbreviation above 1/2 inch high black valve number. Pipe service letter abbreviation shall be in accord with legend on drawings. Color of valve tag shall match pipe marker color. Valve tag attachment shall be 4 ply 0.018 stainless wire meter seal or #6 Type 304 stainless steel bead chain with locking link. Based on Marking Services, Inc.

5. Valve chart frame: Refer to chart information as indicated in Section 3.2.
6. Equipment nameplates:

    a. Indoor: Shall be 1/16 inch thick plastic with black satin surface and white core. Lettering shall be engraved through the surface color to expose the core color. Plate size shall be a minimum of 2-1/2 inch by 4 inch, with 3/4 inch high lettering for equipment and 3/4 inch by 2-1/2 inch, with 3/16 inch high lettering for ceiling grid labeling. Equipment identifying name and number shall be in accord with schedules on the Contract Documents. Plate manufacturer shall

furnish pre-drilled hole locations for pop riveting. Where pop riveting is not suitable, a suitable adhesive for permanently attaching plate to equipment shall be provided.

b. Outdoor: Shall be 125 Mil rigid plastic constructed of printed legend sealed between two layers of chemically-resistant plastic to resist ultraviolet damage. Plate size shall be a minimum of 2-1/2 inch by 4 inch, with 3/4 inch high lettering for equipment. Equipment identifying name and number shall be in accord with schedules on the Contract Documents. Plate manufacturer shall furnish pre-drilled hole locations for pop riveting. Where pop riveting is not suitable, a suitable adhesive for permanently attaching plate to equipment shall be provided.

c. Based on Marking Services Inc. Model MS-215 Max-Tex.

PART 3 - EXECUTION

3.1 GENERAL

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 INSTALLATION

A. Piping and Equipment Identification:

1. Install pipe markers adjacent to each valve and fitting, at each branch connection, on each side of wall, floor, and ceiling penetrations, where entering and leaving underground areas, and at minimum 40 foot spacing on horizontal and vertical pipe runs. Markers shall be arranged for easy reading at eye level.
2. Provide valve tags on all valves exposed or concealed unless otherwise noted.
3. Attach valve tag to stem of each valve to be tagged. Valve numbers shall follow in sequence the Owner's existing valve numbers, where applicable.
4. Provide a marker for each valve and equipment to be tagged, permanently adhered to the ceiling metal grid or access panel/door below the valve. The information on this tag shall match the tag on the valve and include valve service and number.
5. Provide a valve chart in each mechanical and custodial room indicating the quantity, type and system the valve serves (for all valves system wide). Mount framed chart in each mechanical and custodial room, and insert copy of the chart in each operating and maintenance manual under separate tabbed section labeled "Valve Chart". Where project drawings include a piping flow schematic, request AutoCad file from Engineer and label all of the valves according to the valve chart and frame in an 18” x 24” frame in main mechanical or pump room. Valve chart information shall indicate the following:

a. Project Name
b. Contractor Name

c. Date of installation
d. Valve Number
e. Valve Location
f. Valve Type
g. Valve Purpose
h. System in which installed

6. Provide air and water flow diagrams installed in waterproof, laminated frames on the wall in each Mechanical Room. Air flow diagrams shall show locations of dampers, sensors, and exhaust fans associated with the air handling unit. Water flow diagrams shall show shut-off valves and control valve locations.
7. Permanently affix nameplate to each item of equipment using stainless steel pop rivets. Where irregular surface impede direct attachment of plates, affix plate to sheet metal bracket and attach bracket to equipment with screws, bolts or suitable adhesive from nameplate manufacturer.
8. Refrigeration System - Additional Requirements:

    a. Marking and Signage:

        1) Provide a permanent sign containing the following information:

            (a) Name and address of installer.
            (b) Kind of refrigerant.
            (c) Lbs. of refrigerant.
            (d) Field test pressure applied.

        2) Provide a permanent sign: Main electrical supply, i.e., main compr. disc.
        3) Provide metal tags with 0.5" letters:

            (a) Shut-off valves to each vessel, i.e., L.P. receiver shut-off.
            (b) Relief valve.

        4) Piping shall be marked as either:

            (a) Refrigerant - High Pressure - Liquid or Hot Gas.
            (b) Refrigerant - Low Pressure - Suction, Pumped Liquid Supply or Pumped Liquid Return.

SECTION 23_23_00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Refrigerant (RS/RL/RHG) Piping.

B. Valves and Specialties

1.3 DEFINITIONS

A. The pipe sizes given in this document shall be construed as nominal pipe sizes.

1.4 QUALITY ASSURANCE

A. All material provided under this section shall be standard catalogued products of recognized manufacturers regularly engaged in the production of such products, and shall be of the manufacturer's most recent design that is in regular production.

B. Each item provided under this section shall meet the requirements for that item as installed and used, in accordance with the following standards:

1. Metallic Piping Systems employing mechanical joints and grooved-end pipe - ASME/ANSI B-31.9
2. Refrigeration Piping and Heat Transfer Components - ASME/ANSI B31.5
3. Safety Code for Refrigeration Systems – ASHRAE 15
4. Refrigerant Containing Components and Accessories – UL 207

C. Each piping system shall be in accordance with the system design pressures shown in paragraph 2.1 - Materials, this specification section.

D. All materials provided under this section shall be new, except where the specifications and/or drawings permit the reuse of certain existing materials.

1.5 SUBMITTALS

A. Materials List: Submit a list identifying the specific type of material that will be used for each piping system. Include pipe, pipefittings, valves and joints. Include the basic designation of the publication applicable for each type of material and method.

B. Refrigeration Piping Requirements: Submit a letter from the refrigeration equipment manufacturer stating that the refrigeration piping system, as shown on the contract documents, is acceptable for the equipment the manufacturer proposes to furnish, or submit drawings prepared by an authorized representative of the refrigeration equipment manufacturer.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Refrigerant (RS/RL/RHG) Piping.
System Design Pressure: 300 psig.

1. Piping carrying Refrigerants shall be ACR copper.
2. ACR Copper Refrigerant Piping:

   a. Piping, 3" and smaller: Type ACR annealed copper tubing, ASTM B280, ANSI H23.1. (Below Grade in Conduit)
   b. Piping, 3" and smaller: Type ACR hard-drawn copper tubing, ASTM B88, ANSI H23.1. (Above Ground only)
   c. Fittings, 3" and smaller, all types, wrought copper: ASTM B16.22, ANSI B16.22. All 90° elbows shall be the long radius type.
   d. Brazing: Contractors Option:

      (1) 5% silver, 6% phosphorus, balance copper, 1190°F melting point. AWS A5.8 number BCuP -3. J.W. Harris Stay-Silv® 5 or approved substitution.
      (2) 15% silver, 5% phosphorus, balance copper, 1190°F melting point. AWS 5.8 number BCuP-5. J.W. Harris Stay-Silv® 15 or approved substitution.
      (3) 6% silver, 6.1% phosphorus, balance copper, 1190°F melting point. QQ-B-654A number BCuP -5. J.W. Harris Dynaflow® 5 or approved substitution.

   e. Unions used shall be specifically designed for refrigeration piping.

2.2 VALVES AND SPECIALTIES

A. Solenoid Valves:

1. Liquid line shut off.
2. Normally closed.
3. Manual lift stem.
4. Pilot operated.
5. Synthetic seat for permanent tight shut off.
6. 120 volt solenoid coil (interchangeable).
7. Top grade brass, bronze and/or semi-steel body materials.
8. Acceptable Manufacturers: Sporlan, Alco, Hubbell, Phillips, Henry.

B. Filter Drier:

1. Replaceable core type.
2. Heavy steel, cadmium plated with external coat of paint.
3. All internal parts cadmium plated.
4. Outlet seal gasket with spring to prevent bypassing.
5. Copper fittings brazed to steel shell, suitable for soldering with Sil-Fos or Phos-Copper solder.
6. Molded porous core elements.
7. Tie rod assembly to permit external assembly with one piece insert.
8. Bolt and nut attachment.
9. Size for refrigerant capacity and tonnage at 2 psi pressure drop.
10. Acceptable Manufacturers: Sporlan, Alco, Hubbell, Phillips, Henry.

C. Moisture and Liquid Indicators:

1. Suitable for R-410A.
2. Accurately calibrated to change color for indication of moisture.
3. Large full view sight glass.
4. Removable indicator element for sizes 1-3/8" and up. Remove before soldering.
5. Full line size for liquid lines up to 2-1/8" O.D. 3/8" bypass indicator with preformed installation kit on larger sizes.
6. Acceptable Manufacturers: Sporlan, Alco, Hubbell, Phillips, Henry.

D. Sight Glasses:

1. Similar to Sporlan "See-all" moisture and liquid indicator with solder type connections.
2. Install sight glass of the same size as the liquid line.

E. Miscellaneous Valves and Accessories:

1. Drain valves for all pressure vessels.
2. Dual pressure relief valves with manifold for all pressure vessels.
3. Refrigerant service valves where indicated.

F. Refrigerant Charge: Complete operating charge of specified refrigerant.

G. High pressure receiver, designed and constructed for 300 psi design working pressure with liquid seal float control, automatic liquid feed valve, drain and equalizer connections, liquid line filter-drier, moisture indicator, three service and bypass valves, charge valve and manual purge valve.

H. Locking Refrigerant Caps: Precision machined from high grade brass surrounded by a protective aluminum shroud. Provide a 1-year warranty. Provide one multi key per project to maintenance personnel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Furnish and install piping, fittings and appurtenances required to complete the piping systems shown on the drawings. Elbows shall be long radius type. Tees may not be field fabricated.
2. Run piping to true alignment, generally parallel or perpendicular to building walls, floors and ceilings, and with uniform grades and spacing, so as to present a neat and workmanlike appearance.
3. Care shall be paid to the exact locations of piping with respect to equipment, ducts, conduits, slabs, beams, lighting fixtures, columns, ceiling suspension systems, etc. to provide maximum access to mechanical and electrical equipment in the building. Close coordination and cooperation shall be exercised with other trades in locating the piping in the best interests of the Owner. The drawings and specifications covering other work to be done in the building shall be carefully studied and arrangements made to avoid conflict.
4. Not all necessary pipe offsets are indicated on the drawings because of the small scale. The various runs of piping to be installed shall be studied and adjustments made in exact routings as may be required for proper installation.
5. Conflicts arising during the erection of piping shall be brought to the attention of the Owner's Representative. No improvising or field changes will be permitted without the approval of the Owner's Representative.
6. Use full lengths of pipe wherever possible. Short lengths of pipe with couplings will not be permitted. Cut to exact measurement and install without forcing or spring unless otherwise shown on the drawings or specified.
7. Avoid tool marks and unnecessary pipe threads. Burrs formed when cutting pipe shall be removed by reaming. Before installing any pipe, care shall be taken that the inside is thoroughly cleaned and free of cuttings and foreign matter. Measures shall be taken to preserve this cleanliness after erection.
8. Arrange pipe connections to valves and specialties so that there is clearance for easy removal of the valve or specialty from the line, and also for the removal of the valve bonnet and interior, and the specialty top and bottom and interior, except where otherwise approved by the Owner's Representative.
9. Erect piping in such a manner so as to obtain sufficient flexibility and to prevent excessive stresses in materials and excessive bending movements at joints or connections to equipment. Make allowances throughout for expansion and contraction of piping. Provide each riser and horizontal run of piping with expansion loops, expansion joints, or expansion compensators where indicated and required. Securely anchor and adequately guide pipe as required or where indicated to force expansion to the expansion device without bending, binding, or misalignment of pipe. Branch connections from mains to risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Where indicated, in lieu of expansion loops, expansion joints, or expansion compensators, horizontal runs of pipe shall be anchored at approximately midway of the run to force expansion, evenly divided, toward the mains and risers to provide for expansion and

contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining.

10. Installed piping shall not interfere with the operations or accessibility of doors or windows and shall not encroach on aisles, passageways and equipment, and shall not interfere with the servicing or maintenance of any equipment. Adjacent pipelines shall be grouped in the same horizontal or vertical plane.
11. Where lines are purposely pitched for drainage, an accurate grade shall be maintained. No lines shall be supported in such a manner as to permit deflection, due to gravity, sufficient to pocket the lines when full of liquid. Grade mains as indicated by arrows on the drawings and in accordance with gradient as indicated in attached Piping Schedule.
12. Piping found to have water hammer or other objectionable vibrations which cannot be eliminated by proper grading or other natural means, shall be braced, trapped or hung with shock absorbing hangers and equipped with air chambers, mechanical shock absorbers, and flexible pipe connections or otherwise silenced using approved means.
13. Use building steel wherever possible for supporting pipe hangers. Main structural steel shall not be drilled, cut or burned for hangers without the approval of the Owner's Representative. Expansion bolts shall be used only upon the approval of the Owner's Representative.
14. Install unions or flanges in piping connections to equipment, regulating valves, and wherever necessary to facilitate the dismantling of piping and/or removal of valves and other items requiring maintenance.
15. Avoid bushings. Reducing fittings shall be used wherever practical.
16. The drawings indicate the size of piping and connections, and if certain sizes are omitted or unclear, obtain additional information before proceeding.
17. The piping drawings have been worked out with a view to the most economical installation, taking into consideration accessibility and appearances, and the Contractor must follow the drawings accurately and if it is found impractical to install the work in accordance with the drawings and specifications, the Contractor shall notify the Owner's Representative before making any changes and get their approval or revised drawings before proceeding with the work. Verify all measurements on the job before cutting pipes or having piping fabricated, and be responsible for the correct location of all pipe connections, also check sizes and standard of outlets on the equipment, including the dimensions and drilling of flanges, etc.
18. Copper tubing shall not be mixed in any one run of piping.
19. Change in direction shall be made with fittings, except that bending of copper pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.
20. Threaded joints shall be made with tapered threads in accordance with ANSI B2.1, and made tight with an approved pipe thread joint compound or material, applied to the male threads only. Use compounds sparingly and apply with caution to ensure that compounds do not enter piping

systems. When pipe joint is made up a maximum of 3 threads shall be visible.

21. Joints for plastic pipe shall be made in accordance with PPI Piping Manual.
22. Connections between ferrous and nonferrous metallic pipe shall be made with dielectric unions or flanges.
23. Connections between plastic and metallic pipe, between plastic and glass pipe, and between metallic and glass pipe, shall be made with transition fittings manufactured for the specific purpose.
24. Unions and flanges shall not be concealed in walls, partitions, or above inaccessible ceilings.

B. Valve and Specialties Applications

1. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
2. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
3. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
4. Install thermostatic expansion valves as close as possible to distributors on evaporators.

    a. Install valve so diaphragm case is warmer than bulb.
    b. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line. Verify proper location for the bulb with the valve manufacturer
    c. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

5. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety relief-valve discharge line to outside according to ASHRAE 15.
6. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube on each circuit.
7. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

    a. Solenoid valves.
    b. Thermostatic expansion valves.
    c. Hot-gas bypass valves.
    d. Compressor.

8. Install filter dryers in liquid line between compressor and thermostatic expansion valve on each circuit.
9. Install receivers sized to accommodate pump-down charge.
10. Install flexible connectors at compressors.
11. Locking Refrigerant Caps: Provide at all exterior refrigerant service

access ports (Schrader valves).

12. Install gauges with dial in vertical position. Locate between shut-off valve and equipment directly adjacent to equipment within normal visual range of operator standing on floor.
13. Provide gauges where shown on drawings, including the following locations:

    a. Ice builders; leaving each builder on the pumped liquid return header.
    b. Barrel chiller; entering and leaving the pumped liquid lines.
    c. Compressor oil coolers; entering and leaving condenser water lines.
    d. Evaporative condenser; entering and leaving refrigerant lines.
    e. Refrigerant pumps; entering and leaving the pumped liquid lines.

14. Provide nickel plated brass escutcheons or floor plates, around pipes piercing floors and walls in finished spaces. Fit around insulation or around pipe if un-insulated. Secure to pipe with setscrew. Provide deep escutcheon where sleeve projects beyond finished surface

C. Refrigerant Systems Additional Requirements:

1. Installation shall be in accordance with ANSI B31.5 Refrigeration Piping, unless specified otherwise herein.
2. Brazing procedures and operators shall be qualified in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.
3. Refrigerant pipeline accessories that may be damaged by heat shall be disassembled prior to joint brazing. Reassemble accessories after joint brazing operations are completed.
4. Joints shall be made with solder-type fittings. The outside surface of the tube where engaged in the fitting, and the inside surface of the fitting in contact with the tube, shall be cleaned with an abrasive material before brazing. Self-cleaning compounds are not allowed. Care shall be taken to prevent annealing of tube and fittings when making connections. Brazed joints shall be made with flux and the previously specified silver-brazing alloy. The brazing alloy shall be applied and drawn through the full fitting length. Excess brazing alloy shall be wiped from the joint before the brazing alloy hardens. Joints shall be made with heat applied uniformly around the entire circumference of the tube and fittings. Remove all excess flux for a clear visual inspection of all brazed connections.
5. Refrigerant piping installed below concrete slab- on-grade shall be installed in continuous runs without joints, and shall be encased in PVC plastic conduit. Ends of conduit shall be sealed watertight.

3.2 BRAZING AND SOLDERING

A. Operator and Procedure Qualifications: All brazing operators and procedures shall be qualified in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code.

B. Brazing: Silver braze joints in accordance with MSS-SP-73 "Silver Brazing Joints for Wrought and Cast Solder Joint Fittings".

C. Soldering: Joints in copper tubing shall be made with solder- type fittings. Outside surface of the tube where engaged in the fitting, and inside surface of the fitting in contact with the tube, shall be cleaned with an abrasive material before soldering. Self- cleaning compounds shall not be used. Care shall be taken to prevent annealing of tube and fittings when making connections. The solder joint shall be made with flux and wire form solder, except brazed joints. The flux shall be a mildly corrosive liquid or a petroleum based paste containing chlorides of zinc and ammonium. Solder shall be applied and drawn through the full fitting length. Excess solder shall be wiped from joint before solder hardens. Joints in copper tube sizes 2-1/2 inches and larger shall be made with heat applied uniformly around the entire circumference of the tube and fittings by a multi-flame torch. Use of oxy-acetylene cutting torch in lieu of multi-flame torch is not permitted. Disassemble valves and other accessories that may be damaged by heat before soldering.

3.3 TESTING OF PIPING SYSTEMS:

A. Each piping system, after erection, shall be subjected to a pressure test. The test requirements shall be as follows:

1. General: Furnish everything required for the tests. Notify Architect/Engineer at least 48 hours before any testing is performed. Independent Agent/Owner shall verify pressure test and sign off. Report to be furnished to Architect/Engineer. Testing shall be performed at the completion of each phase of the project.
2. Refrigerant Piping Systems shall be tested with dry carbon dioxide, or nitrogen, at 315 psig for the high side, and at 245 psig for the low side. If leaks are to be detected by use of an electronic halogen detector, or a halide torch, the system shall be pressurized with refrigerant gas prior to introduction of dry carbon dioxide or nitrogen into the system. Pre-charging of system with refrigerant gas is not necessary for soap bubble leak detection method.
3. Leaks, if any, shall be located, repaired, and retested in accordance with the test method specified for the system in which the leaks are located.

B. Prior to testing a system, the Contractor shall provide the proper Building Official and the Owner's Representative with not less than 72 hours notice of the proposed test. The Contractor shall obtain approval of the test results. Where written approval is required, the Contractor shall obtain such written approval, and submit a copy of the approval.

C. Work requiring testing shall not be covered, or otherwise concealed, until testing is completed and approval is granted.

D. Work, or portions of work, that is altered in any way after testing and approval shall be retested, witnessed, and approval obtained.

E. Systems requiring hydrostatic tests shall be protected from damage caused by freezing. After tests are completed drain all sections of pipe, including traps, or fill undrained sections and traps with antifreeze solution. Vent all high points to release vacuum and ensure complete drainage of closed systems, and blow out piping with compressed air to remove trapped water.

F. Duration of tests, unless specified otherwise, shall be the time required to examine each joint in the system being tested.

G. During tests, isolate system components that have test pressures less than pressures specified for system tests.

H. Use clean soapy water applied to exterior of joints to locate leaks in systems using compressed air, dry carbon dioxide, or nitrogen, under positive pressure as a test medium.

SECTION 23_81_23

COMPUTER ROOM AIR CONDITIONERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. These specifications describe requirements for a switchgear room cooling system. The system shall be designed to control temperature conditions in rooms containing electronic equipment with a good insulation and vapor barrier. The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements of the room.

1.3 DESIGN REQUIREMENTS

A. The cooling system shall be a self-contained, factory-assembled unit with downflow air delivery. The system shall be air cooled backup with dual Semi-Hermetic compressors, DX Coil, & Outdoor Condenser with a 2-fan microchannel condenser.

1.4 SUBMITTALS

A. Submittals shall be provided after the agreement of the proposal and shall include: Single-Line Diagrams; Dimensional, Electrical and Capacity Data; Piping and Electrical Connection Drawings.

B. Comply with Division 01 for submittal requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Trane (Basis of Design)

B. Owner-Approved SUBSTITUTION

2.2 FABRICATION

A. Frame: The frame shall be MIG welded, formed sheet metal. It shall be

protected against corrosion using the autophoretic coating process. The frame shall be capable of being separated into three parts in the field to accommodate rigging through small spaces.

1. Downflow Front and Side Supply and top unducted return: The supply air shall exit from the bottom of the cabinet with the air throw towards the front and return at the top of the unit.
2. Exterior Panels: The exterior panels shall be insulated with a minimum 1 in., 1.5 lb. density fiber insulation. The main front panel shall have captive 1/4 turn fasteners.

B. Filters 4": Filters shall be deep pleated 4" filters with an ASHRAE 52.2 MERV 8 rating (45% ASHRAE 52.1).

1. Centrifugal Blower Section: The fans shall be the centrifugal type, double width double inlet and shall be dynamically balanced as a completed assembly. The shaft shall be heavy duty steel with self-aligning, permanently sealed, pillow block bearings with a minimum L3 life of 200,000 hours. The fans shall draw air through the A-frame coil to ensure even air distribution and maximum coil performance. A supply air plenum with sidewall supply grilles shall be factory-installed at the bottom of the blower.

C. Motor: The fan motor shall be mounted to an automatic, spring-tensioning base. The motor shall be removable from the front of the cabinet.

1. Drive Package: The motor sheave and fan pulley shall be double-width fixed pitch. Two belts, sized for 200% of the fan motor horsepower shall be provided with the drive package. An auto-tension system shall provide constant tension on the belts. Belts, shaft, blower bearings, sheave and pulley shall be warranted for five years (parts only).

D. Dual Refrigeration System:

1. Each unit shall include two (2) independent refrigeration circuits and shall include hot gas mufflers, liquid line filter driers, refrigerant sight glass with moisture indicator, externally equalized expansion valves and liquid line solenoid valves. Compressors shall be located outside the airstream and shall be removable and serviceable from the front of the unit.
2. Semi-Hermetic Compressor With Four-Step Unloaders Control: The compressor shall be dual compressors of semi-hermetic with a suction gas cooled motor, vibration isolators, thermal overloads, oil sight glass, automatic reset high pressure switch with control lockout after three failures, pump-down low pressure transducer, suction line strainer, service valves, reversible oil pumps for forced feed lubrication, a maximum operating speed of 1750 RPM. The system shall include cylinder unloaders on the semi-hermetic compressors. The unloaders shall be activated by solenoid valves which are controlled from the microprocessor control. In response to the return air temperature, the microprocessor control shall activate the unloader solenoids and the liquid line solenoids such that four stages of refrigeration cooling are

obtained. The stages shall be: 1) one compressor, partially loaded, 2) two compressors partially loaded, 3) one compressor partially loaded, one compressor fully loaded, 4) two compressors fully loaded.

3. Crankcase Heaters: The compressors shall include crankcase heaters, powered from the indoor unit electric panel.
4. Evaporator Coil: The Air Cooled evaporator coil shall be A-frame design with offset orientation. It shall be constructed of rifled copper tubes and aluminum fins. A stainless steel condensate drain pan shall be provided.
5. R-407C Refrigerant: The system shall be designed for use with R-407C refrigerant, which meets the EPA clean air act for phase-out of HCFC refrigerants.

E. Microprocessor Control - The unit control shall be factory-set for Intelligent Control, which uses “fuzzy logic” and “expert systems” methods. Proportional and Tunable PID shall also be user-selectable options. Internal unit component control shall include the following:

1. Compressor Short Cycle Control - Prevents compressor short-cycling and needless compressor wear.
2. System Auto Restart - The auto restart feature shall automatically restart the system after a power failure. Time delay is programmable.
3. Sequential Load Activation - On initial startup or restart after power failure, each operational load is sequenced with a minimum of one second delay to minimize total inrush current.
4. Hot Water/Econ-O-Coil Flush Cycles - Hot water reheat coils and Econ-O-Coils are periodically flushed to prevent a buildup of contaminants.
5. Predictive Humidity Control - calculates the moisture content in the room and prevents unnecessary humidification and dehumidification cycles by responding to changes in dew point temperature.
6. The control shall be compatible with all remote monitoring and control devices. Options are available for BMS interface via Modbus, Jbus, BACnet, Profibus and SNMP.
7. The control processor shall be microprocessor based with a 128x64 dot matrix graphic front monitor display and control keys for user inputs mounted in an ergonomic, aesthetically pleasing housing. The display and housing shall be viewable while the unit panels are open or closed. The controls shall be menu-driven. The display shall be organized into three main sections: User Menus, Service Menus and Advanced Menus. The system shall display user menus for active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in % of each function, date and time), total run hours, various sensors, display setup and service contacts. A password shall be required to make system changes within the service menus. Service menus shall include setpoints, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards and diagnostics/service mode. A password shall be required to access the advanced menus, which include the factory settings and password menus.
8. The User Menus Shall be Defined as Follows:

a. Active Alarms: Unit memory shall hold the 200 most recent alarms with time and date stamp for each alarm.
b. Event Log: Unit memory shall hold the 400 most recent events with ID number, time and date stamp for each event.
c. Graphic Data View: Eight graphic records shall be available: return air temperature, return air humidity, supply air temperature, outdoor temperature and four custom graphs.
d. Unit View - Status Overview: Simple or Graphical “Unit View” summary displays shall include temperature and humidity values, active functions (and percent of operation) and any alarms of the host unit.
e. Total Run Hours: Menu shall display accumulative component operating hours for major components including compressors, Econ-O-Coil (FC), fan motor, humidifier and reheat.
f. Various Sensors: Menu shall allow setup and display of optional custom sensors. The control shall include four customer-accessible analog inputs for sensors provided by others. The analog inputs shall accept a 4 to 20 mA signal. The user shall be able to change the input to 0 to 5VDC or 0 to 10VDC if desired. The gains for each analog input shall be programmable from the front display. The analog inputs shall be able to be monitored from the front display.
g. Display Setup: Customer shall pre-select the desired grouping of display languages at the time of the order from the following choices:

    1) Group 1: English, French, Italian, Spanish, German
    2) Group 2: English, Russian, Greek
    3) Group 3: English, Japanese, Chinese, Arabic

h. Service Contacts: Menu shall allow display of local service contact name and phone number.

9. The Service Menus Shall be Defined as Follows:

    a. Setpoints: Menu shall allow setpoints within the following ranges:

        1) Temperature Setpoint: 65-85ºF*
        2) Temperature Sensitivity: +1-10ºF
        3) Humidity Setpoint: 20-80% RH*
        4) Humidity Sensitivity: 1-30% RH
        5) High Temperature Alarm: 35-90ºF
        6) Low Temperature Alarm: 35-90ºF
        7) High Humidity Alarm: 15-85% RH
        8) Low Humidity Alarm: 15-85% RH

        *The microprocessor may be set within these ranges however, the unit may not be able to control to extreme combinations of temperature and humidity.

10. Standby Settings/Lead-Lag: Menu shall allow planned rotation or

emergency rotation of operating and standby units.

11. Timers/Sleep Mode: Menu shall allow various customer settings for turning On/Off unit.
12. Alarm Setup: Menu shall allow customer settings for alarm notification (audible/local/remote). The following alarms shall be available:

    a. High Temperature
    b. Low Temperature
    c. High Humidity
    d. Low Humidity
    e. Compressor Overload
    f. Main Fan Overload
    g. High Head Pressure
    h. Change Filter
    i. Fan Failure
    j. Low Suction Pressure
    k. Unit Off

13. Audible Alarm: The audible alarm shall annunciate any alarm that is enabled by the operator.
14. Common Alarm: A programmable common alarm shall be provided to interface user-selected alarms with a remote alarm device.
15. Remote Monitoring: All alarms shall be communicated to the monitoring system with the following information: date and time of occurrence, unit number and present temperature and humidity.
16. Sensor Calibration: Menu shall allow unit sensors to be calibrated with external sensors.
17. Maintenance/Wellness Settings: Menu shall allow reporting of potential component problems before they occur.
18. Options Setup: Menu shall provide operation settings for the installed components.
19. System/Network Setup: Menu shall allow Unit-to-Unit (U2U) communication and setup for Teamwork modes of operation (up to 32 units).
20. Teamwork Modes of Operation: Saves energy by preventing operation of units in opposite modes multiple units.
21. Auxiliary Boards: Menu shall allow setup of optional expansion boards.
22. Diagnostics/Service Mode: The control shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as on or off at the front display. Control outputs shall be able to be turned on or off from the front display without using jumpers or a service terminal. Each control output shall be indicated by an LED on a circuit board.
23. Advanced Menus

    a. Factory Settings: Configuration settings shall be factory-set based on the pre-defined component operation.
    b. Change Passwords: Menu shall allow new passwords to be set or changed.

24. Microprocessor Control With Large Graphic Display:

    a. The unit control with large graphic display shall include all of the features as the with small graphic display, except that it includes a larger graphical display and shall include the additional features of: “System View”, Spare Parts List, Unit Diary.
    b. The control processor shall be microprocessor based with a 320x240 dot matrix graphic front monitor display panel and control keys for user inputs mounted in an ergonomic, aesthetically pleasing housing.

25. System View - Status Overview: “System View” shall display a summary of operation for the total number of operating units within a Unit-to-Unit (U2U) configuration.
26. Spare Parts List: Menu shall include a list of critical spare parts, their quantity and part numbers.
27. Unit Diary: Menu shall include a free field area within the unit memory where unit history may be stored for reference.

F. Miscellaneous Options:

1. Locking Disconnect Switch: The manual disconnect switch shall be mounted in the high voltage section of the electrical panel. The switch shall be accessible from the outside of the unit with the door closed and prevent access to the high voltage electrical components until switched to the “OFF” position.
2. High Temperature Sensor: The firestat shall be factory-installed in the unit and shall be factory-set to 125ºF. It shall immediately shut down the environmental control system when activated. The sensor shall be mounted with the sensing element in the return air.
3. Smoke Sensor: The smoke sensor shall immediately shut down the environmental control system and activate the alarm system when activated. The smoke sensor shall be mounted in the electrical panel with the sensing element in the return air compartment. The smoke sensor is not intended to function as or replace any room smoke detection system that may be required by local or national codes. The smoke sensor shall include a supervision contact closure.

G. Air-Cooled Systems, Microchannel Condenser:

1. These specifications describe requirements for an air-cooled condenser as needed for heat rejection matching the indoor unit. The condenser shall be designed to reject waste heat to outdoor air and to control refrigerant head pressure as indoor equipment loading and outdoor ambient conditions change. The manufacturer shall design and furnish all equipment in the quantities and configurations shown on the project drawings. Standard 60Hz units are CSA certified to the harmonized U. S. and Canadian product safety standard CSA C22.2 No 236/UL for “Heating and Cooling Equipment” and are marked with the CSA c-us logo. The air-cooled condenser shall be a factory-assembled unit,

complete with integral electrical panel, designed for outdoor installation. The condenser shall be a draw-through design.

2. The specified system shall be factory-tested before shipment. Testing shall include, but shall not be limited to: Quality Control Checks, “Hi-Pot” Test (two times rated voltage plus 1000V, per NRTL agency requirements), and Metering Calibration Tests. The system shall be designed and manufactured according to world-class quality standards. The manufacturer shall be ISO 9001 certified.

H. Standard Features – All Condensers: Condenser shall consist of microchannel condenser coil, propeller fans, direct-driven by individual fan motor, electrical controls, housing and mounting legs. The air-cooled condenser shall provide positive refrigerant head pressure control to the indoor unit by adjusting heat rejection capacity. Microchannel coils shall provide superior heat transfer, reduce air-side pressure drop, increase energy efficiency and significantly reduce the system refrigerant volume required. EC fans and fan operating techniques shall provide reduced maximum sound levels. Various methods shall be available to match indoor unit type, maximum outdoor design ambient and maximum sound requirements.

I. The entire HVAC unit will be coated for corrosion protection against coastal installations (Sea Coast Coating). The coating shall be applied onto both sides of all the coils in the unit including the headers, return bends and any exposed pipework in the unit. In addition, the rest of the unit including the compressor section, static walls of the compressor area and the exterior of the cabinet will be coated. The coating shall equal or pass a 15,000-hour ASTM B117 salt spray test as well as 4,000-hour ASTM G85 A1 acidified salt spray test. The coating shall be low VOC “environmentally friendly”, UV/UVC light resistant and produce a super hydrophobic water shedding slick surface. The coating shall also have three built in biocides to reject the growth of mold, mildew, and biological film. The coating shall be clear. The Clear coating on the exterior of the cabinet shall equal or pass a 48,000-hour ASTM B117 salt spray test. The coating shall be low VOC “environmentally friendly”, UV/UVC light resistant and produce a super hydrophobic water shedding slick surface. The coating shall be EpoxSil Coatings as provided by Bethel Products LLC and come with a 5 (five) year warranty or an approved equal.

J. Aluminum Microchannel Coil: Microchannel coils shall be constructed of aluminum microchannel tubes, fins and manifolds. Tubes shall be flat and contain multiple, parallel flow microchannels and span between aluminum headers. Full-depth louvered aluminum fins shall fill spaces between the tubes. Tubes, fins and aluminum headers shall be oven-brazed to form a complete refrigerant-to-air heat exchanger coil. Copper stub pipes shall be electric resistance welded to aluminum coils and joints protected with polyolefin to seal joints from corrosive environmental elements. Coil assemblies shall be factory leak-tested at a minimum of 300 psig. Hot gas and liquid lines shall be copper and shall be brazed using nitrogen gas flow to the stub pipes with spun closed ends for customer piping connections. Complete coil/piping assembly shall be then filled and sealed with an inert gas holding charge for shipment.

K. Fan Motor/Blade Assembly: The fan motor/blade assembly shall have an

external rotor motor, fan blades and fan/finger guard. Fan blades shall be constructed of cast aluminum or glass-reinforced polymeric material. Fan guards shall be heavy gauge, close-meshed steel wire, coated with a black corrosion resistant finish. Fan terminal blocks shall be located in an IP54 enclosure located on the top of the fan motor. Fan assemblies shall be factory-balanced, tested before shipment and mounted securely to the condenser structure.

L. EC Fan Motors: The EC Fan motors shall be electronically commutated for variable speed operation and shall have ball bearings. The EC fans shall provide internal overload protection through built-in electronics. Each EC fan motor shall have a built-in controller and communication module, linked via RS485 communication wire to each fan and the Premium Control Board, allowing each fan to receive and respond to precise fan speed inputs from the Premium Control Board.

M. Electrical Controls: Electrical controls and service connection terminals shall be provided and factory wired inside the attached control panel section. A locking disconnect switch shall be factory-mounted and wired to the electrical panel and controlled via an externally mounted locking and lockable door handle. Only high-voltage supply wiring and low-voltage indoor unit communication/interlock wiring are required at condenser installation.

N. EC Fan Speed & Premium Control: The EC Fan/Premium Control System shall include an electronic control board, EC fan motor(s) with internal overload protection, refrigerant and ambient temperature thermistors and refrigerant pressure transducers. The control board shall receive an indoor unit run signal via field-supplied low voltage interlock wires to the compressor side switch, via field-supplied CANbus communication wires from the indoor unit's control (future feature) or via both. The control board shall use sensor and communication inputs to maintain refrigerant pressure by controlling each EC fan on the same refrigerant circuit to the same speed.

O. Cabinet: The condenser cabinet shall be constructed of bright aluminum sheet and divided into individual fan sections by full width baffles. Internal structural support members, including coil support frame, shall be galvanized steel for strength and corrosion resistance. Panel doors shall be provided on two sides of each coil/fan section to permit coil cleaning. An electrical panel shall be contained inside a factory mounted, NEMA 3R weatherproof electrical enclosure.

P. Mounting Legs, Standard Aluminum Legs: Aluminum legs shall be provided to mount unit for vertical air discharge with rigging holes for hoisting the unit into position. Standard height is 18in.

Q. Fusible Plug Kit: A fusible plug kit shall be field-installed on the liquid line for compliance with building codes requiring refrigerant relief during high temperature and building fire conditions.

PART 3 - EXECUTION

3.1 INSTALLATION OF AIR CONDITIONING UNITS

A. General:

1. Install air conditioning units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.
2. Electrical Wiring: Install and connect electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.
3. Piping Connections: Install and connect devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.
4. Field Quality Control & Factory Startup Services: Factory startup services to be included as part of the equipment sale. This will be a factory certified environmental technician providing this service, after completion of installation by the contractor. Start cooling units in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements. These specifications describe requirements for a computer room environmental control system. The system shall be designed to maintain temperature and humidity conditions in the rooms containing electronic equipment. The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements.

DIVISION 26 – ELECTRICAL

SECTION 26_05_02

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

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

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

C. Overall Application of Specifications: This section applies to all sections of Division 26, Electrical and to other sections that include electrical equipment requirements except when in these individual sections requirements are otherwise specified to provide and install all materials necessary for a complete operational system.

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

1.02 DEFINITIONS

A. Hazardous Areas: Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502 and 503. Hazardous areas are as defined by NFPA.

1.03 SYSTEM DESCRIPTION

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

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

1.04 SUBMITTALS

A. General: Provide submittals in accordance with Section 01_33_00. Provide submittals for all electrical material and devices. Including the following:
   1. Submit Technical Information Documents, electronically, at start of construction or within 30 days after Award of the Contract. Provide correct project and equipment designation on outside cover and on end of brochure. Specific shop drawing submittals may be submitted separately after technical information document but before any equipment is purchased; provide index and schedule of shop drawings to be submitted within the technical information brochures.
   2. First section of the document shall be prepared by the Contractor, and shall list Project Addresses and phone numbers with key personnel for this project. Second section shall be the individual referenced specification section which equipment is being submitted under. The specification shall be annotated utilizing a spec check system in which check marks are placed beside each line item indicating the Contractor is complying or else noted with an exception number. All exceptions and clarifications shall be compiled into a single document at the of the section.
   3. Provide bookmarked document tabbed with the appropriate specification reference number or section number.
   4. The Contractor shall review the document before submitting to the Engineer. No request for payment will be considered until the document has been submitted and reviewed completely.
   5. Submit cost breakdown "Schedule of Values" for electrical work in the Technical Information Document. Cost of material and labor for each major item shall be shown.
   6. Acceptance: When returned to Contractor, submittals will be marked with Engineer's stamp. If box marked "returned for correction resubmit" is checked, submittal is not approved and Contractor is to correct and resubmit as noted, otherwise submittal is approved and Contractor is to comply with notation making necessary corrections on submittal and resubmit for final record.
   7. Note that the approval of shop drawings, or other information submitted in accordance with the requirements hereinbefore specified, does not assure that the Engineer, or any other Owner's Representative, attests to the dimensional accuracy or dimensional suitability of the material or equipment involved, the ability of the material or equipment involved or the Mechanical/Electrical performance of equipment. Approval of shop drawings does not invalidate the plans and specifications if in conflict with the submittal. It is the Contractor’s responsibility to request in writing and seek written approval from the engineer for all deviations of the plans and specifications.

B. Product Data and Information: Provide complete list of electrical equipment and materials to be furnished showing manufacturer, catalog number, size, type, voltage rating and other pertinent information.
   1. Provide catalog data on manufacturer's standard equipment and materials. Clearly indicate on catalog cuts the equipment and devices being proposed.
   2. Identification: Provide complete schedule and listing of system and equipment identification labels with legends.
   3. Material shall not be ordered or shipped until the shop drawings have been approved.

4. The Engineer's Shop Drawing review shall be for conformance with the design concept of the project and compliance with the Specifications and the Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and the Drawings.
5. Shop Drawings shall be stamped with the date checked by the Contractor and a statement indicating that the Shop Drawings conform to the Specifications and the Drawings. This statement shall also list all exceptions to the Specifications and the Drawings. Shop drawings not so checked and noted shall be returned.

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

D. Coordination Drawings: Prepare to scale coordination drawings (1/4"=1'-0"); detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including but not necessarily limited to the following:
1. Indicate the proposed locations of major raceway systems, equipment, and materials. All dimensions shall be field verified at the job site and coordinated with the work of all other trades. Include the following:
    a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
    b. Exterior wall and foundation penetrations.
    c. Fire-rated wall and floor penetrations.
    d. Equipment connections and support details.
    e. Sizes and location of required concrete pads and bases.

E. Record Documents: Prepare record documents, and in addition to the requirements specified in Division 1, General Requirements. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, (the "Record Drawings"). Indicate installed conditions for:
1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, and actual equipment and materials installed.

4. Record Drawings shall accurately show the installed condition of the following items: Power Riser Diagram(s). Equipment elevations (front views). Raceways and pullboxes. Conductor sizes and conduit fills. Control Wiring Diagram(s). Underground raceway and duct bank routing. Plan view, sizes and locations of distribution transformers and outdoor electrical equipment enclosure.
5. Submit a schedule of control wiring raceways and wire numbers, including the following information: Circuit origin, destination and wire numbers. Field wiring terminal strip names and numbers.
6. In addition to the schedule, provide point to point connection diagrams showing the same information submitted in the schedule of control wiring raceways including all designations and wire numbers. Comply with PLC tag designation on all instrumentation and control cabling in and out of PLC racks.
7. The schedule of control wiring raceways and wire numbers and the point to point connection diagrams shall be in electronic Autocad and Word format (i.e. no hand-written or drawn schedules, drawings, or diagrams will be accepted)

F. Operation and Maintenance Manuals: Prepare operation and maintenance manuals, and in addition to the requirements specified in other Divisions, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and catalog numbers of replacement parts. Complete parts list with stock numbers, including spare parts. A complete bill of material supplied, including serial numbers, ranges and pertinent data.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions. The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. A comprehensive index.
5. A complete "As Built" set of approved shop drawings.
6. A table listing of the "as left" settings for all timing relays and alarm and trip setpoints.
7. A complete listing of As left programmable parameters for all drives, soft-starters and other microprocessor controlled equipment.
8. System schematic drawings "As Built", illustrating all components, piping and electric connections of the systems supplied under this section.

1.05 QUALITY ASSURANCE

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

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

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

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

1.06 DELIVERY, STORAGE AND HANDLING

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

B. Shipping and Packing: Provide materials and equipment suitably boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Clearly label such boxes, crates or enclosures with manufacturer's name, and name of material or equipment enclosed.

C. Acceptance at Site: Conform to acceptance requirements as required in Division 1, General Requirements. Repair or replace all materials and equipment damaged by handling and storage as directed at no additional Contract cost.

D. Storage and Protection: Protect materials and equipment from exposure to the elements and keep them dry at all times. Handle and store to prevent damage and deterioration in accordance with manufacturer's recommendations.

1.07 PROJECT CONDITIONS

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

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

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

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

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 ROUGH-IN

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

B. The Drawings are not intended to show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.

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

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

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

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

G. All “LB” type fitting hardware to be stainless steel or brass. All junction box hardware to be aluminum or stainless steel only.

3.02 ELECTRICAL INSTALLATIONS

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

B. Homeruns: Drawings show most homerun circuits to be provided. Do not combine power or control circuits into common raceways without authorization of Engineer. Changes shall be documented on record drawings. Homerun circuits shown on Drawings indicate functional wiring requirements for all circuits. Lighting and receptacle Circuits; no more than three circuits to a single raceway. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.

3.03 CUTTING AND PATCHING

A. Perform cutting and patching as specified in Division 1, General Requirements. In addition to the requirements specified in Division 1, General Requirements, the following requirements apply:
   1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
      a. Uncover Work to provide for installation of ill-timed Work.
      b. Remove and replace defective Work.
      c. Remove and replace Work not conforming to requirements of the Contract Documents.
      d. Remove samples of installed Work as specified for testing.
      e. Install equipment and materials in existing structures.
      f. Locate existing structural reinforcing where core drilled penetrations are required so as not to cut the steel reinforcing.
   2. Cut, remove, and properly dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work. Deliver all the existing removed to the Owner as directed.
   3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
   4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
   5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
   6. Patch finished surfaces and building components using new materials as specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

END OF SECTION

SECTION 26_05_11

SPECIAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install complete and make operational, electrical and process instrumentation systems for the Lee County Utilities Department as shown on the Drawings and as specified herein.

B. The work shall include furnishing, installing and testing the equipment and materials specified in other sections of the Specifications and shown on the Drawings.

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

1. Furnish and install new class 1 reliable service entrance switchgear and electrical services.
2. Furnish and install (1) new motor control center.
3. Furnish and install (4) Effluent Pump VFDs.
4. Furnish and install (1) plant PLC sized for future plant expansion.
5. Demolition of existing electrical service, stand-by generator and above ground fuel tank.
6. Installation of temporary electrical feeder system to existing plant MCCs and Blowers.
7. Coordinate and accept delivery, offload, install, start-up and test stand-by power generator set in walk–in enclosure with sub-base fuel tank which has been direct owner purchased.
8. Furnish and install Concrete encased ductbank system for power, fiber optic, instrumentation and control signal distribution.
9. Conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions of these Specifications.
10. Conduit, wiring and terminations for all field-mounted instruments furnished under other Divisions of these Specifications, including process instrumentation primary elements, transmitters, local indicators and control panels. Lightning and surge protection equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions of these Specifications.
11. Power wiring for all heating, ventilating, and air conditioning (HVAC) equipment furnished under other divisions of the specifications, including power wiring for 120-volt motors, thermostats, fan motors, dampers and other HVAC in line unit wiring.
12. Furnish and install precast manholes and precast handholes. Furnish and install manhole and handhole frames and covers.
13. Provide Power and signal Surge Suppression systems.
14. Provide Concrete work for pad mounted equipment.

15. Provide complete Arc Flash evaluation, short circuit and coordination study and Electrical testing of equipment including SKM file of approved studies.
16. Provide Lightning protection, bonding and complete grounding systems and special grounds as required or noted.
17. Provide complete set of electronic and hard copy Project Record Drawings and Vendor Operation and Maintenance manuals.
18. Provide detailed training sessions.
19. Provide witness testing of switchgear.

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

E. Field verify all existing underground electrical and mechanical piping.

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

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

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

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

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

K. Mount transmitters, process instruments, operator’s stations, etc. furnished under other Divisions of these Specifications.

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

1.02 QUALIFICATIONS

A. The electrical contractor shall be dually licensed as an electrical contractor in the State of Florida.

B. The electrical contractor shall be regularly engaged in the installation of industrial electrical power systems. Submit with bid package, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

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

D. A reference list of electrical service contractors is provided in the Lee County Electrical Services Continuing Contracts (Solicitation No. RFP200049AEJ). Bidders are not limited to using the electrical service contractors approved under this Annual Contract; the reference list is provided for bidders convenience only.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
   2. National Electrical Manufacturers Association (NEMA):
   3. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   4. Z535.4, Product Safety Signs and Labels.
   5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   6. Underwriters Laboratories, Inc. (UL).

1.04 RELATED WORK

A. Excavation and backfilling, including gravel or sand bedding for underground electrical work is specified in other Divisions.

B. Cast in place concrete work, including concrete encasements for electrical duct banks, equipment pads, and reinforcing steel, is specified in other Divisions.

1.05 REFERENCE STANDARDS

A. Electric equipment, materials and installation shall comply with the latest edition of National Electrical Code (NEC) and with the latest edition of the following codes and standards:
   1. National Electrical Safety Code (NESC).
   2. Occupational Safety and Health Administration (OSHA).
   3. National Fire Protection Association (NFPA).
   4. National Electrical Manufacturers Association (NEMA).
   5. American National Standards Institute (ANSI).
   6. Insulated Cable Engineers Association (ICEA).
   7. Instrument Society of America (ISA).

8. Underwriters Laboratories (UL).
9. Factory Mutual (FM).
10. International Electrical Testing Association (NETA).
11. Institute of Electrical and Electronic Engineers (IEEE).
12. American Society for Testing and Materials (ASTM).
13. Electrical Safety in the Workplace (NFPA70E).
14. State and Local Codes and Ordinances.

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

1.06 ENCLOSURE TYPES

A. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:
1. NEMA 1 for dry, non-process indoor locations.
2. NEMA 12 for "DUST" locations.
3. NEMA 4X 316 stainless steel powder coated white with continuous hinge, 3 point latch, screw down door clamps for all outdoor locations, rooms below grade (buried vaults), "DAMP" and "WET" locations.
4. NEMA 4X 316 SS powder coated white with continuous hinge, 3 point latch, screw down door clamps for "CORROSIVE" locations.
5. NEMA 7 (and listed for use in the area classifications shown) for "Class I Division 1 Group D", "Class I Division 2 Group D" and "Class II Division 1" hazardous locations shown on the Drawings.

B. Unless otherwise specified herein or shown on the Drawings, junction boxes shall have the following ratings:
1. NEMA rating as applicable and specified above.
2. Have continuous hinge with quick connect door clamp. Flush mounted screw down fronts are not acceptable.

1.07 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction. Completed electrical installation shall be inspected and certified by all applicable agencies that it is in compliance with all codes.

B. Contractor shall obtain all necessary permits and Lee County will pay all fees required for permits and inspections.

1.08 TESTS AND SETTINGS

A. Test systems and equipment furnished under Division 26, Electrical and other divisions supplying electrical equipment. Repair or replace all defective work and equipment. Refer to section 26_08_00, Acceptance Testing and Performance Verifications and the individual equipment sections for additional specific testing requirements.

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

C. In addition to the specific testing requirements listed in section 26_08_00, Acceptance Testing and Performance Verifications and the individual sections, the following minimum tests and settings shall be performed. Submit test reports upon completion of testing in accordance with Section 26_08_00, Acceptance Testing and Performance Verifications.
   1. Mechanical inspection, testing and settings of circuit breakers, disconnect switches, motor starters, overload relays, control circuits and equipment for proper operation.
   2. Check the full load current draw of each motor. Where power factor correction capacitors are provided the capacitor shall be in the circuit at the time of the measurement. Check ampere rating of thermal overloads for motors and submit a typed record to the Engineer of the same, including driven load designation, motor service factor, horsepower, and Code letter. If incorrect thermal overloads are installed replace same with the correct size overload.
   3. Check power and control power fuse ratings. Replace fuses if they are found to be of the incorrect size.
   4. Check settings of the motor circuit protectors. Adjust settings to lowest setting that will allow the motor to be started when under load conditions.
   5. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.
   6. Check rotation of motors prior to testing the driven load. Disconnect the driven equipment if damage could occur due to wrong rotation. If the rotation is incorrect for the driven equipment correct motor connections at the motor terminal box.
   7. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by control schematic and wiring diagrams.
   8. Inspect each piece of equipment in areas designated as HAZARDOUS to ensure that equipment of proper rating is installed.
   9. Verify all terminations at transformers, equipment, panels and enclosures by producing a 1, 2, 3 rotation on a phase sequenced motor when connected to "A", "B" and "C" phases.
   10. Check all wire and cable terminations. Verify to the Engineer connections meet the equipments torque requirements.
   11. Field set all transformer taps as required to obtain the proper secondary voltage.
   12. Infra-red hot spot inspection shall be made of all electrical equipment including but not limited to switchgear, motor control centers, transformers, switches, power and control panels, etc. This shall be done under representative load conditions before the equipment is used by the Owner.

1.09 PHASE BALANCING

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

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

1.10 EQUIPMENT IDENTIFICATION

A. Identify equipment (disconnect switches, control stations, etc) furnished under Division 26, Electrical with the name of the equipment it serves. Control panels, panelboards, main breakers, junction or terminal boxes, etc, shall have nameplate designations as shown on the Drawings. Nameplates shall adequately describe the function of the particular equipment involved. Where nameplates are detailed on the Drawings, inscription and size of letters shall be as shown and Shop Drawing submitted for approval. Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 277/480V, 3-phase, 4-wire". The name of the machine on the nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and P.B. station nameplates for that machine.

B. Nameplates shall be engraved, laminated plastic, not less than 1/16-inch thick by 3/4-inch by 2-1/2-inch with 3/16-inch high white letters on a black background. Attach with Stainless Steel nuts and bolts.

C. Electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks. Electrical contractor is responsible for nameplates on electrical equipment supplied by other divisions and installed and wired by electrical including all instrumentation and controls equipment. A portion of existing equipment affected by this contract shall also receive nameplates as determined by the Engineer.

D. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate, the nameplate shall be permanently fastened to the adjacent mounting surface. Cemented nameplates shall not be drilled.

E. All voltages (e.g. 480 volts, 240 volts, etc.) within pull boxes, junction boxes etc. shall be identified on the front exterior cover. Signs shall be red background with white engraved lettering, lettering shall be a minimum of 1-inch high.

F. All receptacles, wall switches, lighting fixtures, photo cells, emergency lights, exit lights, etc. shall be identified with the panel and circuit to which it is connected. Identification shall be with machine generated labels with 1/4-inch high letters.

1.11 SAFETY REQUIREMENTS

A. The Contractor shall make every effort to keep all employees and/or subcontractors aware of the danger inherent in working in dangerous proximity to the existing power lines. The minimum recommended precautionary measures are as follows:
   1. Make sure that all persons responsible for operating cranes, draglines and other mobile equipment have a copy of, and are familiar with the State Department of Commerce Regulations for Use of Cranes, Draglines and Similar Equipment Near Power Lines, as well as the U.S. Department of Labor OSHA Regulations, before commencing operation of said equipment.
   2. Make sure that all cranes, draglines and other mobile equipment have attached to them the black and yellow Department of Commerce warning signs required by the said Regulations of State Department of Commerce.

3. Warn all employees on the ground, new and old employees alike, of the danger of holding on to or touching a cable or other piece of equipment or machinery that is located or working close to any overhead power line.
4. If, during the course of construction, it becomes necessary for the contractor, or subcontractor, and their employees, to operate cranes, draglines, or their mobile equipment, in dangerous proximity of any overhead power lines, or in such a manner that such equipment might come close to any overhead power lines, the Contractor shall give the Power Company or overhead power line owner prior notice of such proposed operation.

1.12 ABBREVIATIONS OR INITIALS USED

A/C	Air Conditioning
A.C.	Alternating Current
AFF	Above Finished Floor
AFG	Above Finished grade
AHU	Air Handler Unit
AIC	Amps interrupting Capacity
AL	Aluminum
AMP	Ampere
ANSI	American National Standards Institute
ATS	Automatic Transfer Switch
AUX	Auxiliary
AWG	American Wire Gauge
BKR	Breaker
^{o}C	Degrees Centigrade
CAB	Cabinet
C.	Conduit or Conductor
C.B.	Circuit Breaker
CFM	Cubic Feet per Minute
CKT.	Circuit
COND.	Conductor
Conn.	Connection
CP	Control Panel
CPT	Control Power Transformer
CT	Current Transformer
CU.	Copper
DC	Direct Current
Deg.	Degree
Disc.	Disconnect
DO	Draw Out
DPST	Double Pole Single Throw
EMT	Electric Metallic Tubing
E.O.	Electrically Operated
^{o}F	Degrees Fahrenheit
FLA	Full Load Amperes

FHP	Fractional Horsepower
FT.	Feet
FVNR	Full Voltage Non-Reversing
GFI (GFIC)	Ground Fault Interrupting
gnd.(GD.)	Ground
hp.	Horsepower
hr.	Hour
IEEE	Institute of Electrical and Electronic Engineers
in.	Inches
JB	Junction Box
KV	Kilovolt
KVA	Kilo-Volt-Amps
KW	Kilowatts
LCP	Local Control Panel
LED	Light Emitting Diode
max.	Maximum
MCB	Main Circuit Breaker
MCC	Motor Control Center
MCP	Motor Circuit Protector
min.	Minimum
MLO	Main Lugs Only
N.	Neutral
NEC	National Electric Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NIC.	Not in Contract
NF	Non Fused
No.	Number
ph	Phase
OCU	Odor Control Unit
OL	Overload
OSHA	Occupational Safety and Health Act
PB	Pullbox
Ph.	Phase
PNL	Panelboard
PR	Pair
PWR	Power
PF	Power Factor
Pri	Primary
psi	Pounds Per Square Inch
PT	Potential Transformer

PVC	Polyvinyl Chloride
RLA	Running Load Amps
RMS	Root-Means-Square
RPM	Revolutions Per Minute
Recept.	Receptacle
RTD	Resistance Temperature Device
RVNR	Reduced Voltage Non-Reversing
SCA	Short Circuit Amps
SCC	Short Circuit Current
SCCR	Short Circuit Current Rating
Sec.	Secondary
S/N	Solid Neutral
SPST	Single Pole Single Throw
SSRV	Solid State Reduced Voltage
SW.	Switch
SWBD	Switchboard
SWGR	Switchgear
TEFC	Totally Enclosed Fan Cooled
TSP	Twisted Shielded Pair
TYP	Typical
Temp.	Temperature
UL	Underwriters Laboratories
UNO	Unless Noted Otherwise
V	Volt
VFD	Variable Frequency Drive
WP	Weatherproof
XFMR	Transformer

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SLEEVES AND FORMS FOR OPENINGS

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

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

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

D. Seal all openings, sleeves, penetration and slots as specified in Section 26 05 33.

3.02 INSTALLATION

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

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

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

D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted per the field painting requirements Section 09_90_00, Painting and Coating at no additional cost to the Owner.

E. All “LB” type fitting hardware to be stainless steel or brass. All junction box hardware to be aluminum or stainless steel only.

3.03 MANUFACTURERS SERVICE

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

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

C. The manufacturers of the above listed equipment shall provide experienced Field Service Engineer to accomplish the following tasks:
   1. The equipment shall be visually inspected upon completion of installation and prior to energization to assure that wiring is correct, interconnection complete and the installation is in compliance with the manufacturer's criteria. Documentation shall be reviewed to assure that all Drawings, operation and maintenance manuals, parts list and other data required to check out and sustain equipment operation is available on-site. Documentation shall be red-lined to reflect any changes or modifications made during the installation so that the "as-built" equipment configuration will be correctly defined. Spare parts shall be inventoried to assure correct type and quantity.
   2. The Field Service Engineers shall provide engineering support during the energization and check-out of each major equipment assembly. They shall perform any calibration or adjustment required for the equipment to meet the manufacturer's performance specifications.

3. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with manufacturer's test specifications.
4. A final report shall be written and submitted to the Contractor within fourteen days from completion of final system testing. The report shall document the inspection and test activity, define any open problems and recommend remedial action. The reports after review by the Contractor shall be submitted to the Engineer.

3.04 TRAINING

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

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

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

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

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

F. The Work under this Division shall include a warranty period of one year or the manufacturer's standard warranty period, whichever is greater. This warranty shall be by the Contractor to the Owner for any defective workmanship or material that has been furnished under this Contract at no cost to the Owner for a period of one year or the manufacturer's standard warranty period, whichever is greater, from the date of Partial Clearance or Substantial Completion of the System, as applicable. This guarantee shall not include light bulbs or batteries in service after six months from date of Substantial Completion of the System.

END OF SECTION

SECTION 26_05_19

LOW VOLTAGE WIRES AND CABLES

PART 1 GENERAL

1.01 REFERENCED STANDARDS

A. Institute of Electrical and Electronics Engineers, Inc./American National Standards Institute (IEEE/ANSI).

B. Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies.

C. National Electrical Manufacturers Association (NEMA): ICS 4, Industrial Control and Systems: Terminal Blocks.

D. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA): WC 57/S-73-532, Standard for Control Cables: WC 70/S-95-658, Non-Shielded Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.

E. National Fire Protection Association NFPA-70, National Electrical Code (NEC).

F. Underwriters Laboratories, Inc. (UL44): Standard for Safety Thermoset Insulated Wires and Cables; (UL83): Standard for Safety Thermoplastic-Insulated Wires and Cables; UL467 Standard for Safety Grounding and Bonding Equipment. UL486A Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors; UL 486C, Standard for Safety Splicing Wire Connections. UL510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

1.02 DEFINITIONS

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

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

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

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

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

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

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

1.03 SUBMITTALS:

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

B. Submit sample of all cable identification systems products.

C. Submit conduit schedule identifying conduit tag numbers, locations the conduit connects and the wire count.

PART 2 PRODUCTS

2.01 POWER CONDUCTORS:

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

B. Motor leads from variable frequency drives to driven motor shall be shielded VFD drive cable for all VFD motors. Provide flexible VFD shielded drive cables, 3 Class-I conductor cable plus 3 trisectional green insulated ground wires. Provide electrostatic shielding of tinned copper braided shield with aluminum-polyester laminated tape shielding system. Cross-linked Polyethelene insulation (RHH/RHW-2 or XHHW-2) system and PVC, type TC cable as manufactured by Southwire, Service Wire or equal. Shielded VFD motor cables require increased conduit sizes over standard wire installations. Contractor to verify conduit sizes.

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

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

D. Color Coding:
1. All power feeders and branch circuits No. 6 and smaller shall be wired with color-coded wire with the same color used for a system throughout the building. Power feeders above No. 6 shall either be fully color-coded or shall have black insulation and be similarly color-coded with tape or paint in all junction boxes and panels. Tape or paint shall completely cover the full length of conductor insulation within the box or panel except for the wire markings.
2. Unless otherwise approved, color-code shall be as follows: Neutrals to be white for 120/208V system, natural grey for 277/480V system; ground wire green, bare or green with yellow strips. Nominal Voltage: 120/208V, Phase A - black; Phase B - red; Phase C - blue. 480/277V, Phase A brown; Phase B - orange; Phase C -yellow. All switch legs, other voltage system wiring, control and interlock wiring shall be color-coded other than those above. In exiting or expansion projects, comply with existing color coding established within the facility.

2.02 INSTRUMENTATION AND CONTROL CABLE:

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

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

C. Category 6 Unshielded Twisted Pair (UTP), UL listed, and third party verified to comply with TIA/EIA 568 C Category 6 requirements. Suitable for high speed network applications including gigabit Ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket. Cable shall withstand a bend radius of 1 inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking. Manufacturer and Product: Belden; 7852A. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.

2.03 CONNECTIONS:

A. All conductor connections shall be on terminal strips including all spare conductors. Provide terminal strips in all cabinets, motor control centers, etc.

B. All connections of stranded wire to screw terminals shall be by insulated spade lugs, crimp fastened to wire. Provide stranded wire crimp ferrules for all stranded wire connections not requiring spade lugs for screw type terminal blocks. The stranded wire ferrule is to be crimped to all stranded wire using a crimping tool specifically approved for crimping the size and type of ferrule.

C. All conductors shall be marked with mylar wrap type "Brady" labels. Identification labels shall be permanent type and be machine printed. All terminal block terminations shall be labeled. The inside portion of the terminal cabinet doors shall display a protected terminal cabinet drawing with all connections shown and described as to color code, number assigned to connection function of conductor and destination.

D. Wire shall be guided within terminal cabinets by cable supports. All conductors shall be neatly led to terminations.

E. Instrumentation and control field cables on the unprotected side of SPD devices within the cabinet shall not run in parallel to the cables on the protected side of the SPD device. Separate cable supports (duct) will be provided.

F. Cabinets: All cabinets shall be labeled with an engraved plastic laminate label riveted to the door.

G. No splices shall be made within a conduit run or in manholes.

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

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

2.04 MISCELLANEOUS ACCESSORIES

A. Tape:
   1. General Purpose, Flame Retardant: 7 mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.
   2. Flame Retardant, Cold and Weather Resistant: 8.5 mil, vinyl plastic, Scotch Brand 88.
   3. Arc and Fireproofing: 30 mil, elastomer. Manufacturers and Products: 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tape binder.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation shall be in accordance with manufacturer's recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate conductors and cables, unless otherwise indicated.

E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors and aluminum conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

G. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

I. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4 inch smaller than raceway inside diameter.

3.02 SPARE CONDUCTORS

A. All runs of Multi pair Process instrumentation cable and multi conductor Control cable shall have a minimum of 2 spare conductors per conduit.

END OF SECTION

SECTION 26_05_26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. The terms “connect”, “ground” and “bond” are used interchangeably in this specification and have the same meaning

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

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

1.02 RELATED WORK

A. Section 26 05 02, Basic Electrical Materials and Methods: General electrical requirements.

B. Section 26 05 19, Low Voltage Wires and Cables.

C. Section 26 41 00, Lightning Protection Systems.

1.03 SUBMITTALS

A. Submit in accordance with Section 26 05 02, Basic Electrical Materials and Methods.

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

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

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

1.04 APPLICABLE PUBLICATIONS

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

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE).

C. Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

D. National Fire Protection Association (NFPA).

E. National Electrical Code (NEC) 2008.

F. Underwriters Laboratories, Inc. (UL):
   1. Thermoset-Insulated Wires and Cables.
   2. Thermoplastic-Insulated Wires and Cables.
   3. Grounding and Bonding Equipment.
   4. Wire Connectors.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING CONDUCTORS

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

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

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

2.02 SPLICES AND TERMINATION COMPONENTS

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

2.03 GROUND CONNECTIONS

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

PART 3 EXECUTION

3.01 GENERAL

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

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

C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.02 GROUNDING CONNECTIONS

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

3.03 SECONDARY EQUIPMENT AND CIRCUITS

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

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

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

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

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

3.04 CORROSION INHIBITORS

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

3.05 CONDUCTIVE PIPING

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

3.06 GROUND RESISTANCE

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

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

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

3.07 GROUND ROD INSTALLATION

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

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

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

END OF SECTION

SECTION 26_05_29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. The Work under this sections includes conduit and equipment supports, straps, clamps, steel channel, etc, and fastening hardware for supporting electrical work. Furnish and install all supports, hangers and inserts required to mount fixtures, conduit, cables, pull boxes and other equipment furnished under this Division 26, Electrical. All supporting devices and hardware exterior of buildings or interior of structures except in air conditioned spaces shall be stainless steel. Aluminum and nonmetallic supports (fiberglass) and hardware will be reviewed by the Engineer on a case-by-case basis.

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

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

1.02 RELATED WORK

A. Applicable provisions of Division 1, General Requirements govern Work under this section.
   1. Section 26 05 33, Conduit Systems.

1.03 SUBMITTALS: PRODUCT DATA

A. Provide data for support channel.

1.04 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 PRODUCTS

2.01 MATERIAL

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

B. Hardware: Stainless steel throughout.

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

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

PART 3 EXECUTION

3.01 INSTALLATION

A. All steel conduits shall be securely fastened in place on maximum of 6 foot intervals; all PVC conduits shall be securely fastened in place on maximum of 3 foot intervals vertically and 2 foot intervals horizontally. Hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by two-hole malleable straps, clamp-backs, or other approved devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

B. On concrete or masonry construction, use "Tapcon" type fasteners. For brick construction, insert anchors shall be installed with round head machine screws. In wood construction, round head screws shall be used. An electric or hand drill shall be used for drilling holes for all inserts in brick, concrete or similar construction. Steel members shall be drilled and tapped, and round head machine screws shall be used. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from stainless steel, or approved substitution.

C. Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure using preset inserts, beam clamps, expansion anchors, or spring steel clips (interior metal stud walls only). Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction.

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

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

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

END OF SECTION

SECTION 26_05_33

CONDUIT SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

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

B. Heavy wall PVC (Schedule 80) shall be used for all raceways directly buried without concrete encasement protection. Conduits in concrete encasement use Schedule 40-PVC. Above ground in areas subject to chemical degradation (chemical storage, chemical feeder rooms, chlorine rooms, odor control and scrubber area, etc) use Schedule 80-PVC. Use aluminum conduit for exposed above grade interior area. Electrical Metallic Tubing shall be used within air conditioned spaces and in electrical rooms for power and for instrumentation and control conduits. Use rigid aluminum conduit above grade on exterior of buildings and in above grade interior wet locations. Where PVC conduit penetrates a floor from underground or in a slab; PVC coated rigid aluminum conduit shall be used at penetration for all conduits.

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

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

1.02 SUBMITTALS

A. Product Data:
   1. Product data shall be submitted on:

B. Conduit, raceways, wireways.

C. Conduit fittings, boxes, enclosures and cabinets.

D. Surface metal raceway.

E. Conduit Schedule identifying conduit tag numbers, locations the conduit connects and the wire count.

PART 2 PRODUCTS

A. ELECTRIC METALLIC TUBING
   1. Electric metallic tubing (thin wall) shall meet Federal EMT Specifications WW-C-563 ANSI C80.3 and UL 797 with chromated and lacquered protective layer.

B. FLEXIBLE CONDUIT
   1. Flexible, Nonmetallic, Liquid-Tight Conduit: Type B.
      a. Material: PVC core with fused flexible PVC jacket. UL 1660 listed for:
   2. Dry Conditions: 80 degrees C insulated conductors.
   3. Wet Conditions: 60 degrees C insulated conductors.
      a. Manufacturers and Products:
   4. Carlon; Carflex or X Flex.
   5. T & B; Xtraflex LTC or EFC.
   6. Flexible Steel Conduit: Continuous length, spirally wound steel strip, zinc-coated, each convolution interlocked with following convolution. Federal Specification WW-C-566. Liquid-tight Flexible Steel Conduit: Plastic (PVC) jacketed flexible steel conduit with copper bonding conductor (UL 1660). Flexible conduit fittings: UL 514B.

C. PVC CONDUIT
   1. PVC conduit shall be composed of High Impact Virgin homopolymer, PVC (polyvinyl chloride C-200 Compound), and shall conform to industry standards, and be UL 651 listed in accordance with Article 347 of National Electrical Code for underground, concrete encasement and or direct sunlight exposed use and NEMA standard TC-2. Materials must have tensile strength of 55 psi, at 70oF, flexural strength of 11,000 psi, compression strength of 8600 psi. Manufacturer shall have five years' extruding PVC experience. Consistent with requirements provide PVC conduit products by one of the following manufacturers:
      a. Carlon.
      b. Cantex.
      c. J.M. Plastics.
      d. Queen City Plastics.
         1) Rigid Aluminum Conduit
   2. Provide Rigid Aluminum Conduit of 6063 alloy in temper designation T-1. The fittings are of the same alloy. Provide threaded Rigid Aluminum Conduit to Underwriters Laboratories U.L. 6A, “Standard for Electrical Rigid Metal Conduit and manufactured to ANSI C80.5.
   3. Provide threaded aluminum conduit fittings, of 6063 alloy, cast copper free aluminum with integral insulated throat as manufactured by Allied, OZ Gedney, T&B, Crouse-Hinds, Killark or Appleton.
   4. Provide supplementary corrosion protection for aluminum conduit imbedded in concrete or in contact with soil. Where aluminum conduits are in contact with or penetrate concrete, coast conduit with asphaltic or bitumastic type coating.

D. CONDUIT FITTINGS
   1. 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.
   2. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
   3. Fittings for EMT: Steel compression type.

4. Fittings, surface boxes and conduit bodies for Rigid Aluminum Conduit shall be heavy cast aluminum with external raised hubs and mounting lugs; Appleton, Crouse Hinds or approved substitution. Cover plates cast aluminum. Zinc die cast not acceptable.
5. Conduit locknuts shall be aluminum throughout except steel is acceptable within air conditioned spaces.
6. Conduit expansion fittings shall be malleable iron, and shall be hot dipped galvanized inside and outside. These fittings shall have a four-inch expansion chamber to allow approximately two-inch movement parallel to conduit run in either direction from normal. They shall have factory-installed packing and internal tinned copper braid packing to serve as an emergency bonding jumper. Unless the fitting used is listed by Underwriters' Laboratories for use "without external bonding jumpers", an external copper bonding jumper shall be installed with each expansion fitting with one end clamped on each conduit entering fitting.
7. Flexible, Nonmetallic, Liquid-Tight Conduit shall meet requirements of UL 514B with High strength plastic body, complete with lock nut, O-ring seal, threaded ferrule, sealing ring. Threaded ferrule designed to ensure high mechanical pullout strength and watertight seal. Manufacturer, Carlon; Type LN or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

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

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

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

D. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.

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

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

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

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

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

J. Raceways which do not have conductors furnished under this Division 26, Electrical of the Specifications shall be left with an approved nylon pull cord in raceway.

K. Rigid Aluminum Conduit, electrical metallic tubing, flexible steel conduit and PVC conduit shall be manufactured within the United States.

L. All connections to motors or other vibrating equipment (except dry type transformers) or at other locations where required shall be made with not less than 12 inches no more than 20 inches of flexible liquid-tight steel conduit, using special type of connectors with strain relief fittings at both terminations of conduit. Flex connectors shall have insulated throat and shall be T & B 3100 Series or approved substitution. Use angle connectors wherever necessary to relieve angle strain on flex conduit. Connections to dry type transformers shall be made with flexible conduit. Typical length of flex conduit shall be limited to 20 inches unless specifically approved by the engineer.

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

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

O. Electric metallic tubing (thin wall) where installed inside air conditioned buildings above grade shall be joined with steel fittings and steel compression connectors.

P. Conduit installations on roofs shall be kept to a bare minimum. Where required, conduit shall be rigid aluminum conduit, including couplings. Conduit shall be supported above roof at least 6 inches using approved conduit supporting devices. Supports to be fastened to roof using roofing adhesive as approved by roofing contractor.

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

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

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

T. All conduit runs shall have (1) spare conduits installed in the run sized to match the largest conduit in the run.

END OF SECTION

SECTION 26_05_43

UNDERGROUND DUCTS AND DUCTBANKS

PART 1 GENERAL

1.01 GENERAL

A. Provide underground duct banks for power and lighting feeders; instrumentation and control systems as shown or as specified herein; from point of service switchgear or equipment to the point of distribution or equipment served.

1.02 SUBMITTALS

A. Submit Shop Drawings or cut sheets on:
   1. Conduit.
   2. Fittings.
   3. Conduit Separators.
   4. PVC solvent.
   5. Precast concrete manholes.
   6. Composite handholes.
   7. Cable lubricants.

1.03 DESCRIPTION OF ASSEMBLY

A. Underground ductbanks shall be multiple individual conduits encased in reinforced concrete as indicated on the Drawings. Conduits within building or structural foundations and protected by a concrete slab above them do not require encasement (except provide encasement or flowable fill under electrical and pump room slabs). The conduit shall be of plastic (PVC Schedule 40 for concrete encasement and Schedule 80 without concrete encasement), unless indicated or specified otherwise. The conduit used shall not be smaller than 4 inches in diameter, inside, unless otherwise noted. The concrete encasement surrounding the duct bank shall be rectangular in cross section, having a minimum concrete thickness of three inches around all conduits. All concrete encased duct banks shall be steel reinforced as detailed. Power distribution conduits shall be separated by a minimum dimension of four inches and not less than 7.5-inch center to center. Power conduits shall be separated from low voltage instrumentation & control conduits by a minimum dimension of 24 inches.

B. The concrete work shall conform to Section on "Concrete". The top of the concrete envelope shall be not less than 24 inches below grade unless otherwise indicated. Concrete shall be installed in a continuous pour to eliminate joints in the duct run. The ductbank sides shall be formed in place using suitable concrete formwork or corrugated metal forms. Open trench pours will not be allowed.

C. Plastic conduit, fittings and joints shall not have been stored in the sun or weather, in any excessively heated space, or unevenly supported during storage. Use and installation shall be in accordance with the National Electrical Code requirements for the installation of non-metallic rigid conduit. Plastic conduit shall be protected against the direct rays of the sun prior to installation. Conduit shall be PVC schedule 40 manufactured by Carlon, Queen City Plastics, or approved substitution. Conduit shall be U.L. listed and conform to NEMA Standards for schedule 40 PVC conduit.

D. Trenches for ductbanks shall be completely dry before setting conduits or pouring concrete. Provide well pointing as required if necessary to keep trench dry.

E. Wires and cables in manhole/handhole shall be placed on cable racks. Manhole/handhole shall be cleaned of all loose materials, dirt and debris immediately after completion of new work and shall be in a clean condition when Project is completed. Cable racks shall be stainless steel or nonmetallic with stainless steel hardware, cable racks shall be complete with insulators. Racks shall be Underground Devices or approved substitution.

F. Back filling of trenches shall be in layers not more than 8 inches deep, and shall be thoroughly tamped. The first layer shall be earth or sand, free from particles that would be retained on a 1/4 inch sieve. The succeeding layers shall be excavated material having stones no larger than would pass through a 4-inch ring. The back fill shall be level with adjacent surface, except that in sodded or paved areas, a space equal to the thickness of the sod or paving shall be left.

G. The surface disturbed during the installation of duct shall be restored to its original elevation and condition if not refinished in connection with Site Work.

H. All unused conduit openings shall be plugged or capped with a suitable device designed for the purpose; caulking compound shall not be used for plugging conduit openings.

I. One No. 2 bare solid tinned copper counterpoise shall be run above all duct banks and shall be run into all manholes/handholes and grounded to 5/8 inch by 20 foot driven ground rods. Counterpoise shall run into buildings and be grounded at each structures service ground.

J. All conduits entering a building or structure shall be sealed with duct seal.

PART 2 PRODUCTS

2.01 DUCT BANK STRUCTURES

A. Precast Concrete Construction: Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes and pullboxes.

1. General: Concrete for precast work shall have an ultimate 28-day compressive strength of not less than 4,000 psi. Structures may be precast to the design and details indicated precast monolithicly and placed as a unit, or structures may be assembled sections, design and produced by the manufacturer in accordance with the requirements specified. Structures shall be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.
2. Construction: Structure top, bottom and wall shall be of a uniform thickness of not less than 4 inches. Quantity, size, and location of ductbank entrance windows shall be as required, and cast completely open by the precaster. Size of windows shall exceed the nominal ductbank envelope dimensions by at least 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows shall be a minimum of 6 inches from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. The minimum concrete cover for reinforcing steel shall be 2 inches. Provide drain sumps for precast structures a minimum of 12 inches in diameter and 6 inches deep.
3. Joints: Provide tongue-and-groove or shiplap joints on mating edges of precast components. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to AASHTO M198, Type-B. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

B. Precast Concrete manholes and pullboxes (handholes): ASTM C478. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete manholes and pullboxes. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Metal Covers shall fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, shall be adequate to accommodate the cable.

C. Metal Frames and Covers: Shall be made of Aluminum. Covers shall have engineered lift assistance. Frames and covers of steel shall be welded by qualified welders in accordance with standard commercial practice. Covers shall have raised letters of identification as indicated on the drawings. Covers shall have an approved antislip surface. Covers shall be rated AASHTO H20.

D. Pulling-In Irons: Shall be steel bars bent cast in the walls and floors. In the floor they shall be centered under the cover and in the wall they shall be not less than 6 inches above or below, and opposite the conduits entering the manhole or pullbox. Pulling-in irons shall project into the box approximately 4 inches. Iron shall be hot-dipped galvanized after fabrication.

E. Cable Racks: Rack arms and insulators, shall be sufficient to accommodate the cables. Racks in manhole and pullbox shall be spaced not more than 2 feet apart, and each box wall shall be provided with a minimum of two racks. The wall bracket shall be stainless steel or fiberglass. Slots for mounting cable rack arms shall be spaced at 8-inch intervals. The cable rack arms shall be of stainless steel or fiberglass and shall be of removable type. Insulators shall be dry-process glazed porcelain. All metal fasteners and hardware portion of racks shall be stainless steel.

F. Grounding in manholes and pullboxes: Provide No. 6 AWG bare copper grounding pigtails on walls of each manhole and pullbox. The pigtails shall be exothermically welded to the reinforcing bars and shall extend at least 8 inches into box. Two pigtails shall be provided in each box.

G. Pull Wire: Plastic rope having a minimum tensile strength of 200 pounds in each empty duct. Leave a minimum of 24 inches of slack at each end of the pull wires.

H. Composite Handholes: Only where composite handholes are indicated on the drawings, use handholes, covers and boxes of polymer concrete as manufactured by Quazite Corporation. The material shall consist of aggregate bound together with a polyester resin and reinforced with continuous woven glass strands. The covers and boxes shall be designed to be installed flush to grade with cover fitting flush to the box and shall be capable of withstanding normal shipping and installation process without chipping, cracking or structural damage. All boxes shall be manufactured with the use of male/female molds to ensure a consistent wall thickness and structural strength and shall be stackable or extra depth. The boxes and covers shall have dimensions as indicated and shall be concrete gray in color. The cover logo shall be recessed into the cover and shall read INSTRUMENTATION or ELECTRIC as indicated. The composite covers shall be designed for a static vertical load of 8,000 pounds and shall be tested, in the box, to a static load of 12,000 pounds (1.5 safety factor). The test load shall be distributed over a 10 inch by 10 inch by 1 inch thick distribution plate located at the center of the cover. The maximum deflection at a load of 8,000 pounds shall not exceed 0.50 inches. The covers shall be skid resistant and have a minimum coefficient of friction of 0.50 on the top surface for the life of the cover. Coatings will not be provided. The permanent deflection of any surface shall not exceed 10 percent of the maximum allowable test load deflection. The lockdown mechanism shall be capable of withstanding a minimum torque of 30 foot-pounds. All inserts and fasteners shall be of stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION: CONFORM TO NFPA 70 AND ANSI C2.

A. The top of the conduit shall be not less than 24 inches below grade, for low voltage conduits and 48 inches for high voltage ducts. Run conduit in straight lines except where a change of direction is necessary. Provide not less than 3 inches clearance from the conduit to each side of the trench. A minimum clearance of 2-1/2 inches shall be provided between adjacent conduits. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 1/4 inch sieve.

B. Precast manhole and pullbox Installation: Commercial precast assembly shall be set on 6 inches of level, 90 percent compacted granular fill, 3/4-inch to 1-inch size, extending 12 inches beyond the manhole or pullbox on each side. Granular fill shall be compacted by a minimum of four passes with a plate type vibrator.

C. Buried Warning and Identification Tape: Metallic core or metallic-faced, acid-and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3-inch-minimum width, color coded as specified below for the intended utility and warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil.

Warning Tape Color Codes
Yellow or red: Electric power
Orange: Instrumentation and Control

D. Conduit Placement: Duct lines shall have a continuous slope downward toward manholes/handholes and away from buildings with a pitch of not less than 3 inches in 100 feet. Except at conduit risers, accomplish changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature of 25 feet. Manufactured bends may be made up or one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 18 inches for use with conduits of less than 3 inches in diameter and a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.

E. Termination and Cleaning of Conduit: Terminate conduits in end-bells where duct lines enter manholes and pullboxes. Separators shall be of precast concrete, high impact polystyrene, steel, or a combination of these. Stagger conduit joints by rows and layers to provide a duct line having the maximum strength. During construction, protect partially completed duct lines from the entrance of debris such as mud, sand, and dirt with suitable conduit plugs. As each section of a duct line is completed, draw a non-flexible testing mandrel not less than 12 inches long with a diameter 1/4 inch less than inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush having the same diameter of the duct through the duct, until duct is clear of particles of earth, sand, and gravel; then immediately install end plugs.

F. Conduit Protection at Concrete Penetrations: Conduits which penetrate concrete (slabs, pavement, and walls) shall be galvanized rigid steel; protected by a PVC sheath at the penetration; PVC sheath shall be 40-mils thick conforming to NEMA RN 1, and shall extend from at least 2 inches below the concrete to the first coupling or fitting outside the concrete (minimum of 6 inches above concrete).

G. Cable Pulling: Pull Cables down grade with the feed-in point at the manhole or pullbox or point of the highest elevation. Use flexible cable feeds to convey cables through box opening and into duct runs. Accumulate cable slack at each box where space permits by training cable around the interior to form one complete loop. Maintain minimum allowable bending radii in forming such loops.

H. Cable Lubricants: Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables. Cable lubricants shall be soapstone, graphite, or talc for rubber or plastic jacketed cables. Lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.

I. Cable Pulling Tensions: Tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer.

J. Installation of Cables in manholes and pullboxes and Handholes: Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators at a maximum of 18 inches. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space opening for future cables, except as otherwise indicated for existing installations.

K. Fireproofing of Cables in Manholes: All wire and cables in manholes shall be fireproofed. Strips of fireproofing tape approximately 1/16-inch thick by 3 inches wide shall be wrapped tightly around each cable spirally in one-half lapped wrapping, or in two butt-jointed wrappings with the second wrapping covering the joints in the first. The tape shall be applied with the coated side toward the cable, and shall extend one inch into the ducts. To prevent unraveling, the fireproofing (Arc-proofing) tape shall be random wrapped with tape conforming to type FGT of specification MIL-I-15126. The fireproofing (arc proofing) tape shall consist of a flexible, conformable fabric having one side coated with a flame-retardant, flexible, polymeric coating and/or a chlorinated elastomer. The tape shall not be less than 0.050 inch thick, and shall weigh not less than 2.5 pounds per square yard. The tape shall be non-corrosive to cable sheath, shall be self-extinguishing, and shall not support combustion. The tape shall not deteriorate when subjected to oil, water, gases, saltwater, sewage and fungus. The tape shall have a tensile strength of not less than 40 pounds per inch width, and when tested under USA Standard L14.184 cut strip method. Provide certification the product retains 65 percent of its original tensile strength for the following tests for 168 hours for each requirement;
    1. Immersion in distilled water,
    2. Immersion in 3 percent salt water,
    3. Exposure to ultra-violet light (30-watt germicidal lamp),
    4. Exposure to sunlight (Type S-1 sun lamp), and exposure to concentrated sewage.

END OF SECTION

SECTION 26_05_53

IDENTIFICATION OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 GENERAL

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

B. Related Work Specified in Other Sections Includes:
   1. Sections 26 05 02, Basic Electrical Materials and Methods; 26 08 00, Acceptance Testing Performance Verifications; 26 05 19, Low Voltage Wires and Cables; and Section 26 29 13, Control Panels.

1.02 REFERENCES:

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

1.03 SUBMITTALS: FURNISH ALL PRODUCT SUBMITTALS USED.

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

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

2.02 MATERIALS

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

B. Laminated Plastic Nameplates: Provide engraved three layer laminated plastic nameplates with black letters on white background with lettering etched through the outer covering and fastened with corrosion resistant pan head brass or stainless steel machine nuts and bolts. Do not use mounting cement for fastening nameplates.
   1. Provide nameplates with 1-inch high lettering for main breakers, automatic transfer switches, panelboards, transformers, VFD's, control panels and disconnect switches.
   2. Provide nameplates for each motor identifying service or function and lettering of an appropriate size to suit each motor. Submersible motor nameplates to be affixed to equipment disconnect.
   3. Provide approved directories of circuits with typewritten designations of each branch circuit in each panelboard.
   4. Provide smaller lettering for a neat, legible nameplate where the amount of lettering causes excessively large nameplates.

2.03 WIRE MARKERS: IDENTIFY WIRE BUNDLES AND EACH INDIVIDUAL WIRE

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

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

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

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

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

F. Manufacturers and Products:
   1. Sleeve: Raychem; Type D SCE or ZH SCE. Brady, Type 3PS.
   2. Heat Bond Marker: Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive. Self-laminating protective shield over text. Machine printed black text. Manufacturer 3M Co.; Type SCS HB.
   3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
   4. Tie-On Cable Marker Tags: Chemical-resistant white tag. Size: 1/2 inch by 2 inches. Manufacturer and Product: Raychem; Type CM SCE.

2.04 SAFETY SIGNS

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

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

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

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

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

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

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

H. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing, and with colors, legend, and size required for application and with 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

2.05 EQUIPMENT IDENTIFICATION LABELS

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

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

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

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

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

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

G. Multiple Power Supply Sign: Install permanent plaque or directory at each service disconnect location denoting other services, feeders, and branch circuits supplying equipment in building, and the area served by each.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Install laminated nameplates identifying, each electrical equipment enclosure and Individual equipment and devices. The following items shall be equipped with nameplates: All motors; motor starters, motor-control centers, pushbutton stations, control panels, time switches, disconnect switches panelboards, circuit breakers, contactors, recorders, transmitters, instruments or relays in separate enclosures, thermostats, photocells, power receptacles, switches controlling equipment or receptacles, switches controlling lighting fixtures where the fixtures are not located within the same space as the controlling switch, termination cabinets, manholes and pull boxes, instrumentation and control terminal cabinets, pull boxes manholes and cabinets. Special electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.

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

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

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

F. Label all disconnects with nameplates as well as the location from which they are fed.

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

H. Wire Markers: Identify each individual wire with identification tags as follows:
   1. Wire identification markers: Provide wire identification markers on each wire at all termination points.

I. On power and lighting circuits: The branch circuit or feeder number as indicated on drawings

J. On control circuits terminated in motor control centers, switchgears, control panels and alike: The field device and terminal number of the opposite end connection.

K. On control circuits at each field device: The panel or compartment number and terminal number of the opposite end connection.
   1. Provide oversize wire markers so that after heat shrinking the wire marker can be rotated on the wire. Rotate wire markers so that wire identification number is visible.
   2. All wires whether spare or used shall be tagged.
   3. Mark wire at both ends.

L. Raceway Tags:
   1. Provide raceway tags to identify origin and destination of conduit. Install tags at each terminus and at midpoint of run. Provide tags at minimum intervals of every 50 feet of above grade raceway except where concealed in walls. Provide two color hard plastic engraved tags and UV resistant cable ties for attachment.
   2. Tag numbers to match that submitted on approved conduit schedule.

M. Safety Signs: Provide safety signs as follows or as shown:
   1. Wording: "DANGER -ELECTRICAL EQUIPMENT, AUTHORIZED PERSONNEL ONLY" Location: On the outside door of all electrical equipment rooms or areas. On the outside door of all electrical equipment cabinets.
   2. Wording: "DANGER -POWERED FROM MORE THAN ONE SOURCE" Location: Outside all equipment that operates from more than one power source; ATS, PLCs, Main Tie Main switchgear/MCCs, etc.
   3. Wording: "NOTICE -KEEP DOOR CLOSED" Location: On all doors with another safety sign installed.
   4. Wording: "CAUTION -CONTROLS & INTERLOCKS POWERED FROM MULTIPLE SOURCES". Location: On all control panel doors, MCCs I&C terminal cabinets, etc.

N. Create and submit conduit schedule. Schedule to identify conduit tag numbers, the locations the conduit connects and the wire count.

END OF SECTION

SECTION 26_05_70

WIRING DEVICES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Work of this section shall consist of furnishing all labor, materials, and equipment necessary for installation of wiring devices and plates.

1.02 REFERENCES

A. The latest edition of the following codes or standards shall apply to the design and fabrication of the products and equipment to be supplied under this Contract.
   1. NEC (NFPA 70) National Electrical Code.
   2. NETA International Electrical Testing Association - Acceptance Testing specifications.
   3. NEMA 250 - Enclosure for Electrical Equipment (1,000 Volts Maximum).
   4. Local Building Codes and Standards.
   5. UL 1449 3rd edition Standard for Surge Protection Devices.
   6. UL 498 Standard for Safety Attachment Plugs and Receptacles.

1.03 SUBMITTALS

A. Shop Drawings: Complete catalog cuts of switches, receptacles, enclosures, covers, and appurtenances, marked to clearly identify proposed materials

B. Documentation showing that proposed materials comply with the requirements of NEC and U.L.

1.04 TESTING

A. Provide checkout, field, and functional testing of wiring devices in accordance with Section 26 05 11, Special Electrical Requirements.

B. Test each receptacle for polarity and ground integrity with a standard receptacle tester.

C. Test GFCI receptacle for correct tripping operation with tester.

PART 2 PRODUCTS

2.01 SNAP SWITCHES

A. Unless otherwise specified, each snap switch (flush tumbler-toggle) shall be of the Specification grade, heavy-duty type for mounting in a single-gang spacing, fully rated 20 amperes, minimum, at 120-277V ac, conforming to minimum requirements of the latest revision of the UL.

B. Switches shall operate in any position and shall be fully enclosed cup type with entire body molded phenolic or melamine. Fiber, paper of similar insulating material shall not be used for body or cover. Ivory color handles unless otherwise indicated on the drawings. Silver or silver alloy contacts. Brass contact arm.

C. Switches for hazardous locations shall be factory sealed, rated at 20 amperes, 120-277V ac, capable of controlling 100 percent tungsten filament, fluorescent and HID lamp loads.

2.02 RECEPTACLES

A. Industrial or Hospital Grade: receptacles shall be in accordance with NEMA Publications and UL Listings. Receptacles shall be rated for 125V ac, 20 amperes, shall be polarized 3 wire type for use with 3 wire cord with grounded lead and 1 designated stud shall be permanently grounded to the conduit system (NEMA 5-20R). Receptacles shall also be fire-resistant, with nylon top (face) and bodies and bases with metal plaster ears (integral with the supporting member).

B. Provide single or duplex receptacles as shown or noted on drawings, and ivory color unless otherwise noted, with triple wipe or equivalent brass alloy power contacts for each prong. Approved manufacturers are Hubbell, Cooper, Pass & Seymour, or Leviton.

C. All receptacles shall be grounding type with a green-colored hexagonal equipment ground screw of adequate size to accommodate an insulated grounding jumper in accordance with NEC, Article 250. Grounding terminals of all receptacles shall be internally connected to the receptacle mounting yoke.

D. GFCI: Ground-fault circuit interrupting receptacles (GFCI's) shall be installed at the locations indicated and as required by the NEC. GFCI's shall be duplex, Industrial or Hospital grade, tripping at 5 mA. Ratings shall be 125V, 20 amperes, NEMA WD-1, Configuration 5-20R, capable of interrupting 5,000 amperes without damage.

E. Provide GFCI receptacles where shown and as required. Feed-through type GFCI's serving standard receptacles will not be permitted.

F. Pedestal type boxes receptacles shall be cast iron 3/4 inch N.P.T. tapped flanged inlet; double gang, meeting UL Standard 514.

G. Special purpose receptacles shall have ratings and number of poles as indicated or required for anticipated purpose. Matching plug with cord-grip features shall be provided with each special-purpose receptacle.

H. Receptacles for hazardous locations shall be single gang receptacles with spring door. Receptacles shall have a factory sealed chamber. The receptacles shall have a delayed action feature requiring the plug to be inserted in the receptacle and rotated before the electrical connection is made. The receptacle shall not work with non-hazardous rated plugs. One plug shall be furnished with each receptacle. The receptacles shall be rated for 20 amps at 125V ac.

I. SPD Receptacles: Transient voltage surge suppressing receptacles provide with a filtering capacitor for 7 to 1 average noise reduction and Two way protection for line equipment. Response time less than 1 nanosecond for un-mounted Metal Oxide Varistor (MOV); Overcurrent protection; Thermal protection; Varistor with voltage capabilities of 150V RMS.

J. Outdoor mounted Receptacles shall be Corrosion-Resistant and shall in addition to meeting the requirements of general-purpose receptacle have Nickel coated metal parts. Manufacturer; Hubbell Bryant; 20A rated HBL53CM62 Series or equal.

2.03 SWITCH, MOTOR RATED

A. Two-pole or three-pole, manual motor starting/disconnect switch without overload protection. UL 508 listed. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts. Minimum General Purpose Rating: 30 amperes, 600V ac. Manufacturer: Cooper Arrow Hart; Hubbell Bryant: HBL78 Series; Leviton.

2.04 PLUG CAPS & CORDS

A. Provide and install a matching plug cap and properly sized cord for equipment items noted on the Drawings.

2.05 DEVICE PLATES

A. Provide device plates for each switch, receptacle, signal and telephone outlet, and special purpose outlet. Do not use sectional gang plates for multi-gang boxes.

B. All Plates shall be of stainless steel except provided cast covers for cast boxes.

C. Coverplates for exterior GFCI receptacles shall be cast.

PART 3 EXECUTION

3.01 GENERAL

A. Perform work in accordance with the National Electrical Code.

3.02 CONNECTION

A. Rigidly attach wiring devices in accordance with National Electrical Code. Coordinate installation avoiding interference with other equipment.

3.03 GROUNDING

A. Ground all devices, including switches and receptacles, in accordance with NEC, ART 250.

B. Ground switches and associated metal plates through switch mounting yoke, outlet box, and raceway system.

C. Ground flush receptacles and their metal plates through grounding jumper connections to outlet box and grounding system.

END OF SECTION

SECTION 26_05_73

SHORT CIRCUIT AND COORDINATION STUDY AND ARC FAULT HAZARD ANALYSIS

PART 1 GENERAL

1.01 GENERAL SCOPE

A. Provide the services of a recognized corporately and financially independent firm for the purpose of performing electrical studies and reports on all new electrical equipment supplied in this contract and on existing equipment as herein specified. It is the intent of these Specifications that the study firm work in direct communication with the engineer of record with frequent updates as the work progresses. The study firm shall provide all material, equipment, labor and technical supervision required to perform the studies and reports.

B. Provide a short circuit, coordination and arc-flash study for entire electrical system. Provide a single final electrical study report incorporating the short circuit, coordination and arc flash study. The final document shall become part of the operation and maintenance manuals for the facility. The report shall be submitted on 8.5-inch by 11-inch paper bound with all field data in appendix form. Drawings within the testing report shall be on 11-inch by 17-inch paper folded to 8.5-inch by 11-inch and drawn with a computer aided design (CAD) package. The computer aided design package shall be Autocad or converted to Autocad. All adjustable breakers shall be fitted with a sticker indicating the coordination values for the equipment.

C. Provide a short circuit, coordination and arc-flash study from the Generator AND Utility Service primary OCP to all points downstream. Provide system studies in latest release of SKM Power Systems software, using 2018 IEEE 1584 Calculation methodolgy. Provide CD-Rom electronic version of SKM Power Systems software data files bound in study report for future use by Owner. The electrical system studies shall be signed and sealed by a Florida registered electrical engineer. All documentation and record drawings shall be verified by the signing engineer. The signing engineer shall meet at the Site with the electrical design Engineer during the information gathering phase and after system evaluation to discuss remedial changes necessary for code compliance. The remedial work study changes shall be incorporated within the electrical studies at no additional cost to the Owner.

1.02 APPLICABLE CODES, STANDARDS, AND REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
   2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
   4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.

5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):
1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents.

C. The National Fire Protection Association (NFPA:
1. NFPA 70 - National Electrical Code, latest edition adopted by Florida Building Code.
2. NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition.

1.03 QUALIFICATIONS

A. The study firm shall be regularly engaged in the study of electrical equipment devices, installations, and systems. The lead, technical person shall be a electrical professional engineer in the state of Florida. The study firm shall provide in house electrical studies and reports as specified. The study firm shall submit proof of 5 similar studies with the above qualifications when requested. At least two of the similar project examples shall include arc flash studies with variable frequency drives.

B. Pre-qualified study firms are:
1. Emerson Electrical Reliability Services, Inc. (239)-693-7100.
2. Industrial Electrical Testing, Inc. (904) 260-8378.
3. Expert Power Solutions, (239) 789-5458.

C. Other firms will be considered by the engineer on submittal of qualifications on or before 20 days prior to Bid.

PART 2 PRODUCT

2.01 SHORT-CIRCUIT ANALYSIS AND COORDINATION STUDY FOR ALL NEW ELECTRICAL EQUIPMENT

A. Provide an integrated complete study for the total electrical system.
   1. Data Collection: Study Firm shall furnish all field data as required by the power system studies. All data shall be verified on site by the signing engineer. The study firm shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
   2. Data my require combination to include present and future utility supplies, motors, and generators.
   3. Load data utilized may include existing and proposed loads obtained from Contract Documents and site visits.
   4. Include fault contribution of existing motors in the study, with motors < 10 hp grouped together. The testing firm shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

B. Provide a current and complete short-circuit study, equipment interrupting or withstand evaluation, and a protective device coordination study for the electrical distribution system.
   1. The studies shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.
   2. The studies shall be submitted to the project electrical engineer prior to granting final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture.
   3. The study shall be in accordance with applicable ANSI and IEEE Standards. The study input shall include the utility company's short circuit single and three phase contribution, with the X/R ratio, the resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and all other applicable circuit parameters.
   4. Short circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
   5. An equipment evaluation study shall be performed to determine the adequacy of new and existing circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the available fault currents. Any problem areas or inadequacies in the existing equipment shall be documented back to the project engineer with recommended remedial actions. The study firm shall coordinate with the supplier of the new equipment to assure all specifications of the new equipment meet or exceed the ratings required by the study at no additional cost to the owner.

6. A protective device coordination study shall be performed to select or to check the selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and settings. The coordination study shall include all voltage classes of equipment from the utility's incoming line protective device down to and including each motor control center and/or panelboard. The phase and ground overcurrent protection shall be included, as well as settings for all other adjustable protective devices.
7. The time current characteristics of the specified protective devices shall be plotted on appropriate log-log paper. The plots shall include complete titles, representative one-line diagram and legends, associated power company's relays of fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves, and fuse curves. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, ANSI transformer magnetizing inrush and withstand curves per ANSI C37.91, cable damage curves, symmetrical and asymmetrical fault currents. All requirements of the current National Electric Code shall be adhered to. Reasonable coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a complete system basis. Sufficient curves shall be used to clearly indicate the coordination achieved to each utility main breaker, primary feeder breaker, unit substation primary protective device rated or more. There shall be a maximum of four protective devices per plot.
8. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. A tabulation of the recommended power fuse selection shall be provided for all fuses in the system. Discrepancies, problem areas, or inadequacies shall be coordinated with the equipment suppliers and resolved within the scope of the Project and at no additional cost to the Owner.

C. The results of the power system study shall be summarized in a final report and made part of the operation and maintenance manuals. The report shall include the following sections:
   1. Description, purpose, basis written scope, and a single line diagram of the portion of the power system which is included within the scope of study.
   2. Tabulations of circuit breaker, fuse and other equipment ratings versus calculated short circuit duties, and commentary regarding same.
   3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection and commentary regarding same.
   4. Fault current tabulations including a definition of terms and a guide for interpretation.

D. The Contractor's certified study firm shall be responsible for setting the breakers. Each breaker shall be fitted with an engraved tag or permanent vinyl label indicating the breaker name and the settings listed:
   1. Adjustable pickups and time delays (long time, short time, ground); Adjustable time-current characteristic; Adjustable instantaneous pickup; Recommendations shall incorporate revised settings to mitigate excessive arc flash hazard.

2.02 ARC FLASH EVALUATION

A. Provide an investigation to quantify the arc-flash hazard to which workers could be exposed to throughout the facility. Establish arc-flash intensity data for all electrical equipment where there may be an occasion to open doors, remove covers or work on the electrical equipment in such a way that workers are exposed to energized conductors.

B. Provide a safety policy to include procedures and information regarding the arc flash data developed for the Site. Provide a written recommendation for PPE equipment. The Site safety manual to include procedures and methods related to energized work, PPE standards, and the arc-flash data developed in the analysis.

C. Provide arc flash evaluations in conformance to IEEE Std. 1584-2018 *IEEE Guide for Performing Arc-Flash Hazard Calculations* and NFPA 70-2020 (NEC) and NFPA 70E-2021 *Standard for Electrical Safety in the Workplace.* The arc flash study shall be performed using computer software that uses methods based on IEEE Std. 1584-2018. The software used must be capable of modeling all protective devices at the Site and any mitigation devices used to limit the incident energy. The software used must have the capability of modeling user defined PPE descriptions and ATPV values as well as limiting the maximum clearing time where engineering judgment deems it prudent.

D. The study firm shall collect all data required for the arc flash evaluation. The existing settings and equipment types and ratings shall be field verified. Any data that should be determined to be unverifiable (due to safety or operational concern) shall be identified to the engineer and alternate means to determine the data shall be used.

E. Where the calculations determine that the breaker settings result in arc flash hazard with incident energy levels (>40 cal/cm^2), the study engineer shall provide recommended breaker settings or other mitigation recommendations to reduce the incident energy to the lowest level and where energized work is capable of being performed. The study firm shall document the recommended changes and provide time-current curves indicating the coordination that reflects the recommended settings. Where main switchgear incorporates fully compartmentalized breakers and insulated bus, analyze utility main and genset main breaker compartments separate from feeder breaker compartments.

F. Provide color coded labels per ANSI Z535.4; Yellow=Caution, Orange=Warning, Red=Danger. Use orange “Warning” labels for incident energy levels below 1.2cal/cm^2. Provide equipment with incident energy level equal to 1.2cal/cm^2 up to 12cal/cm^2 with Orange “Warning” Labels. Provide Orange “Warning” labels for incident energy levels greater then 12cal/cm^2 up to 40cal/cm^2. Provide Red “Danger” labels with the words “Energized Work Prohibited” in areas of extreme hazard above 40cal/cm2. Provide labels as approved by the engineer consistent with utility standards.

G. Provide permanent labels for each electrical enclosure or equipment where workers could be exposed to energized conductors and where required by NEC. Provide die-cut 4-inch by 6-inch labels with preprinted headers. Organize safety information in approved order to communicate quickly, clearly and accurately. Provide Die-cut labels made from industrial grade indoor/outdoor vinyl, providing a long label life. Labels shall not include study firm information. Label layout shall be approved by the Project Engineer. Provide yellow Caution; orange Warning and red Danger labels for category zero, 1-3, 4 and above incident energy categories. Study firm shall supervise installation of labels and provide a statement in the project report that the labels are approved as installed. These labels shall comply with the requirements of NFPA 70E-2018 and include at least the following information:
   1. Voltage (phase to phase).
   2. Arc Flash Boundary (inches).
   3. Incident Energy at the working distance (cal/cm^2) OR working distance and PPE Category and Description (Including glove rating) NOT BOTH.
   4. Restricted Approach Boundary (inches).
   5. Limited Shock Approach Boundary (inches).
   6. Location Identification.

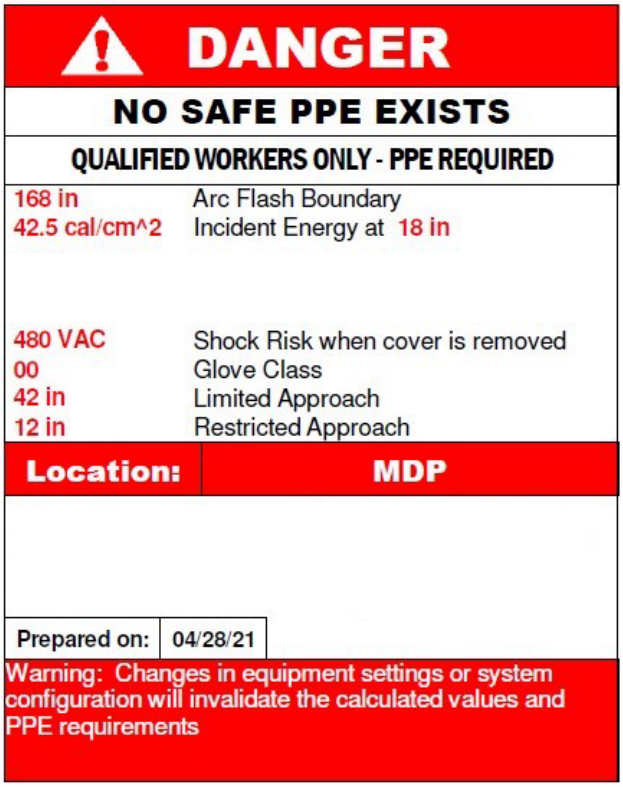
H. Provide a comprehensive report that includes the basis for and results of numerical assessments. The report shall include any significant conclusions and recommendations for corrective or mitigative action as appropriate. In addition, the report shall include the following:
   1. Summary of Project.
   2. Description of system and equipment included in the assessment.
   3. Identification of the methods or software used.
   4. Date Work was performed.
   5. Identification of the person that performed the assessment.
   6. Tabular data indicating; the incident energy and required PPE for all locations evaluated.
   7. Detailed datasheets for each location studied.
   8. Tabular data of recommended settings changes.
   9. Time-current curves for the locations with recommended settings changes.
   10. A one-line diagram of the computer model.

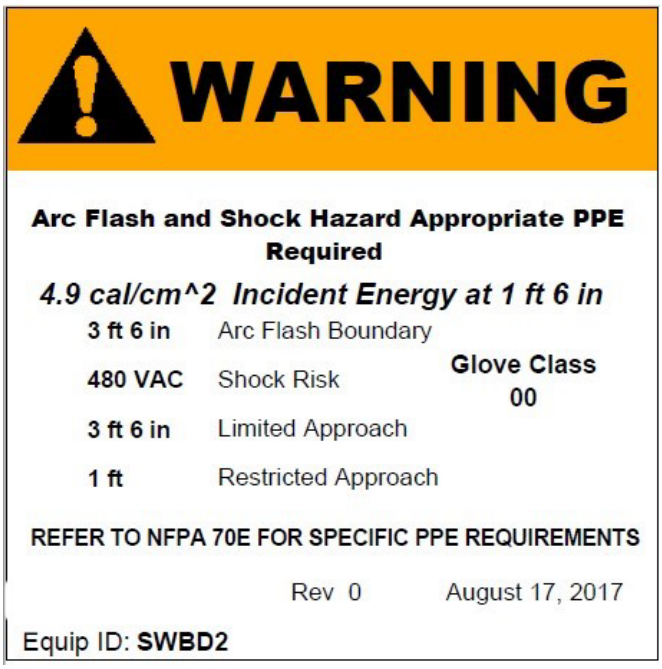
I. Provide all arc flash hazard tables within the report for all possible scenarios. Provide Arc Flash Labels for the worst case and highest hazard rating for each piece of equipment from any of the possible scenarios. Additionally provide the best case and lowest hazard rating informational CAUTION label adjacent to the worst case hazard label. Provide HRC tables for the following scenarios:
   1. Utility main breaker closed in open transition; normal operation.
   2. Generator breakers closed in open transition; normal operation with two generators paralleled.

3. Generator breaker closed in open transition; normal operation with one generator.
4. During 100msec closed transition with Utility and Generator mains closed. Assume second genset paralleled with the other genset of like kind and with Utility.
5. Utility man breaker closed in open transition with the generators locked out and the arc flash maintenance mode operational.
6. Generator breaker closed in open transition with the utility main breaker locked out and the arc flash maintenance mode operational.
7. Switchgear tie breaker closed and one bus utility and standby main breakers open and locked out.
8. Provide additional scenarios as may become evident during the study report.

2.03 SAMPLE LABELS.

A. Sample Arc Flash Label:





B. Sample Informational Labels:

CAUTION

Arc Flash Hazard is
Reduced to Category-X when Generator Source is locked out from operation.

CAUTION

Arc Flash Hazard is Reduced to Category-X when Generator Source is locked out and Switchgear Arc Flash Maintenance Mode is Active.

END OF SECTION

SECTION 26_08_00

ACCEPTANCE TESTING AND PERFORMANCE VERIFICATION

PART 1 GENERAL

1.01 GENERAL SCOPE

A. The Contractor shall engage the services of a recognized corporately and financially independent testing firm for the purpose of performing inspections and tests on all new electrical equipment supplied in this contract and on existing modified equipment as herein specified. All tests shall be documented.

B. It is the intent of these Specifications that the testing firm work in direct communication with the engineer of record with frequent testing data updates as the work progresses. Submit draft test reports of work in progress at a minimum 48 hours after test is completed and PRIOR to energizing of any equipment for testing or start-up.

C. The testing firm shall provide all material, equipment, labor and technical supervision to perform such tests and inspections. Testing shall be supervised by qualified professional engineering staff.

D. It is the purpose of these tests to assure that all tested electrical equipment, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications. Tests shall be performed with and in cooperation with certification tests performed by switchgear and generator manufacturer. The testing contractor shall be an integral part in assuring the coordinated testing and startup of the power system. The tests and inspections shall determine suitability for energization.

E. An itemized description of existing equipment to be inspected and tested is as follows:
    a. Provide testing of existing feeders that are relocated, extended or disturbed in any way.
    b. Provide testing of existing breakers that are re-fed, relocated, re-cabled or disturbed in any way.

F. The above electrical testing shall be used in the development of the final testing report encompassing all new and existing electrical equipment; submitted with the operation and maintenance manuals prior to substantial completion of the project. The testing report shall be submitted on 8.5-inch by 11-inch paper bound with all field test data in appendix form plus an electronic copy in Adobe PDF format. All tested breakers shall be fitted with a sticker indicating the testing firm, date and technician performing the test.

1.02 APPLICABLE CODES, STANDARDS, AND REFERENCES

A. All inspections and test shall be in accordance with the following codes and standards except as provided otherwise herein:
   1. National Electrical Manufacturer's Association – NEMA.
   2. American Society for Testing and Materials – ASTM.
   3. Institute of Electrical and Electronic Engineers – IEEE.
   4. International Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1991.
   5. American National Standards Institute - ANSI C2: National Electrical Safety Code.
   6. State and local codes and ordinances.
   7. Insulated Cable Engineers Association – ICEA.
   8. Association of Edison Illuminating Companies – AEIC.
   9. Occupational Safety and Health Administration – OSHA.
   10. National Fire Protection Association – NFPA.
      a. ANSI/NFPA 70: National Electrical Code.
      b. ANSI/NFPA 70B: Electrical Equipment Maintenance.
      c. NFPA70E: Standard for Electrical Safety in the Workplace.
      d. ANSI/NFPA 780: Lightning Protection Code.
      e. ANSI/NFPA 101: Life Safety Code.

B. All inspections and test shall utilize the following references:
   1. Project design Specifications.
   2. Project design Drawings.
   3. Manufacturer's instruction manuals applicable to each particular apparatus.

1.03 QUALIFICATIONS OF TESTING FIRM

A. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, supplier, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the International Electrical Testing Association (NETA).

D. The lead, on-site, technical person shall be currently certified by the International Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing or be a electrical professional engineer in the state of Florida.

E. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing services. The testing firm shall provide in house electrical studies and reports as specified. The testing firm shall have a Florida registered professional electrical engineer on staff.

F. The testing firm shall submit proof of the above qualifications when requested. Pre-qualified testing firms for this Project are:
   1. Emerson Electrical Reliability Services, Inc.
   2. Industrial Electrical Testing, Inc.
   3. Circuit Breaker Sales & Service.

G. Other firms will be considered by the engineer on submittal of qualifications on or before 20 days prior to Bid.

1.04 DIVISION OF RESPONSIBILITY

A. The Contractor shall perform routine insulation-resistance, continuity, and rotation test for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.

B. The Contractor shall supply a suitable and stable source of electrical power to each test Site.

C. The Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling. However the testing firm shall visit the Site a minimum of once a week to perform coordination duties required and make reports to the engineer of the installation progress.

D. The testing firm shall notify the engineer prior to commencement of any testing.

E. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported to the Engineer.

F. The testing firm shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

G. Safety and Precautions:
   1. Safety practices shall include, but are not limited to, the following requirements:
      a. Occupational Safety and Health Act.
      b. Accident Prevention Manual for Industrial Operations, National Safety council.
      c. Applicable state and local safety operating procedures.
      d. Owner's safety practices.
      e. National Fire Protection Association - NFPA 70E-2009.
      f. American National Standards for Personnel Protection.
   2. All test shall be performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.
   3. The testing firm shall have a designated safety representative on the project to supervise the testing operations with respect to safety.

1.05 SUITABILITY OF TEST EQUIPMENT

A. All test equipment shall be in good mechanical and electrical condition.

B. Digital multimeters used shall be RMS sensing when the variable be measured contains harmonics or dc offset or any deviation from a pure sine wave. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of 2 percent of the scale used.

PART 2 INSPECTION AND TEST PROCEDURES

2.01 SWITCHGEAR AND SWITCHBOARD ASSEMBLIES

A. Visual and Mechanical Inspection:
   1. Inspect for physical, electrical, and mechanical condition.
   2. Compare equipment nameplate information with latest one-line diagram.
   3. Check for proper anchorage, required are clearances, physical damage and proper alignment.
   4. Inspect all doors, panels, and sections for paint, dents, scratches, fit and missing hardware.
   5. Verify that fuse and/or circuit breaker sizes and types correspond to Drawings.
   6. Verify that current and potential transformer ratios correspond to drawings. Inspect all bus connections for high resistance.
   7. Check tightness of bolted bus joints by using a calibrated torque wrench. Refer to manufacturer's instructions for proper torque levels. Inspect shipping splits for mechanical connection assuring adequate surface contact.
   8. Test all electrical and mechanical interlock systems for proper operation and sequencing. Closure attempt shall be made on locked open devices. Opening attempt shall be made on locked closed devices. Key exchange shall be made with devices operated in off normal positions.
   9. Clean entire switchgear using manufacturer's approved methods and materials.
   10. Inspect insulators for evidence of physical damage or contaminated surfaces.
   11. Verify proper barrier and shutter installation and operation.
   12. Lubrication: Verify appropriate contact lubricant on moving current carrying parts. Verify appropriate lubrication on moving and sliding surfaces.
   13. Exercise all active components.
   14. Inspect all mechanical indicating devices for proper operation.

B. Electrical Tests:
   1. Perform tests on all instrument transformers.
   2. Perform ground resistance tests.
   3. Perform insulation resistance on each bus section, phase-to-phase and phase-to-ground for three (3) minutes. Test voltages and minimum resistances shall be in accordance with NETA recommendations.
   4. Perform low ohm resistance test on ground bonding & shipping splits with ductor tester (Digital low ohm resistance meter) to insure connection is a low resistance connection. Test from one fixed bus to adjacent fixed bus through the shipping split connector to measure both connection points. Microhm values shall not vary more than 50 percent from other phase readings and meet the manufactures published data based on bus size, ampacities and material.

5. Perform an overpotential test on each bus section, each phase-to-ground, for three (3) minutes at values indicated in ANSI/IEEE C37.20.2. or manufacturer's recommended potential.
6. Perform insulation-resistance test on control wiring except where connected to solid state components.
7. Perform control wiring performance test. Use the elementary diagrams of the switchgear to identify each remote control and protective device. Conduct tests to verify satisfactory performance of each control feature.
8. Perform secondary voltage energization test on all control power circuits and potential circuits as detailed in this specification. Check voltages levels at each point on terminal boards and at each terminal on devices.
9. Perform current injection tests on the entire current circuit in each section of switchgear. Perform current test by primary injection where possible; secondary injection if not.
10. Determine accuracy of all meters and calibrate watt-hour meters. Verify multipliers.
11. Perform phasing check on double-ended switchgear to ensure proper bus phasing from each source.
12. Control Power Transformers - Dry Type:
    a. Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
    b. Verify proper primary and secondary fuse ratings or circuit breakers.
    c. Verify proper interlock function and contact operation.
    d. Perform insulation-resistance test. Perform measurements from winding-to-winding and windings-to-ground.
    e. Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to proper secondary voltage. Check potential at all devices. Verify proper secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
13. Potential Transformer Circuits:
    a. Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to proper secondary voltage. Check for proper potential at all devices.
    b. Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

C. Test Values: Verify Bolt-torque values, Insulation resistance, overpotential levels in conformance to NETA standards or specified by manufacturer.

2.02 CABLES - LOW VOLTAGE - 600V MAXIMUM (ALL CABLES EXCEPT 20 AND 30AMP LIGHTING AND RECEPTACLE CIRCUITS).

A. Visual and Mechanical Inspection:
    1. Inspect cables for physical damage and proper connection in accordance with Drawings.
    2. Test cable mechanical connections to manufacturer's recommended values or NETA Standards using a calibrated torque wrench.
    3. Check cable color coding with applicable engineer's specifications and National Electrical Code standards.

B. Electrical Tests:
   1. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1,000-volts dc for 3 minutes.
   2. Perform continuity test to insure proper cable connection.
   3. Test Values; Evaluate results by comparison with cables of same length and type. Minimum acceptable value shall be no less than 50 megohms for new feeders; 5megohms for existing reused, renovated, rerouted or extended feeders.

2.03 CIRCUIT BREAKERS (ALL BREAKERS EXCEPT 20AMP LIGHTING AND RECEPTACLE BREAKERS; TEST ALL GFCI BREAKERS)

A. Circuit Breakers - Low Voltage insulated case/molded case:
   1. Visual and Mechanical Inspection:
      a. Check circuit breaker for proper mounting and compare nameplate data to drawings and specifications.
      b. Operate circuit breaker to ensure smooth operation.
      c. Inspect case for cracks or other defects.
      d. Check tightness of connections using calibrated torque wrench. Refer to manufacturer's instructions or NETA standards for proper torque levels.
   2. Electrical Tests:
      a. Perform a contact-resistance test.
      b. Perform an insulation-resistance test at 1,000-volts dc from pole to pole and from each pole to ground with breaker closed and across open contacts of each phase.
      c. Determine long-time minimum pickup current by primary current injection where practical.
      d. Perform long-time delay time-current characteristic tests by passing three hundred percent (300%) rated current through each pole separately. Record trip time.
      e. Determine short-time pickup and delay by primary current injection, if applicable.
      f. Determine ground-fault pickup and time delay by primary current injection, if applicable.
      g. Determine instantaneous pickup current by primary injection using run-up or pulse method.
   3. Test Values:
      a. Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%). Investigate any value exceeding manufacturer's recommendations.
      b. Insulation resistance shall not be less than 100 megohms.
      c. Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
      d. All trip times shall fall within NETA Standards. Circuit breakers exceeding specified trip time at three hundred percent (300%) of pickup shall be tagged defective.
      e. Instantaneous pickup values shall be within NETA standards.

2.04 METERING AND INSTRUMENTATION

A. Visual and Mechanical Inspection:
   1. Examine all devices for broken parts, shipping damage and tightness of connections.
   2. Verify that meter types, scales and connections are in accordance with Drawings and Specifications.

B. Electrical Tests:
   1. Determine accuracy of meters at 25/50/75/100 percent of full scale.
   2. Calibrate watt-hour meters to one-half percent (0.5%).
   3. Verify all instrument multipliers.
   4. Verify calibration of all instrumentation is accurate to the operator interface terminals.

2.05 GROUNDING SYSTEMS: (PROVIDE FOR NEW AND UPGRADED GROUNDING SYSTEMS)

A. Visual and Mechanical Inspection:

B. Inspect ground systems for compliance with Drawings and Specifications.

C. Perform ground-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System." Instrumentation utilized shall be as Approved by NETA Standards and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten. In large ground grid systems where adequate pole distance is not practical provide Tagg Slope technique or the intersecting curves method (Ref. Nos. 40 and 41 in IEEE Std. 81.) of calculating system resistance.

D. Equipment Grounds: Utilize two-point method of IEEE Standard 81. Measure between equipment ground being tested and known low-impedance grounding electrode of system:
   1. Lightning protection ground system test values within the ground system should be 5 ohms or less tested with a clamp on ground test instrument. Down conductor tests at grade level should be 2 ohms or less. Investigate high resistance connections and correct readings above these limits.
   2. The main ground electrode system impedance-to-ground should be no greater than one (1) ohms. Equipment grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.

2.06 GROUND-FAULT SYSTEMS

A. Visual and Mechanical Inspection:
   1. Inspect for physical damage and compliance with Drawings and Specifications.
   2. Inspect neutral main bonding connection to assure:
      a. Zero-sequence sensing system is grounded.
      b. Ground-strap sensing systems are grounded through sensing device.

c. Ground connection is made ahead of neutral disconnect link on zero-sequence sensing systems.
d. Grounded conductor (neutral) is solidly grounded.

3. Inspect control power transformer to ensure adequate capacity for system.
4. Manually operate monitor panels (if present) for: Trip test; No trip test; Non-automatic reset.
5. Record proper operation and test sequence.
6. Set pick-up and time-delay settings in accordance with the settings provided by the manufacturer.

B. Electrical Tests:
1. Measure system neutral insulation resistance to ensure no shunt ground paths exist. Remove neutral-ground disconnect link. Measure neutral insulation resistance and replace link.
2. Determine the relay pickup current by current injection at the sensor and operate the circuit interrupting device.
3. Test the relay timing by injecting three hundred percent (300%) of pickup current, or as specified by manufacturer.
4. Test the system operation at fifty-seven percent (57%) rated control voltage, if applicable.
5. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.
6. On multiple source, tie breaker, etc., systems, devise a simulation scheme that fully proves correct operation.

C. Test Parameter:
1. System neutral insulation shall be a minimum of one hundred (100) ohms, preferable one (1) megohm or greater.
2. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves but in no case longer than one (1) second for fault currents equal to or greater than 3,000 amperes.
3. Relay pickup value shall be within 10 percent of setting and in no case greater than 1,200A.

2.07 MOTORS (1 HP AND GREATER)

A. Visual and Mechanical Inspection:
1. Inspect for physical damage.
2. Inspect for proper anchorage, mounting, grounding, connection and lubrication.
3. When applicable, perform special tests as air gap spacing and pedestal alignment.

B. Electrical Tests - Induction Motors:
1. Perform insulation resistance tests in accordance with ANSI/IEEE Standard 43.
2. Motors 200 hp and Less - Test duration shall be for one minute with resistances tabulated at 30 and 60 seconds and calculate the dielectric absorption ratio. Motors larger than 200 hp perform tests for ten minutes and calculate polarization index. Minimum acceptable polarization index for Class B or F insulated motors shall be 2.0.

3. Perform insulation resistance test on pedestal per manufacturer instructions.
4. Perform insulation resistance test on surge protection device in accordance with this Specification.
5. Check that the motor space heater circuit is in proper operating conduction.
6. Check all protective devices in accordance with other sections of these Specifications.
7. Perform a rotation test to ensure proper shaft direction if the motor has been disconnected.
8. Measure running current and evaluate relative to load conditions and nameplate full load amperes. Verify proper overload relays.

2.08 MOTOR CONTROL (ALL MOTORS)

A. Visual and Mechanical Inspection:
   1. Inspect for physical damage, proper anchorage, and grounding.
   2. Inspect equipment for compliance with drawings and specifications.
   3. Motor-running protection
      a. Compare overload heater rating with motor full-load current rating to verify proper sizing.
      b. If motor-running protection is provided by fuses, verify proper rating considering motor characteristics and power-factor correction capacitors if applicable. Check tightness of bolted connections using calibrated torque wrench.

B. Electrical Tests:
   1. Insulation tests:
      a. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground for three (3) minutes. Test voltage shall be in accordance with NETA Standards.
      b. Measure insulation resistance of each starter section phase-to-phase and phase-to-ground with the starter contacts closed and the protective device open. Test voltage shall be in accordance with NETA Standards.
      c. Measure insulation resistance of each control circuit with respect to ground.
   2. Test motor overload units by injecting current through overload unit and monitoring trip time at three hundred percent (300%) of motor full-load current.
   3. Three phase power unbalance: Run motor at full load steady state conditions and take current readings on all three leads. Roll the motor leads maintaining the proper rotation and take motor current readings on all three possible hook-ups. Choose the least unbalance hookup for each motor. The maximum acceptable unbalance is 10 percent at full load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If on the three possible hook ups, the leg of "greatest unbalance" (furthest from the average) stays on the same power lead then most of the unbalance is being caused by the power source. However, if the leg of greatest unbalance moves on each of the hookups with a particular motor lead, the primary source of unbalance is on the motor side of the starter. Check for damaged cable, leaking splices, poor connections, or faulty motor winding.

2.09 TRANSFORMERS - DRY TYPE TRANSFORMERS - SMALL DRY TYPE, AIR-COOLED (600 VOLT AND BELOW)

A. Inspect for physical damage, broken insulation, tightness of connections, defective wiring, and general condition.

B. Thoroughly clean unit prior to making any tests.

C. Perform insulation-resistance test. Perform test verification for impedance.

D. Energize primary winding with system voltage. Measure secondary voltage with the secondary load disconnected. Record results.

2.10 THERMOGRAPHIC SURVEY (PROVIDE FOR ALL NEW OR MODIFIED SWITCHGEAR, BUS DUCTS, TRANSFORMERS, POINTS OF POWER CONNECTION EQUAL TO OR GREATER THAN 30AMPS, MCC'S AND DISTRIBUTION CENTERS)

A. Visual and Mechanical:
   1. Remove all necessary covers prior to scanning.
   2. Inspect for physical, electrical, and mechanical condition.

B. Equipment to be Scanned:
   1. All new and existing equipment with ratings of 30 amps or more.

C. Provide report indicating the following:
   1. Problem area (location of "hot spot").
   2. Temperature rise between "hot spot" and normal or reference area.
   3. Cause of heat rise.
   4. Phase unbalance, if present.
   5. Areas scanned.

D. Test Parameters:
   1. Scanning distribution system with ability to detect 1^{o}C between subject area and reference at 30^{o}C.
   2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
   3. Infrared surveys should be performed during periods of maximum possible loading but not less than twenty percent (20%) of rated load of the electrical equipment being inspected.
   4. Provide photographs and/or the thermogram of the deficient area as seem on the imaging system.

2.11 LOW VOLTAGE SURGE SUPPRESSORS

A. Visual and Mechanical Inspection:
   1. Verify suppressors are installed with minimum length leads to the protected equipment. Verify connections to bus.
   2. Verify ground connections to ground bus.

B. Electrical Tests:

1. Test clamping voltage and verify meets specified ratings; test in accordance with ANSI C62.33 section 4.4 and 4.7.

2.12 LOW VOLTAGE AIR SWITCHES (DISCONNECT SWITCHES, MANUAL AND AUTOMATIC TRANSFER SWITCHES)

A. Visual and Mechanical Inspection:
   1. Compare equipment nameplate data with drawings and specs.
   2. Inspection for mechanical and physical damage. Cleaning of interior, insulators, arc chutes.
   3. Testing of mechanical operator. Cleaning and lubrication of contacts and mechanism, as applicable.
   4. Verification of contact alignment and wipe. Verify phase barrier insulation.
   5. Inspect anchorage, alignment, grounding, and required clearances.
   6. Documentation of fuse and types are in accordance with drawings, short circuit studies and coordination study.
   7. Verification of tightness of accessible bolted electrical connections by calibrated torque-wrench method.
   8. Verification of presence of expulsion-limiting devices on all holders having expulsion-type elements.
   9. Verification of interlocking systems for proper operation and sequencing.
   10. Verify proper lubrication on current carrying and moving sliding parts.

B. Electrical Tests:
   1. Contact resistance testing across each switch blade and fuse holder.
   2. Measurement of fuse resistance.
   3. Insulation resistance testing on each pole, phase-to-phase and phase-to-ground with switch closed and across each open pole for one minute.
   4. ac or dc overpotential testing phase-to-phase and phase-to-ground.
   5. Verification of proper space heater operation.

2.13 ADJUSTABLE-SPEED DRIVE SYSTEMS

A. Visual and Mechanical Inspection:
   1. Inspect physical and mechanical condition.
   2. Inspect anchorage, alignment, and grounding.
   3. Prior to cleaning the unit, perform as-found tests.
   4. Clean the unit.
   5. Ensure vent path openings are free from debris and that heat transfer surfaces are not contaminated by oil, dust, or dirt.
   6. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
   7. Motor running protection
      a. Compare drive overcurrent set points with motor full-load current rating to verify correct settings.
      b. If drive is used to operate multiple motors, compare individual overload element ratings with motor full-load current ratings.
      c. Apply minimum and maximum speed set points. Confirm set points are within limitations of the load coupled to the motor.

8. Inspect bolted electrical connections for high resistance using one or more of the following methods:
    a. Use of a low-resistance ohmmeter.
    b. Verify tightness of accessible bolted electrical connections by calibrated torque wrench method.
    c. Perform a thermographic survey.
9. Verify correct fuse sizing in accordance with manufacturer's published data.
10. Perform as-left tests.

B. Electrical Tests:
1. Perform resistance measurements through bolted connections with low-resistance ohmmeter.
2. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
3. Test input circuit breaker by primary injection.
4. Test for the following parameters in accordance with relay calibration procedures or as recommended by the manufacturer:
    a. Input phase loss protection
    b. Input overvoltage protection
    c. Output phase rotation
    d. Overtemperature protection
    e. DC overvoltage protection
    f. Overfrequency protection
    g. Drive overload protection
    h. Fault alarm outputs
5. Perform continuity tests on bonding conductors.
6. Perform operational tests by initiating control devices.
    a. Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.
    b. Verify operation of drive from remote start/stop and speed control signals.

C. Test Values
1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2. Bolt-torque levels should be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA Maintenance Testing Specifications for Electrical Power Equipment and Systems Table 100.12.
3. Results of the thermographic survey shall be in accordance with NETA Maintenance Testing Specifications for Electrical Power Equipment and Systems Section 9.
4. Overload test trip times at 300 percent of overload element rating should be in accordance with manufacturer's published time-current curve.
5. Input circuit breaker test results shall be in accordance with NETA Maintenance Testing Specifications for Electrical Power Equipment and Systems Section 7.6.
6. Relay calibration test results shall be in accordance with NETA Maintenance Testing Specifications for Electrical Power Equipment and Systems Section 7.9.
7. Continuity of bonding conductors shall be in accordance with Section 7.13.

8. Control devices should perform in accordance with system requirements.

END OF SECTION

SECTION 26_22_00

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies the furnishing, installation and connection of the dry type general-purpose transformers.

1.02 RELATED WORK

A. Section 26_05_11, Special Requirements for Electrical Installations.

B. Section 26_05_33, Conduit Systems.

C. Section 26_05_19, Low-Voltage Wires and Cables.

D. Section 26_05_26, Grounding and Bonding for Electrical Systems.

1.03 SUBMITTALS

A. In accordance with Section 26_05_02, Basic Electrical Materials and Methods.

B. Shop Drawings:
   1. Sufficient information, clearly presented, shall be included to determine compliance with Drawings and Specifications.
   2. Include electrical ratings, impedance, dimensions, weight, mounting details, decibel rating, terminations, temperature rise, no load and full load losses, and connection diagrams.
   3. Complete nameplate data including manufacturer’s name and catalog number.

C. Manuals:
   1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets and wiring diagrams.

1.04 REVERENCES

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

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

PART 2 PRODUCTS

2.01 GENERAL PURPOSE DRY TYPE TRANSFORMERS

A. Unless otherwise specified, dry type transformers shall be in accordance with NEMA, NEC and as shown on the Drawings. Transformers shall be UL listed or labeled.

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

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

   7. Nominal impedance shall be as per NEMA.
   8. Single phase transformers rated 15 KVA through 25 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All transformers rated 30 KVA and larger shall have two, 2-1/2 percent full capacity taps above, and four, 2-1/2 percent full capacity taps below normal rated primary voltage.
   9. Core assemblies shall be grounded to their enclosures by adequate flexible ground straps.
   10. Enclosures:
      a. Not less than code gage steel.
      b. Outdoor enclosures shall be NEMA 4X stainless steel powder coated white or NEMA 3R stainless steel painted grey.

c. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
d. Ventilation openings shall prevent accidental access to live components.
e. Thoroughly clean and paint enclosure at the factory with manufacturer's prime coat and standard finish.

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

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

PART 3 EXECUTION

3.01 INSTALLATION

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

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

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

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

END OF SECTION

SECTION 26_23_00

AUTOMATIC TRANSFER AND POWER DISTRIBUTION SWITCHGEAR

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install, where indicated on the drawings, a deadfront type, low voltage metal-enclosed open transition drawout automatic transfer switchgear assembly utilizing compartmentalized drawout insulated case power circuit breakers, as specified here specified herein and as shown on the contract drawings. Provide all switchgear with insulated isolated bus for enhanced arc flash mitigation. The switchgear shall be suitable for use as service entrance equipment and be labeled in accordance with ul 1558 requirements.

B. Provide EPA class-one reliable switchgear; double ended and sectionalized main-tie-main gear.

C. Provide Arc Resistant low voltage drawout switchgear assembly constructed to ANSI C37.20.1 and tested to C37.20.7.

1.02 RELATED SECTIONS

A. Section 26_43_00 Surge Protection Devices

B. Section 26_08_00 Electrical Testing

C. Section 26_05_02 Basic Electrical Materials and Methods

D. Section 26_28_11 Circuit Breakers & Fused Switches

1.03 CODES STANDARDS

A. The low voltage metal-enclosed switchgear assembly and all components shall be designed, manufactured, and tested in accordance with the following latest applicable standards:
   1. UL 508a -- Industrial Control Systems.
   2. NEMA ICS -- Industrial Controls and Systems.
   3. ANSI C37.51 – Conformance Testing of Metal-Enclosed Low Voltage AC Power Circuit Breaker Switchgear Assemblies.
   4. ANSI C37.50; Test Procedure for Low Voltage AC Power Circuit Breakers.
   5. ANSI-C37.20 – Switchgear assemblies.
   6. ANSI-C37.20.7 – Arc Resistant Metal Clad Switchgear
   7. ANSI-C37.13 – Low voltage power circuit breakers.
   8. ANSI-C37.17 – Trip devices.
   9. ANSI-62.41.
   10. NEMA SG-5 – Switchgear assemblies.
   11. NEMA SG-3 – Low voltage power circuit breakers.
   12. UL 1558.

13. ANSI: Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
14. NFPA: 70, National Electrical Code (NEC).
15. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

1.04 QUALIFICATIONS

A. The equipment must be purchased from the manufacturer's authorized representative authorized to represent the manufacturer in the projects territory.

B. The manufacturer of the automatic transfer switch shall be the manufacturer of the major components within the assembly.

C. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

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

E. The automatic transfer switches shall be suitable for Service Entrance.

1.05 SUBMITTALS

A. Shop Drawings
   1. Itemized Bill-of-Material
   2. Master drawing index
   3. Dimensional drawings; Front view and plan view of the assembly.
   4. Anchoring instructions and details.
   5. One-line, three-line, wiring diagrams and control schematic drawings.
   6. Connection and interconnection drawings.
   7. Incoming line section equipment data. Conduit entrance locations.
   8. Nameplate schedule
   9. Component list
   10. Ground Fault protection: Relay time-current characteristics.
   11. Circuit Breakers: Copies of time-current characteristics.
   12. Conduit space locations within the assembly
   13. Assembly ratings including:
      a. Short-circuit rating
      b. Voltage
      c. Continuous current rating
   14. Major component ratings including:
      a. Voltage
      b. Continuous current rating
      c. Interrupting ratings
   15. Cable terminal sizes
   16. Product data sheets.
   17. SPD data
   18. Bus data; Busway connections
   19. Key interlock scheme drawing and sequence of operations
   20. Operational description.

B. Quality Control Submittals:
   1. Manufacturer's installation instructions.
   2. Certified Factory Test Report.
   3. Operations and Maintenance Manual.

C. Operation and Maintenance Manuals:
   1. Equipment operation and maintenance manuals shall be provided, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component. O&M manuals shall include site specific layout and assembly drawings with complete module and device information.
   2. The following information shall be included for record purposes:
      a. Final as-built drawings and information for all items listed above.
      b. Wiring diagrams
      c. Certified production test reports
      d. Installation information
      e. Seismic certification.
   3. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the manufacturing process.

1.06 REGULATORY REQUIREMENTS

A. The switchgear and switchboards shall bear a UL 1558 label.

B. Provide ATS system that meets the requirements of NEC-2011 section 225-31 and 225-36. Provide service entrance rated equipment suitable for disconnecting means.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be handled and stored in a dry building and in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.08 SPARE PARTS

A. Provide a list of manufacturer's recommended spare parts. The owner may purchase spare parts separate from or as an added cost to the project.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Equipment manufacturer shall be the same manufacturer as the stand-by power system, ATS and paralleling systems.

B. Provide equipment by Cummins Onan utilizing approved circuit breaker and structure manufacturers Square D. Provide with arc flash maintenance mode for increased arc flash mitigation for maintenance personnel.

C. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 RATINGS

A. Voltage rating shall be as indicated on the drawings. The entire assembly shall be suitable for 600 volts maximum AC service.

B. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of minimum 65,000 amperes symmetrical at rated voltage or higher as shown on the drawings.

C. The bus system shall have a minimum ANSI 4-cycle short-circuit withstand rating of 100,000 amperes symmetrical.

D. Circuit breakers shall have interrupting, close and latch, and 30-cycle withstand ratings that meet the application requirements. Interrupting rating shall be available up to 100 kA RMS amperes without fuses. Close and latch ratings to 100 kA available on all frame sizes. Thirty-cycle withstand rating available up to 100 kA to provide maximum coordination with downstream circuit breakers.

E. The transfer pair shall be 100 percent equipment rated for continuous duty as shown on the drawings and shall conform to the applicable requirements of UL 1558 for emergency systems. It shall also be fully rated for inductive and resistive loads, without derating.

F. All pilot devices and relays shall be of the industrial type (30MM) with self-cleaning contacts and rated 10-amperes.

G. All ratings shall be tested to the requirements of ANSI C37.20.1, C37.20.7, C37.50 and C37.51 and UL witnessed and approved.

2.03 DRAWOUT CONSTRUCTION

A. The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure. The switchgear rear access shall be through lockable full size hinged swing doors. Doors and shall be secured using captive hardware. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills. Provisions shall be made for jacking of shipping groups, for removal of skids or insertion of equipment rollers. Base of assembly shall be suitable for rolling directly on pipes without skids. The base shall be equipped with slots in the base frame members to accommodate the use of pry bars for moving the equipment to its final position. Provide a breaker trolley winch capable of lifting breakers in and out for service.

B. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment and a rear cable compartment. Each individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections by means of steel barriers to the maximum extent possible. All protective devices shall be compartmentalized with line and load bus connections. Devices shall be front removable and load connections rear accessible. Insulated rigid copper bus connections shall extend from the load side of over-current feeder devices into rear compartment where outgoing cable connections may be made without reaching into the main horizontal or vertical bus compartment. Distribution sections shall be sectionalized to provide a front device section, an intermediate bus section and a rear feeder cable section. It shall be equipped with drawout rails and primary and secondary disconnecting contacts. Current transformers for feeder instrumentation shall be located within the appropriate breaker cells and be front accessible and removable.

C. The stationary part of the primary disconnecting devices for each power circuit breaker shall be breaker mounted and consist of a set of contacts extending to the rear through glass polyester insulating support barrier; corresponding moving finger contacts, suitably spaced, shall be furnished on the power circuit breaker studs which engage in only the connected position. The assembly shall provide multiple silver-to-silver full floating high pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit shall include three-phase bus connections between the section bus and the breaker line side studs. Load studs in the rear cable compartment of each structure shall be equipped with insulated copper load extension buses terminating in two hole long barrel hypress crimp lugs (Burndy, no equal). Bus extensions shall be silver or tin-plated where outgoing terminals are attached.

D. The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.

E. The secondary disconnecting devices shall consist of floating terminals mounted on the stationary unit and engaging mating contacts at the front of the breaker. The secondary disconnecting devices shall be gold-plated and engagement shall be maintained in the “connected” and “test” positions.

F. The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for drawout application. It shall have four positions, “connected,” “test,” “disconnected” and “removed.” The breaker drawout element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell. The breaker shall include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall provide for securing the breaker in the connected, test, or disconnected position by preventing levering.

G. The switchgear mains, utility and paralleling breakers, shall be suitable for use as service entrance equipment and be labeled in accordance with UL requirements.

H. Provide a rear compartment steel barrier between the cable compartment and the main bus to protect against inadvertent contact with main or vertical bus bars.

I. Provide in the cell when the circuit breaker is withdrawn, a safety shutter which automatically covers the line and load stabs and protects against incidental contact.

J. Provide a metal barrier full height and depth between adjacent vertical main utility and emergency breakers and the paralleling breaker structures in the cable compartments.

K. Provide individual breaker compartmentalization.

L. Vertical sections shall be equipped with floor damper ventilation covers. These dampers shall cover all ventilation holes during arcing flash event.

M. Complete lineup shall meet requirements to be certified as NEMA Type 2B Arc Resistant.

N. Each circuit breaker shall be mounted in its own barriered compartment.

O. Neutral termination block and neutral to ground bonding plate shall be located in the bottom 1/3 of the ULSE compartment and have downward facing lugs for bottom incoming cable connection.

2.04 BUS

A. All bus bars shall be insulated tin or silver-plated copper and be density rated at maximum of 1000amps/sq-in. Temperature rated bus is not acceptable. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane.

B. Provide a neutral bus in the main ATS and emergency main sections for connection of the genset neutral cables to the common neutral to ground connection. The neutral is not required in the distribution sections.

C. A 1/4 x 4 inch copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short-time withstand rating shall meet that of the largest circuit breaker within the assembly. Bus shall be braced for peak symmetrical amperage available from all generator sets plus motor contributions and shall be rated at 100,000 amps RMS, minimum.

D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with Belleville-type washers. Provide all switchgear with insulated isolated bus for enhanced arc flash mitigation.

2.05 WIRING/TERMINATIONS

A. Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required. Control components mounted within the assembly shall be suitably marked for identification corresponding to the appropriate designations on manufacturer's wiring diagrams.

B. Provide a front accessible, isolated vertical wireway for routing of factory and field wiring. Factory provisions shall be made for securing field wiring without the need for adhesive wire anchors.

C. Front access to all circuit breaker secondary connection points shall be provided for ease of troubleshooting and connection to external field connections without the need of removing the circuit breaker for access.

D. All control wire shall be type SIS. Control wiring shall be 14 ga for control circuits and 12 ga for shunt trip and current transformer circuits. Wire bundles shall be secured with nylon ties and anchored to the assembly with the use of pre-punched wire lances or nylon non-adhesive anchors. All current transformer secondary leads shall first be connected to conveniently accessible shorting terminal blocks before connecting to any other device. Shorting screws with provisions for storage shall be provided. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips and provisions for #10 AWG field connections. Each control wire shall be marked to the origin zone/wire name/destination zone over the entire length of the wire using a UV cured ink process. Provide wire markers at each end of all control wiring. Plug-in terminal blocks or spade lug terminal blocks shall be provided for all shipping split wires. Terminal connections to remote devices or sources shall be front accessible via doors above each circuit breaker.

E. Provide switchgear cable connections with long barrel double crimp insulated two-hole Hi-press compression lugs as manufactured by Burndy, no equal.

F. Reusable insulating boots shall be provided to cover all power cable terminations.

G. Switchgear wiring shall be composed of UL listed, 105 degree centigrade rated material, with all wiring labeled at each end. Each wire, device or function shall be suitably identified by silk screen or similar permanent identification corresponding to the same identifiers shown on the shop drawings.

2.06 DRAW OUT POWER CIRCUIT BREAKERS

A. Provide power circuit devices, type low-voltage power circuit breakers, Square D type MasterPact ArcBlok NW or approved equal with electronic trip units as specified on the associated drawings. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating. Circuit breakers shall be available in 800, 1600, 2000, 3200, and 4000 frame sizes. An adjustable rating plug (range of 0.4 to 1 times the sensor plug value) and a field-replaceable sensor plug (available in standard amperage steps from 50% to 100% of the frame size) shall determine the ampere rating of the circuit breaker

B. All switchgear Breakers shall be electrically operated (EO). Breakers to be operated by an electrically charged, mechanically held and electrically trip free stored energy mechanism. Provide for manual charging of the mechanism.

C. Electrically operated breakers shall be complete with close/open pushbuttons control switch, plus red and green indicating lights to indicate breaker contact position 120 Vac motor operators; the charging time of the motor shall not exceed 6 seconds. Source voltage shall be taken from a control power transformer internal to the switchgear assembly. Provide all breakers with open and close pilot lights. Provide all main breakers, generator breakers and tie breakers with T-handle open-close switches and open and close pilot lights.

D. Breakers shall be provided in drawout configuration with rack out mechanisms. Physical frame sizes shall have a common height and depth.

E. All circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000amperes or higher where shown on the drawings. To ensure a selective system, all circuit breakers shall have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85,000 amperes, regardless of whether equipped with instantaneous trip protection or not.

F. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standards. The circuit breakers shall carry a UL label.

G. Provide Arc Flash Reduction Maintenance Remote accessory. The Arc Flash Reduction Maintenance Remote shall allow the operator to enable a maintenance mode with a preset accelerated instantaneous override trip to reduce arc flash energy.

H. Breaker shall be 480VAC charging, with DC shunt trip system. Provide system with an individual control power transformer for the generator and stand-by mains, on the generator side of the breaker; and the utility main breaker, on the utility side of the breaker. The tie breaker shall have control power for charging from both sides. Provide surge voltage isolation and voltage sensors on all phases of both sources.

I. Provide interlocks to prevent withdrawal of the breaker unless it is open.

J. To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker. Provide trolley hoist system with rails on top of the gear.

K. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

L. The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.

M. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a “Positive On” feature. The breaker flag will read “Closed” if the contacts are welded and the breaker is attempted to be tripped or opened.

N. The current sensors shall have a back cover window that will permit viewing the sensor rating on the back of the breaker. A rating plug will offer indication of the rating on the front of the trip unit.

O. A position indicator shall be located on the faceplate of the breaker. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green). The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open.

P. Each power circuit breaker shall offer sixty (60) front mounted dedicated secondary wiring points. Each wiring point shall have finger safe contacts, which will accommodate #10 AWG maximum field connections with ring tongue or spade terminals or bare wire.

Q. Power circuit breakers shall utilize a two-step stored-energy mechanism to charge the closing springs. The closing of the breaker contacts shall automatically charge the opening springs to ensure quick-break operation.

R. The power circuit breaker shall have a closing time of not more than 3 cycles.

S. Include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall secure the breaker in the connected, test or disconnected position by preventing levering.

T. Provide main breakers with NEC required LSIG protection as required. Provide generator mains with LSIA to alarm only on ground fault and not trip the breaker.

2.07 TRIP UNITS

A. Each low-voltage power circuit breaker and insulated case circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The trip unit shall Square D Micrologic P with MODBUS communication module.

B. The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall

be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

C. The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

D. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

E. Trip unit shall have selectable thermal memory for enhanced circuit protection.

F. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A test pushbutton shall energize a LED to indicate the battery status.

G. The trip unit shall be equipped to permit communication via Modbus to the Square D PM8000 power monitors provided in the equipment for remote monitoring and control. All monitored parameters shall be transmitted via Modbus TCP to the existing plant power monitoring and control system network.

H. The trip unit shall include a power/relay module, which shall supply control power to the readout display. Following an automatic trip operation of the circuit breaker, the trip unit shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. An internal relay shall be programmable to provide contacts for remote ground alarm indication.

I. The trip unit shall include a voltage transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the power relay module shall be connected internally to the line side of the circuit breaker through a dielectric test disconnect plug.

J. The display for the trip units shall be a 24-character LED display.

K. Metering display accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of full scale for current values. Metering display accuracy of the complete system shall be +/- 2% of full scale for power and energy values.

L. The unit shall be capable of monitoring the following data:
   1. Instantaneous value of phase, neutral and ground current
   2. Instantaneous value of line-to-line voltage
   3. Minimum and maximum current values
   4. Watts, vars, VA, watthours, varhours, and VA hours, Peak demand, Present demand,Energy consumption.
   5. Crest factor, power factor, percent total harmonic distortion, and harmonic values of all phases through the 31st harmonic.

M. An adjustable high load alarm shall be provided, adjustable from 50 to 100% of the long delay pickup setting.

N. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements: All circuit breakers shall have individually adjustable Long Time, Short Time, Instantaneous & ground fault current pickup and time, and include I2t settings.

O. The trip unit shall have provisions for a single test kit to test each of the trip functions. One circuit breaker test kit shall be provided in this contract.

P. The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings. The protection functions shall not be affected during test operations. The breaker may be tested in the TRIP or NO TRIP test mode.

Q. Programming may be done via a keypad at the faceplate of the unit or via the communication network.

R. System coordination shall be provided by the following microprocessor-based programmable time-current curve shaping adjustments. The short-time pickup adjustment shall be dependent on the long delay setting.
   1. Programmable long-time setting
   2. Programmable long-time delay with selectable I^2t or I^4t curve shaping
   3. Programmable short-time setting
   4. Programmable short-time delay with selectable flat or I^2t curve shaping
   5. Programmable instantaneous setting
   6. Programmable ground fault setting trip on main only provide ground fault setting alarm on generator breakers.
   7. Programmable ground fault delay with selectable flat or I^2t curve shaping.

S. The trip unit shall have the following advanced features integral to the trip unit:
   1. Adjustable undervoltage release
   2. Adjustable overvoltage release
   3. Reverse load and fault current
   4. Reverse sequence voltage alarm
   5. Underfrequency
   6. Overfrequency
   7. Voltage phase unbalance and phase loss during current detection

T. Provide Arcflash Reduction Maintenance System for all switchgear breakers. Alternate Maintenance Setting (AMS) switch. The switch will enable temporary arc-flash incident energy reduction during maintenance activities.
   1. For each utility main circuit breaker, provide a manual switch on the compartment door to switch the circuit breaker short time tripping characteristics to instantaneous with minimum pick-up setting, in order to reduce the danger from potential arc-flash at downstream equipment.
   2. Provide a lock feature for the AMS switch so that it may be locked in either the Off or On maintenance mode position.
   3. Provide a blue LED indicating light to indicate AMS switch is in the maintenance mode.

4. Wire contacts on all AMS switches to a common alarm input to plant control system.
5. Provide for remote AMS switches or indication, as needed.

2.08 AUTOMATIC TRANSFER CONTROLS

A. The logic of the switchgear based transfer pair automatic control shall function via a special purpose built microprocessor controller. Programmable Logic Controllers are acceptable. Provide dedicated microprocessor based electronic transfer device for each transfer pair equal to Cummins-Onan MCM3320 ATS Controller

B. Set points shall be field adjustable through a HMI keypad and without the use of special tools. LED lights shall be included on the exterior of the switch to show:
1. Normal Source Available.
2. Emergency Source Available.
3. Normal Source Connected.
4. Emergency Source Connected.
5. Load Energized.
6. System not in Auto.
7. Generator Test active.

C. A digital readout shall display each option as it is functioning. Readouts shall display actual line-to-line voltage, line frequency and timers. When timers are functioning, the microprocessor shall display the timer counting down. All set points can be re-programmed from the front of the switch when the switch is in the program mode. A genset test pushbutton shall be included as part of the microprocessor. The switch shall include the following:
1. Provide overvoltage protection with time delay.
2. Provide a time delay transfer from the normal power source to the emergency power source (0 seconds to 30 minutes). This option does not effect the engine start circuit.
3. Provide a timer to override a momentary power outage or voltage fluctuation (0 seconds to 120 seconds).
4. Provide a time delay transfer from the emergency power source to the normal power source (0 seconds to 30 minutes).
5. Provide a timer to allow the generator to run unloaded after re-transfer to the normal power supply (1 second to 30 minutes).
6. Provide single-phase under voltage and under frequency sensing on the emergency power source. Voltage shall be factory set at 90 percent pickup and 80 percent dropout. Frequency sensing shall be set at 58-hertz pickup and 56-hertz dropout.
7. Provide indication that the switch is in the normal position as an integral part of the microprocessor.
8. Provide indication that the switch is in the emergency position as an integral part of the microprocessor.
9. Provide indication that the normal power is available as an integral part of the microprocessor.
10. Provide indication that the emergency power is available as an integral part of the microprocessor.
11. Provide auxiliary relay contacts that are energized when the power is available on the normal source.

12. Provide auxiliary relay contacts that are energized when the power is available on the emergency source.

D. The following features shall be provided:
   1. Time delay normal to emergency, adjustable.
   2. Time delay emergency to normal, adjustable.
   3. Indication switch in normal position and red pilot light to indicate switch in emergency position.
   4. Indication marked "Normal Source" and "Emergency Source" to indicate that respective source voltages are available.
   5. Tripped position indicating lights for both sources.
   6. Relay auxiliary contacts (2 NO and 2 NC) to indicate transfer switch position and the availability of each source.
   7. Time delay engine start, adjustable.
   8. Time delay engine cool off, adjustable.
   9. Engine start contact.
   10. Frequency/voltage relay for emergency source, frequency adjustable from 45 to 60 Hz and voltage fixed at 90 percent pickup, 70 percent dropout.
   11. Open transition mode delayed transition time delay, adjustable from 0 to 30 seconds, to allow disconnection of the load during transfer in either direction to prevent excessive inrush currents due to out-of-phase switching of large inductive loads.
   12. Remote start and transfer to standby power from plant control signal.
   13. “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
   14. “Reset” push button that will clear any faults present in the control.
   15. “LAMP TEST” push button to test all lamps on the panel by lighting them.
   16. The transfer pair automatic control will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Provide one set Form C auxiliary contacts for each power breaker, operated by transfer switch position, rated 10 amps 250V ac. The transfer switch shall provide relay contacts to indicate the following conditions: source 1 available, load connected to source 1, source 2 available, source 2 connected to load.

E. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
   1. Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98 percent of the normal voltage level and dropout in a range of 75 to 98 percent of normal voltage level).
   2. Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98 percent of the normal voltage level and dropout in a range of 75 to 98 percent of pickup voltage level).
   3. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
   4. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.

5. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation and phase sequence (phase angle).
6. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135 percent of normal voltage, and pickup at 95-99 percent of dropout voltage level).
7. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.

F. Internal Controls. The following internal control components or functions shall be provided for the transfer control:
1. The system shall be configurable for open transition operation (including configurable operating time for breakers).
2. The system shall include logic and controls to diagnose failure of a breaker and/or breaker auxiliary contact to properly operate, and shall logically respond to the failure in a manner to protect the generator system, utility system and operators of the system.

G. Provide an LED 20 light Alarm and status panel to indicate the following conditions via and LED display and configurable alarm horn.
1. Utility available
2. Utility connected
3. Genset bus available
4. Genset bus connected
5. Not in auto
6. Common alarm
7. Fail to sync
8. Genset “n” running
9. Test mode
10. Genset bus overload
11. Load demand mode
12. Genset Battery System Alarm
13. Switchgear Battery System Alarm

H. The transfer pair shall consist of completely enclosed and separated power circuit breaker assemblies and a separate control logic panel. All protective devices shall be low voltage power circuit breakers Square-D NW (NT type not acceptable) or approved equal. All breakers shall be UL listed for application in their intended enclosures for 100 percent of their continuous ampere rating. The contact assemblies shall be operated by stored energy mechanism and be energized only momentarily during transfer, providing inherently double throw switching action. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.

I. Transfer pair shall be capable of being operated manually under full load conditions. Manual operation shall be available via integrally mounted pushbutton operators located on the face of the breakers or through handle switches on the enclosure door. The transfer breakers shall not have mechanical close push buttons accessible to the operator that bypasses the electrical interlocks. In addition, electrical operators, control of all switchgear breakers including distribution breakers shall be provided through T-handle breaker switches. Provide open/closed pilot lights above each breaker T-Handle switch. The ATS shall be fitted with a Manual-

Off-Auto switch. The ATS shall allow operator manual control of the main and emergency breakers only when the ATS M-O-A switch is in the manual position. The manual operator circuits for breaker close function shall be double interlocked with the associated opposing breaker for open only transition control. Provide manual mode dedicated hard wired electrical interlocking of the transfer switch breakers from auxiliary contacts from the associated opposing breaker. Provide closed/open/tripped indicator lights for utility and genset main breakers.

J. When in open transition mode each transfer pair shall be hardwired interlocked electrically to prevent simultaneous closing of both sources under manual operation. Main contacts shall be mechanically locked in position in both normal and emergency positions. Each transfer pair shall have a manual neutral position for load circuit maintenance. A transfer pair position indicator shall be visible from the front of the switch to show to which source the transfer switch is connected.

K. Provide a neutral disconnect link for three-pole solid neutral switches, and a neutral-to-ground main bonding jumper for all switches to meet UL service entrance requirements.

2.09 MASTER CONTROL MONITORING SYSTEM

A. Provide an independent digital master control & monitoring system for the switchgear and generator sets. The master control panel will provide monitoring with only minimal non-critical control functions system-level functions, including FPL load management control, load demand, and system operator interface. The switchgear standby power system will function normally on loss of power with the master control system out of operation. Provide equipment as follows:

B. Provide a 21.5” Operator Interface Color Touchscreen Panel. Allen Bradley Panelview Plus 1500 - XGA TFT color LCD display with 1024 x 768 minimum resolution to allow the operator to view the status and control operation of system.

C. Provide an Allen Bradley ControlLogix or CompactLogix, latest model at time of production, PLC based controller with integral Ethernet/IP communications compatibility for connection to the plant control system. Provide Modbus and Modbus Plus conversion within the master control PLC to communicate with internal transfer switch microprocessors, genset microprocessors and breaker trip units.

D. Provide on the control panel screen 1% accuracy digital AC output instruments; Ammeter, Voltmeter, Frequency Meter, Wattmeter, KW-hour meter, Power Factor Meter, kVAR meter, KVA meter shall be provided for the utility supply service and the generator bus. AC metering shall provide total values and per phase values. Provide metering displays for each bus source indicating voltage, current, kW load, power factor, and frequency. PM8000 power monitors are acceptable to provide required metering information.

E. The master system provides a standby system global alarm history screen. The master control records the date, time and nature of all alarm and shutdown conditions reported on the system. This log includes all alarms reported on the generator sets, the transfer controls and all standby network connected equipment. Any alarm on any generator set or in the system will cause an alarm bar and warning condition display to appear on the touchscreen. A click on the bar displays

a pop-up screen describing the equipment where the fault has occurred, and the name of the fault.

F. A system control screen provides the operator with the ability to enable or disable load demand operation, view timer values and the load demand sequence; initiate test (with or without load); control the shutdown sequence for the generator sets in the load demand mode; set the load demand time delays; set the load demand operation set points; and display and modify the automatic load add and shed sequence. The screen also allows setting of the source availability settings and sequence timing for power transfer. The control screen shall include a master remote auto/manual switch and individual breaker controls switches for each breaker power transfer pair and for each feeder breaker. They shall be configured so that in the manual mode power may be manually transferred in an open transition sequence between sources.

G. A one-line diagram screen displays system status by a combination of animation, changing screen color, text messages, and pop-up indicators. Conditions visible on the screen include:
   1. Generator set(s) and bus configuration with generator set, parallel breaker and bus energized/de-energized indication (red indicating energized, green indicating de-energized).
   2. Generator set designation, with control data, and performance summary screens accessible through hot keys (links) located on or adjacent to the genset icon.
   3. Generator set mode (run/off/auto).
   4. Generator set status (normal/warning/shutdown/load demand stop).
   5. Paralleling breaker status (open/closed/tripped/racked out).
   6. Control and status and condition displays of distribution breakers.
   7. Tie Breaker Status.
   8. Bus condition (energized or de-energized) Clicking on the bus icon provides access to a bus AC data screen.

H. Provide a genset status summary screen with analog and graphical display of critical generator set operating parameters for each generator set in the system. The screen includes generator set state display (stopped, time delay start, idle speed state, rated volts/hertz, synchronizing, load share); analog AC metering for generator set (3-phase, AC volts and current, frequency, kW and power factor); and three-phase AC bus voltage and frequency. The screen provides a complete display of engine and alternator data present in the generator set control. In addition the status screen shall display the following conditions:
   1. Genset Bus Overvoltage Warning
   2. Genset Bus Undervoltage Warning
   3. Genset Bus Frequency Warning
   4. Genset Bus Overload Warning
   5. Common Warning Event
   6. Utility Bus Loss of Phase Warning
   7. Genset Bus Available Event
   8. TD Start
   9. TD Stop
   10. Manual/Auto
   11. Standby
   12. Generator Set #n On Line. (One for each genset in the system)

13. Load Demand Mode
14. System Genset Test; no transfer
15. Remote System Test Start/Transfer Bus A
16. Remote System Test Start/Transfer Bus B
17. Check Generator Set #n (one for each genset in the system)
18. System Not in Auto Mode
19. Feeder Breaker Status Open/Closed/Tripped
20. Genset Fuel Tank Level & Tank leak alarm
21. FPL load management alarm

I. A genset manual screen shows status of the generator set breaker and provides manual control of the generator set paralleling function for each genset in the system.

J. Misc Controls. The following internal control components or functions shall be provided for the master control:
   1. The system shall include a master synchronizer for each breaker transfer pair which is configurable for slip frequency or phase lock loop operation, phase angle and time closing window. The synchronizer shall match both frequency and voltage of the generator bus to the reference source.
   2. Provide load demand control signals for each generator set provided, which operate to minimize fuel consumption during extended outages by shutting one genset down during light loading periods. The load demand system shall include a master auto/off switch to disable load demand operation.
   3. The system shall control the feeder breakers through commands from the plant SCADA system.

2.10 TRANSFER AND MASTER CONTROL CONSTRUCTION

A. The master control system shall be listed and labeled under the requirements of UL 1558, including all covers, barriers, and supports. Individual control sections shall be isolated from each other and from power carrying components by metal barriers. All components and surfaces operating at more than 50 volts shall be shielded to prevent inadvertent contact.

B. All wiring shall be UL listed 105 degree C, 600 volt rated, and sized as required. Each wire, device or function shall be suitably identified by silk-screen or similar permanent identification.

C. The framework and all other sheet metal components of the system shall be primed with a rust-inhibiting primer, and finished with two coats of satin finish ANSI 61 gray enamel.

D. All door mounted control components shall be industrial type oil-tight devices with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Toggle switches and other light duty control devices are not acceptable. Indicator lamps shall be high intensity LED type devices. Indicator lamp condition (on or off) shall be easily visible in bright room lighting conditions.

E. AC control circuits in the switchboard shall be protected with properly sized fuses in safety fuse blocks, with visible fuse blown indication for each fuse. Potential transformers shall be protected on line and load side.

F. All CT installations shall include shorting type terminal blocks and thyrite overvoltage protection.

G. All field control interconnecting wiring shall be sized as specified by system manufacturer with minimum 14 AWG copper stranded.

H. All active control system components in the system shall be suitable for operation in ambient temperatures ranging from -40 to +70 degrees C. The active control electronics shall be environmentally protected from dust, dirt, and humidity. The controls shall be suitable for operation in an ambient ranging from 5-95% relative humidity, and shall be protected from the effects of equipment vibration.

2.11 TRANSFER AND MASTER CONTROL SYSTEM CONTROL POWER

A. Control power for the system controls shall be derived from the generator set 24VDC starting batteries and from switchgear 24VDC battery systems. Provide 24VDC switchgear battery system for each switchgear side, bus-A and bus-B. A solid state, no break "best battery" selector system shall be provided so that control voltage is available as long as any battery bank in the system is available, and that all battery banks are isolated to prevent the failure of one battery from disabling the entire system. The power transfer control shall be provided with redundant DC control power from two independent sources. Provide independent battery alarm for each battery system or UPS in the system.

B. The Entire System including load add and shed, load demand, generator set governing, voltage regulation, load sharing, synchronizing, and protection, shall be capable of proper operation with battery voltage levels down to 8 VDC without external battery support. The control power for the system master controls shall be derived from at least two different sets of battery banks.

C. Paralleling breaker control power for each paralleling breaker shall be derived from the generator set for charging, opening, and closing the breakers.

2.12 SECONDARY TERMINATIONS:

A. All customer secondary control and communication connections shall be made from a barriered control compartment on the front of the switchgear lineup.

B. All control wire wiring shall be type #14 gauge SIS wire. Current transformer wire shall be type #10 gauge SIS wire. All wire shall be secured to terminal blocks by ring-tongue type connectors. Control wiring for breakers shall be at a minimum type #22 gauge SIS wire. All secondary and communication wire shall be securely fastened to the switchgear

C. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.

2.13 POWER MONITORING

A. Provide Square D PM8000 power monitors with optional Ethernet card, ECC21 and remote mounted display.

B. Mount power monitors to switchgear face. Mount easily accessible and visible to the operator without requiring a step stool or bending over to read display.

C. The power monitors shall act as the control system “switch” between the Modbus RTU circuit breaker trip units and the plant Ethernet power monitoring system.

2.14 DEVICES AND MISC HARDWARE

A. All control components shall be industrial type heavy duty oil tight devices. Indicator lamps shall be high intensity LED type devices. Toggle switches and other light duty and durability limited control devices are not acceptable.

B. Protect AC control circuits with fuses in safety fuse blocks, with visible fuse blown indication for each fuse. Potential transformers shall be protected on line and load side. All Current Transformers shall include shorting type terminal blocks.

C. Provide each switchboard section with a minimum of two infrared windows. Place the infrared windows to allow infrared scans of all cable terminations. Where required provide additional infrared windows for adequate field of view to all cable terminations.

D. Provide key interlocks as shown on the single line drawing.

E. Control power for the transfer switch shall be derived from both the utility and generator set sources. Control power for charging each breaker in the power transfer switch shall be derived from the source it is connected to. The tie breaker shall have control power for charging from both sides.

F. The transfer switch metering and control equipment shall be provided with a 24VDC battery based auxiliary power supply to allow monitoring of the transfer switch when both AC power sources are non-operational. The battery power supply shall be monitored for proper condition, and the transfer switch shall include an alarm condition contact closure to indicate low battery condition. The generator battery shall act as a backup 24VDC source through a best battery logic circuit.

G. Provide for padlockable pushbutton hinged cover plates to block access to the PUSH-TO-CLOSE buttons on the transfer breaker faceplate.

H. Both front and rear enclosure access doors shall be hinged with no tools needed for access.

2.15 ENCLOSURES

A. NEMA 12 Enclosure for indoor installation.

2.16 NAMEPLATES

A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum.

B. Furnish master nameplate giving switchgear designation, voltage ampere rating, short-circuit rating, and manufacturer's name.

C. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's drawings.

2.17 FINISH

A. All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchgear shall be ANSI 61.

2.18 ACCESSORIES

A. Provide a traveling type circuit breaker lifter, rail-mounted on top of drawout switchgear.

B. Provide a microprocessor trip unit functional tester.

C. Provide a portable remote racking device kit with factory installed brackets designed specifically for the switchgear breakers. Kit will be complete with motorized racking device, controller with 30 foot cable and all control and power wiring.

D. All control components shall be industrial type heavy duty oil tight devices. Indicator lamps shall be high intensity LED type devices. Relays shall be heavy duty industrial type with 10amp minimum contact rating. Provide relays with integral illuminated indicator when energized.

E. Protect AC control circuits with fuses in safety fuse blocks, with visible fuse blown indication for each fuse. Potential transformers shall be protected on line and load side. All Current Transformers shall include shorting type terminal blocks.

2.19 SEQUENCE OF OPERATION (OPEN TRANSITION)

A. Under normal operating conditions, utility power is provided to the load through the normal (utility) circuit breaker. The emergency main and genset paralleling circuit breakers are open and the Genset is stopped. The transfer pair shall automatically transfer its load circuit to an emergency generator power supply upon failure of its normal (utility) source. Provide through the local switchgear HMI and Plant SCADA system an operator selectable setting for "Automatic(Open) or Manual" to allow the operator to select the preferred transfer mode. When Open transition is selected, a several second load break transfer will occur between sources.

B. Upon loss of phase-to-phase voltage of the normal source to 80 percent of nominal, and after a time delay, adjustable from 0.5 to 15 seconds, to override momentary dips and/or outages, a 10-ampere, 30Vdc contact shall close to initiate starting of the emergency or standby source power plant. Transfer to the alternate source shall take place immediately upon attainment of 90 percent of rated voltage and frequency of that source.

C. When the normal source has been restored to 95 percent of rated voltage, and after a time delay, adjustable from 0.5 to 32 minutes (to ensure the integrity of the normal power source), the load shall be retransferred to the normal source.

D. The transfer switch shall have an adjustable time delay to control the operation time from source to source (program transition operation).

E. A retransfer time delay, adjustable from 0.5 to 32 minutes, shall delay shutdown of the emergency or standby power source after retransfer to allow the generator to run unloaded for cool-down, after which the generator shall be automatically shut down.

F. Return to Normal Power, Open Transition: If open transition is selected, the ATS controller will wait for the retransfer time delay and then issue the emergency main breaker open signal. It will verify that the emergency breaker is open, wait for the program transition time delay and then initiate a normal (utility) breaker close signal. The ATS controller will remove its start signal from the GenSet, the GenSet will continue to run for a cool down period and then shut down.

G. If the standby power should fail while carrying the load, transfer to the normal power supply shall be initiated immediately upon restoration of the normal source to satisfactory conditions.

2.20 MANUAL TIE BREAKER OPERATION

A. In normal operation the switchgear ATS bus A and switchgear ATS bus B are independent of each other. They each shall have an independent ATS controller, with independent 24V dc Control power, independent utility power source transformers (common utility primary) with only the standby power bus being shared from A to B. Each switchgear ATS can be transferred from utility to generator and back independent of each other.

B. During maintenance and testing one of the switchgear buses can be tied to the other to maintain service to all loads within the plant. The switchgear tie breaker is key interlocked with the Utility and Emergency Main breakers (ATS).

C. Sequence of operation for Switchgear AB tie: Select one ATS for manual tie operation. Select switchgear manual mode on the switchgear Auto/Manual operation mode switch which will lockout the ATS from automatic operation. Manually trip-open the utility and emergency main breakers with their respective T-handles which will remove power to the bus. Move the main and emergency breaker kirk key interlock switches to lockout position and remove kirk keys. Insert keys in tie breaker captive key bar and turn to captive position and remove tie breaker Kirk key. Insert tie breaker Kirk key in tie breaker key lock and turn to unlock position (captive position) which will allow tie breaker operation. Tie breaker will now operate with tie breaker T-handle; close breaker and both bus A and B are tied together and all loads are service from one utility or standby source. Reverse operation to go back to normal two bus operation.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested to ensure the accuracy of the wiring and the functioning of all equipment. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities.

B. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute, or 1800 volts for one second, between live parts and ground, in accordance with ANSI C37.20.1.

C. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
   1. Insulation check to ensure the integrity of insulation and continuity of the entire system.
   2. Visual inspection to ensure that the switch matches the specification requirements and to verify that the fit and finish meet quality standards.
   3. Mechanical tests to verify that the switch's power sections are free of mechanical hindrances.
   4. Electrical tests to verify the complete electrical operation of the switch and to set up time delays and voltage sensing settings of the logic.

D. A certified test report of all standard production tests shall be shipped with each assembly.

E. Include attendance of up to 2 County Employees, 2 Contractor Employees and 2 Engineer Representatives to witness Factory testing at the switchgear manufacturers plant.

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer’s representative to assist the Contractor in installation and start-up of the equipment specified under this section. The manufacturer’s representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The manufacturer shall provide three (3) hard copies, or an electronic version of the manufacturer’s field start-up reports direct to the engineer with copies to the Contractor. Assume a minimum of 3 separate site visits for off-loading and assembly, installation, testing and initial energization and startup. Cost shall be included in bid price.

3.03 MANUFACTURER’S CERTIFICATION

A. A qualified factory-trained manufacturer’s representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations prior to energization.

3.04 TRAINING

A. The Contractor shall provide a training session for owner's operation and maintenance staff for two separate days at the jobsite or location determined by the owner. Training session will not be scheduled the same day as the manufacturers field checkout and start-up.

B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation and maintenance of the assembly, circuit breakers, and major components within the assembly.

C. Training dates shall be coordinated with the facility owner at least 2 weeks prior to proposed training date.

D. Contractor shall record training session and provide (2) copies on DVD with the project O&M Manuals.

3.05 INSTALLATION

A. The Contractor shall install all equipment under the supervision of the manufacturer and in conformance to manufacturer's recommendations and the contract drawings.

B. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

C. Install in each section a minimum of two infrared windows. Place infrared windows to allow infrared scans of all cable terminations. Field-install additional infrared windows as required for adequate field of view to all cable terminations. Route cable so it does not affect infrared scanning of adjacent terminations.

D. The Contractor shall install all equipment per the manufacturer's recommendations and the Contract Drawings. Equipment shall be installed by the Contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

E. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The Contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

F. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the Site.

G. The equipment shall be installed and checked in accordance with the manufacturer's recommendations. This shall include but not limited to:
   1. Checking to ensure that the pad location is level to within 0.125 inches per three foot of distance in any direction.

2. Checking to ensure that all bus bars and structure assembly hardware is torqued to the manufacturer's recommendations.
3. Assembling all shipping sections, removing all shipping braces and connecting all shipping split mechanical and electrical connections.
4. Securing assemblies to foundation or floor channels.
5. Coordinating with the testing sub-contractor for proper testing of the equipment.
6. Inspecting and installing all circuit breakers in their proper compartments.

3.06 FIELD ADJUSTMENTS

A. The factory technician shall field adjust all timing and voltage settings of the transfer switch as necessary for proper operation of the unit. The equipment vendor shall coordinate with the generator manufacturer for proper settings.

3.07 FIELD TESTING

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer. The Engineer shall be notified in advance and shall have the option to witness the tests.

3.08 WARRANTY

A. The complete electrical transfer power system; controls, switchgear and accessories, and ancillary equipment shall be warranted by the manufacturer against defects in materials and workmanship for a period of five years or the manufacturer's stated warranty, whichever is greater, from the date of system startup and substantial acceptance of the completed system. Coverage shall include parts, labor, travel expenses and labor to remove reinstall defective equipment. No deductibles shall be applied to the warranty except for switchgear batteries being warranted for one year.

END OF SECTION

SECTION 26_24_16

PANELBOARDS

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall provide panelboards complete and operable, in accordance with the Contract Documents.

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

1.02 REFERENCES

A. The latest edition of the following codes or standards shall apply:
   1. NEC (NFPA 70) National Electrical Code.
   2. NEMA 250 Enclosure for Electrical Equipment (1,000 Volts Maximum).
   3. UL 50 - Standard for Safety for Enclosures for Electrical Equipment.
   4. UL 67 – Panelboards.

1.03 SUBMITTALS

A. General:
   1. Submittals shall be in accordance Section 26_05_02, Basic Materials and Methods.
      a. Breaker layout drawings with dimensions and nameplate designations.
      b. Drawings of conduit entry/exit locations.
      c. Assembly ratings including: Short circuit rating, Voltage; Continuous current.
      d. Cable terminal sizes.
      e. Descriptive bulletins.
      f. Product sheets.

PART 2 PRODUCTS

2.01 GENERAL

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

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

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

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

E. Panelboards shall be labeled with a UL short circuit rating. Panels shall be fully rated, series ratings are not acceptable.

F. Provide panelboards by Square-D or approved equal.

2.02 CONSTRUCTION:

A. All lighting and power distribution panels shall have copper bus bars density rated for maximum of 1000amps/sq-in. Enclosures for panelboards shall be galvanized and painted steel except enclosures for panelboards located in corrosive, damp or wet locations shall be stainless steel and NEMA-4X

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

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

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

E. Panelboards shall be UL listed.

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

PART 3 EXECUTION

3.01 GENERAL

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

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

END OF SECTION

SECTION 26_24_19

MOTOR CONTROL CENTERS, ARC FLASH RESISTANT

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install the motor control centers as specified herein and as shown on the Contract Drawings.

1.02 RELATED SECTIONS

A. Section 26_28_11, Circuit Breakers and Fusible Switches-Low Voltage.

B. Section 26_43_00, Surge Protective Devices.

1.03 REFERENCES

A. Equipment shall be manufactured in a certified ISO 9001 facility and shall be designed and tested to the latest edition of the following standards:
   1. UL 845, UL Listed
   2. National Electrical Manufacturers Association (NEMA) ICS 18-2001
   3. NEMA ICS 2.3 – Instruction for Handling, Operation and Maintenance of Motor Control Centers
   4. Canadian Standards Association – (CSA) C22.2 No. 245-05
   5. Electrical Equipment Manufacturers Association of Canada (EEMAC)
   6. National Electrical Code - NFPA 70
   7. Motor Control Centers rated for arc resistance shall be provided and tested according to the IEEE C37.20.7-2007 “IEEE Guide for Testing Metal Enclosed Switchgear Rated up to 38 kV for Internal Arcing Faults.” MCCs shall be provided with documentation and labeling indicating equipment is rated for these applications. Tests shall be witnessed and certified by a UL representative.

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:
   1. Master drawing index.
   2. Front view elevation.
   3. Floor plan.
   4. Top view.
   5. Unit wiring diagrams.
   6. Nameplate schedule.
   7. Starter and component schedule.
   8. Conduit entry/exit locations.
   9. Assembly ratings including:
      a. Short-circuit rating.
      b. Voltage.
      c. Continuous current.
   10. Major component ratings including:

a. Voltage.
b. Continuous current.
c. Interrupting ratings.
11. Cable terminal sizes.
12. Product data sheets.

B. Where applicable the following information shall be submitted to the Engineer:
1. Busway connection.
2. Connection details between close-coupled assemblies.
3. Key interlock scheme drawing and sequence of operations.

1.05 SUBMITTALS

A. The following information shall be submitted for record purposes:
1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process.
2. Unit wiring diagrams.
3. Certified production test reports.
4. Installation information.

1.06 QUALIFICATIONS

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

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

1.07 REGULATORY REQUIREMENTS

A. The motor control centers shall bear a UL label.

1.08 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer’s instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.09 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sqaure D Model 6 Arc Resistant or equal.

2.02 RATINGS

A. The Motor Control Center(s) shall be 600-volt class suitable for operation on a three-phase, 60 Hz system. The system operating voltage and number of wires shall be as indicated on the Drawings.

B. The Motor Control Center bus shall be braced for a minimum of 65K amperes, the main breakers shall have a minimum fully rated interrupting capacity of 65fkAIC.

2.03 CONSTRUCTION

A. Structures shall be totally enclosed, dead-front, free-standing assemblies. Structures shall be capable of being bolted together to form a single assembly.

B. The overall height of the MCC shall not exceed 90 in (not including base channel, lifting angle, baffle, or plenum). Base channels, of 1.5 in in height, and lifting angles, of 3 in in height, shall be removable. The total width of one section shall be 20 in; (widths of 25 in, 30 in, and 35 in can be used for larger devices).

C. Structures shall be NEMA/EEMAC type 1A (gasketed general purpose).

D. Each 20 in. wide standard section shall have all the necessary hardware and bussing for modular plug-on units to be added and moved around. All unused space shall be covered by hinged blank doors or appropriate cover plate and equipped to accept future units. Vertical bus openings shall be covered by manual bus shutters.

E. Each section shall include a top plate (single piece or two-piece). MCC shall have single piece top plate with exhaust flaps as specified in 2.03 G below. Top and bottom plates shall be removable for ease in cutting conduit entry openings.

F. MCC shall provide Type 2 Accessibility as defined by IEEEC37.20.7-2007 ‘IEEE Guide for Testing Metal-enclosed Switchgear Rated up to 38 kV for Internal Arcing Faults’.

G. MCCs shall have a Gas Management System that redirects and exhausts all arc fault yielding pressures and gases through a chimney chute out of the top of the MCC. The internal portion of the Gas Management System shall include unit midshelves fitted with breathable openings that redirect arc fault pressures and gases out of the unit towards the arc exhaust chimney. The external portion of the Gas Management System shall include MCC top plates designed with hinged flaps that allow for exhausting of arcing gases out of the top of the MCC. MCC shall be available with optional field-installable plenum assembly which provides continuous reinforced duct for directing arc flash energy outside MCC room.

2.04 WIREWAYS

A. Structures shall contain a minimum 12 in high horizontal wireway at the top of each section and a minimum 6 in high horizontal wireway at the bottom of each section. These wireways shall run the full length of MCC to allow room for power and control cable to connect between units in different sections.

B. A full-depth vertical wireway shall be provided in each MCC section that accepts modular plug-on units. The vertical wireway shall connect with both the top and bottom horizontal wireway. The vertical wireway shall be 4 in. wide minimum with a separate hinged door. There should be a minimum of 80 $in.^2$ of cabling space available for 20-inch-deep sections. Access to the wireways shall not require opening control unit doors. Structures that house a single, full section control unit are not required to have vertical wireways. Those control units must open directly into the MCC horizontal wireways.

C. Vertical wireway doors on MCCs rated for arc resistance shall be 12 gauge steel and have additional fasteners/receptacles installed for reinforcement from arc blast pressure

2.05 BARRIERS

A. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a glass filled polyester support assembly that braces the bus against the forces generated during a short circuit. The horizontal bus shall be isolated from the top horizontal wireway by a two-piece rigid non-conductive barrier. The barrier design shall allow qualified personnel to slide the barriers both left and right, to allow access to the bus and connections for maintenance without having to remove the barrier. Barrier sliding shall occur via an upper and lower track system.

B. The vertical bus shall be housed in a molded glass-filled polyester support that provides bus insulation and braces the bus against the forces generated during a short circuit. These supports shall have openings every 3 in for unit stab-on connections. Each opening shall be provided with a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the MCC.

C. Barriers shall be provided in the vertical structure and unit designs to prevent the contact of any energized bus or terminal by a fishtape inserted through the conduit or wireway areas.

D. Automatic shutters shall be provided for each plug-on unit which will automatically close to cover the vertical bus opening with a non-conductive shutter when the unit is removed from the MCC and automatically open the vertical bus opening as the unit is inserted in the same location in the MCC.

2.06 BUS

A. Each structure shall contain a main horizontal tin-plated copper bus, with minimum ampacity as indicated on contract drawings. Vertical bus feeding unit compartments shall be tin-plated copper and shall be securely bolted to the horizontal main bus. All joints shall be front-accessible for ease of maintenance. The vertical bus shall have a minimum rating of 300amps. Both vertical and horizontal bus shall be fully rated and shall not be tapered. All buss shall be density rated at a maximum of 1000A/square-inch.

B. The vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical buses to prevent any fault-generated gases to pass from one phase to another. The vertical bus shall include a shutter mechanism that will allow the unit stabs to engage the vertical bus every 6 inches and provide complete isolation of the vertical bus when a unit is removed. Buses shall be braced for 85K amperes RMS symmetrical, minimum.

C. A tin-plated copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the motor control center. The ground bus shall be located in the bottom horizontal wireway.

D. Each structure shall contain tin-plated vertical ground bus rated 300 amperes. The vertical ground bus shall be directly connected to the horizontal ground bus via a tin-plated copper connector. Units shall connect to the vertical bus via a tin-plated copper stab.

2.07 WIRING/TERMINATIONS

A. Wiring shall be NEMA Class-II Type- B.

2.08 MOTOR CONTROLLERS

A. Combination Starters:
   1. All combination starters shall use a unit disconnect as described in specification 2.08. Magnetic starters shall be furnished in all combination starter units. All starters shall utilize NEMA/EEMAC rated contactors. Starters shall be provided with a three-pole, external manual reset, overload relay for ambient compensated bimetallic thermal overload units.
   2. When provided, control circuit transformers shall include two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads. The transformer rating shall be fully visible from the front when the unit door is opened.
   3. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.
   4. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.

5. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.
6. Units provided in MCCs rated for arc resistance shall be fitted with 12 gauge steel doors and control station panels. Each unit shall have additional door hinges, arc latches, and fasteners that have been tested and provide additional rigidity and support in the event of an internal arc fault.

B. Terminal Blocks:
1. When Type B wiring is specified, all starter units shall be provided with unit control terminal blocks.
2. Terminal blocks shall be the pull-apart type with a minimum rating of 250 volt and 10 amps. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.
3. When Type C wiring is specified, all starter units shall be provided with unit control terminal blocks as described for Type B wiring along with power terminal blocks for size 1-3 units. An additional set of terminal blocks shall be provided in a terminal compartment located in each section. These terminal blocks shall be pre-wired to the unit terminals so that all field control connections can be made at the terminal compartments.

C. Pilot Device Panel.
1. Each combination starter unit shall be proved with a hinged/removable control station plate, which can accommodate up to five 22 mm pilot devices or three 30 mm pilot devices.
2. Each combination unit shall be rated 85,000 AIC symmetrical at 480-volt minimum. The HMCP shall provide adjustable magnetic protection and be adjustable to 1,700 percent motor nameplate full load current to comply with NEC requirements. All HMCP combination starter units shall have a “tripped” position on the unit disconnect and a push-to-test button on the HMCP. Type HMCP motor circuit protectors through size 4 shall include transient override feature for motor inrush current. HMCP shall be used to provide IEC 947-4 Type 2 coordination to 85,000 amperes.
3. Each starter shall be equipped with a fused, 120V ac nominal, control power transformer, two (2) indicating lights, Hand-Off-Auto (HOA) selector switch, and two (2) normally open contacts, unless otherwise scheduled on the drawings..
4. Solid-state reduced-voltage starters shall be provided where shown on the Contract Drawings. The solid-state reduced-voltage starter shall be UL and CSA listed in the motor control center, and consist of an SCR-based power section, logic board and paralleling bypass contactor. The paralleling bypass contactor shall be energized when the motor reaches full speed.

2.09 OVERCURRENT DEVICES

A. Circuit Breakers:
   1. Individual feeder breakers shall have a minimum full rated interrupting capacity of 65kAIC at rated voltage or as scheduled on the Drawings.
   2. Feeder breakers shall have a series rated interrupting capacity of 85kAIC, when rated in series with 85kAIC rated MCC main breakers.

2.10 VOLTAGE PRESENCE INDICATOR

A. Voltage Presence Indicators shall be provided on the unit door of MCC starter and feeder units as per Contract Documents. This will be a power on push to test 30 mm pilot light.

2.11 INCOMING FEEDER TERMINATIONS AND DEVICE

A. Incoming cable shall terminate within the control center on a main breaker termination point. Main lug terminations shall have adequate dedicated space for the type and size of cable used and the lugs shall be two hole long barrel double compression-type with anti-turn feature. Main breakers shall be provided as indicated on the drawings and shall be molded case unless otherwise noted as power circuit breakers, stored energy device.

2.12 OWNER METERING

A. Provide a separate, owner metering compartment with front hinged door.

B. Provide as a minimum of three (3) current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.

C. Provide potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the Drawings.

D. Microprocessor-Based Metering System. Provide Square-D PM8244 power monitor with Ethernet TCP/IP communication module. No equal.

2.13 ENCLOSURES

A. The type of enclosure shall be in accordance with NEMA standards for NEMA Type 1A or as shown on the drawings. All enclosing sheet steel, wireways and unit doors shall be gasketed.

2.14 NAMEPLATES

A. Shall be engraved phenolic nameplates for each MCC and unit compartment. Provide nameplates as specified in 26 05 53 to match other facility equipment.

2.15 FINISH

A. The control center shall be given a phosphatizing pretreatment. The paint coating shall be a polyester urethane, thermosetting powder paint. Manufacturer's standard color shall be used. All structural steel and panels will be painted.

B. The control center finish shall pass 600 hours of corrosion-resistance testing per ASTM B 117.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. Representative motor control centers shall have been tested in a high-power laboratory to prove adequate mechanical and electrical capabilities.

B. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.

C. A certified test report of all standard production tests shall be available to the Engineer upon request.

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and startup of the equipment specified under this section as determined by the engineer. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative:
   1. Rig the MCC assembly into final location and install on level surface.
   2. Check all removable cells and starter units for easy removal and insertion.
   3. Perform insulation tests on each phase and verify low-resistance ground connection on ground bus.
   4. Connect all power wiring and control wiring and verify basic operation of each starter from control power source.
   5. Torque all bolted connections made in the field and verify all factory bolted connections.
   6. Calibrate any solid-state metering or control relays for their intended purpose and make written notations of adjustments on Record Drawings. Perform startup of any solid-state starters and adjustable frequency drives.

C. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. Provide three (3) copies of the manufacturer's representative's certification.

3.04 TRAINING

A. The Contractor shall provide a training session for owner's representatives as requested by the Owner or Engineer.

B. A manufacturer's qualified representative shall conduct the training session.

C. The training program shall consist of the following:
   1. Review of the MCC one-line drawings and schedules.
   2. Review of the factory record shop drawings and placement of the various cells.
   3. Review of each type of starter cell, components within, control, and power wiring.
   4. Review contactor coil replacement and contact replacement procedures.
   5. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
   6. Provide three-ring binders to participants complete with copies of Drawings and other course material covered.

3.05 EXAMINATION

A. Provide overload relay heater ratings that are properly sized and coordinated for each motor starter unit.

B. Verify NEC clearances as dictated on the contract drawings prior to installation. Verify UL labeling of the assembly prior to installation.

END OF SECTION

SECTION 26_27_13

ELECTRIC SERVICE

PART 1 GENERAL

1.01 DESCRIPTION OF SYSTEM:

A. The Electrical Utility Company will provide the electrical service of the characteristics as shown on the Drawings. This Contractor's work will begin where the Utility Company's work ends.

B. The Contractor shall furnish all labor, materials, etc., necessary for a complete approved electrical service as required for this project, including inspection and approval by the Utility and local Inspection Departments (if any) and inform the Engineer prior to energizing power lines.

C. This Contractor shall notify the Utility Company in writing, with two copies to the Engineer, no later than ten (10) days after signing contracts as to when this Contractor anticipates the building power service will be required.

D. The Contractor is responsible for complete application, coordination and scheduling of the electrical service with FPL. Contractor is required to complete all service applications and deliver to County project manager to acquire proper signatures.

1.02 CONSTRUCTION FACILITIES:

A. The facilities and equipment required to provide all electrical power for construction, lighting and balancing and testing consumed prior to final acceptance of the project shall be provided under this section of the specifications. All wiring, outlets and other work required to provide this power at the site and within the building for all trades shall be arranged for, furnished and installed under this section of the specifications including any fee, charge or cost due the utility company for temporary power installation or hook-ups.

B. Facilities shall be furnished in a neat and safe manner in compliance with governing codes, good working practices and OSHA regulations.

1.03 UNDERGROUND ELECTRICAL SERVICE:

A. Furnish and install underground 480V/277 volt 3ph, 4 wire service from power company pad-mount transformers or pole base handholes to main service equipment. Seal conduit with duct-seal where entering building.

B. The underground service shall comply with all the requirements of the NEC, local Utility Company and local enforcing authority.

1.04 UTILITY COMPANY FEES, CHARGES AND COSTS

A. It is the Contractor's responsibility to contact the required Utility Company to determine if any fees, charges or costs will be due the Utility Company, as required

by the Utility Company for temporary power, installations, hook-ups, etc. This fee, charge or cost shall be turned over to the County Project manager for payment.

B. This project was coordinated with FPL:
Service Designer, Engineer I:
Brandon Parrish at 239.415.1319 or Brandon.Parrish@fpl.com.

FPL has been provided a set of the final plans and specs for the project.

1.05 SUBMITTALS

A. Submit product data on:
1. Meter base and CT, cabinet if applicable.
2. Copy of Contractors notice to FPL.
3. Copy of Contractors transmittal of FPL invoice to County.

PART 2 PRODUCTS

2.01 METERING:

A. Meter bases shall be furnished and installed by this contractor. Provide aluminum meter bases. Metering bases and conduits must be installed in accordance with the Utility Company requirements.

B. FP&L requirements. Work to be completed under this section shall be in accordance with FP&L documentation and standards.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 26_28_11

CIRCUIT BREAKERS AND FUSIBLE SWITCHES – LOW VOLTAGE

PART 1 GENERAL (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

2.02 POWER CIRCUIT BREAKERS

A. Provide power circuit devices, type low-voltage power circuit breakers, Square D type MasterPact NW or approved equal. Frame ratings shall be 800, 1600, 2000, 3200, 4000 amperes. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.

B. Breakers shall be manually operated (MO) or electrically operated (EO) as indicated on the drawings.

C. Electrically operated breakers shall be complete with close/open pushbuttons control switch, plus red and green indicating lights to indicate breaker contact position 120 Vac motor operators; the charging time of the motor shall not exceed 6 seconds. Source voltage shall be taken from a control power transformer internal to the switchgear assembly.

D. All circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000amperes or higher where shown on the drawings. To ensure a selective system, all circuit breakers shall have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85,000 amperes, regardless of whether equipped with instantaneous trip protection or not.

E. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standards. The circuit breakers shall carry a UL label.

F. Provide units Arc Flash Reduction Maintenance Remote accessory as specified in Paragraph 2.03. The Arc Flash Reduction Maintenance Remote shall allow the operator to enable a maintenance mode with a preset accelerated instantaneous override trip to reduce arc flash energy.

G. To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker. The power circuit breaker shall have a closing time of not more than 3 cycles. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

H. The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.

I. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a “Positive On” feature. The breaker flag will read “Closed” if the contacts are welded and the breaker is attempted to be tripped or opened.

J. The current sensors shall have a back cover window that will permit viewing the sensor rating on the back of the breaker. A rating plug will offer indication of the rating on the front of the trip unit.

K. A position indicator shall be located on the faceplate of the breaker. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green). The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open.

L. Each power circuit breaker shall offer sixty (60) front mounted dedicated secondary wiring points. Each wiring point shall have finger safe contacts, which will accommodate #10 AWG maximum field connections with ring tongue or spade terminals or bare wire.

M. include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall secure the breaker in the connected, test or disconnected position by preventing levering

2.03 TRIP UNITS

A. Each low-voltage power circuit breaker and insulated case circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The trip unit shall Square D Micrologic P with MODBUS communication module.

B. The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

C. The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

D. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

E. Trip unit shall have selectable thermal memory for enhanced circuit protection.

F. The trip unit shall provide zone interlocking for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream breaker and allow the breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after a preset time delay. Factory shall wire for zone interlocking for the power circuit breakers within the switchgear.

G. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A test pushbutton shall energize a LED to indicate the battery status.

H. The trip unit shall be equipped to permit communication via Modbus to the switchgear Allen Bradley compactlogix PLC system provided in the equipment for remote monitoring and control. All monitored parameters shall be transmitted.

I. The trip unit shall include a power/relay module, which shall supply control power to the readout display. Following an automatic trip operation of the circuit breaker, the trip unit shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. An internal relay shall be programmable to provide contacts for remote ground alarm indication.

J. The trip unit shall include a voltage transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the power relay module shall be connected internally to the line side of the circuit breaker through a dielectric test disconnect plug.

K. The display for the trip units shall be a 24-character LED display.

L. Metering display accuracy of the complete system, including current sensors, auxiliary CTs, and the trip unit, shall be +/- 1% of full scale for current values. Metering display accuracy of the complete system shall be +/- 2% of full scale for power and energy values.

M. The unit shall be capable of monitoring the following data:
   1. Instantaneous value of phase, neutral and ground current
   2. Instantaneous value of line-to-line voltage
   3. Minimum and maximum current values
   4. Watts, vars, VA, watthours, varhours, and VA hours, Peak demand, Present demand,Energy consumption.

5. Crest factor, power factor, percent total harmonic distortion, and harmonic values of all phases through the 31st harmonic.

N. An adjustable high load alarm shall be provided, adjustable from 50 to 100% of the long delay pickup setting.

O. The trip unit shall contain an integral test pushbutton. A keypad shall be provided to enable the user to select the values of test currents within a range of available settings. The protection functions shall not be affected during test operations. The breaker may be tested in the TRIP or NO TRIP test mode.

P. Programming may be done via a keypad at the faceplate of the unit or via the communication network.

Q. System coordination shall be provided by the following microprocessor-based programmable time-current curve shaping adjustments. The short-time pickup adjustment shall be dependant on the long delay setting.
   1. Programmable long-time setting
   2. Programmable long-time delay with selectable I2t or I4t curve shaping
   3. Programmable short-time setting
   4. Programmable short-time delay with selectable flat or I2t curve shaping, and zone selective interlocking
   5. Programmable instantaneous setting
   6. Programmable ground fault setting trip or ground fault setting alarm
   7. Programmable ground fault delay with selectable flat or I2t curve shaping and zone selective interlocking

R. The trip unit shall offer a three-event trip log that will store the trip data, and shall time and date stamp the event.

S. The trip unit shall have the following advanced features integral to the trip unit:
   1. Adjustable undervoltage release
   2. Adjustable overvoltage release
   3. Reverse load and fault current
   4. Reverse sequence voltage alarm
   5. Underfrequency
   6. Overfrequency
   7. Voltage phase unbalance and phase loss during current detection

T. The main breakers fitted with trip units shall be provided with an Arcflash Reduction Maintenance System Technology capability. The Arcflash Reduction Maintenance System shall allow the operator to enable a maintenance mode using a remote control which enables a preset accelerated instantaneous override trip to reduce arc flash energy. A blue LED on the trip unit shall indicate the trip unit is in the maintenance mode

2.04 INSULATED CASE CIRCUIT BREAKERS

A. Protective devices shall be switchboard class insulated case low-voltage power circuit breakers. Frame ratings shall be 800, 1600, 2000 amperes. All breakers shall be UL listed for application in their intended enclosures for 100 percent of their continuous ampere rating.

B. Breakers shall be manually operated (MO) or electrically operated (EO) as indicated on the Drawings.

C. Electrically operated breakers shall be complete with close/open pushbuttons control switch, plus red and green indicating lights to indicate breaker contact position 120V ac motor operators; the charging time of the motor shall not exceed 6 seconds. Source voltage shall be taken from a control power transformer internal to the switchgear assembly.

D. All insulated case circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes or greater where shown. To ensure a selective system, all circuit breakers shall have 30-cycle short-time withstand ratings equal to 18 times their frame ratings. Insulated case circuit breakers without an instantaneous trip element adjustment shall be equipped with a fixed internal instantaneous override set at that level.

E. All insulated case circuit breakers shall be constructed and tested in accordance with UL 1066. The circuit breakers shall carry a UL label.

F. Provide units Arc Flash Reduction Maintenance Remote accessory as specified in Paragraph 2.05. The Arc Flash Reduction Maintenance Remote shall allow the operator to enable a maintenance mode with a preset accelerated instantaneous override trip to reduce arc flash energy.

G. To facilitate lifting, the insulated case circuit breaker shall have integral handles on the side of the breaker. The insulated case circuit breaker shall have a closing time of not more than 3 cycles. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.

H. The insulated case circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.

I. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a “Positive On” feature. The breaker flag will read “Closed” if the contacts are welded and the breaker is attempted to be tripped or opened.

J. The current sensors shall have a back cover window that will permit viewing the sensor rating on the back of the breaker. A rating plug will offer indication of the rating on the front of the trip unit.

K. A position indicator shall be located on the faceplate of the breaker. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test (Yellow), and Disconnect (Green). The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open.

L. Each insulated case circuit breaker shall offer sixty (60) front mounted dedicated secondary wiring points. Each wiring point shall have finger safe contacts, which will accommodate #10 AWG maximum field connections with ring tongue or spade terminals or bare wire.

2.05 TRIP UNITS

A. Each low-voltage power circuit breaker and insulated case circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker.

B. The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

C. The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

D. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.

E. Trip unit shall have selectable thermal memory for enhanced circuit protection. Protective device coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid-state elements:
   1. All circuit breakers shall have adjustments for long delay pickup and time.
   2. All circuit breakers shall have individual adjustments for short delay pickup and time, and include I^2t settings.
   3. All circuit breakers shall have an adjustable instantaneous pickup.
   4. All circuit breakers shall have individually adjustable ground fault current pickup and time, and include I^2t settings or ground alarm only.

F. The trip unit shall have provisions for a single test kit to test each of the trip functions.

G. The trip unit shall provide zone interlocking for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream breaker and allow the breaker closest to the fault to trip with no intentional time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after a preset time delay. Factory shall wire for zone interlocking for the power circuit breakers within the switchgear.

H. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A test pushbutton shall energize a LED to indicate the battery status.

I. The trip unit shall have a 4-character LCD display showing phase, neutral, and ground current. The accuracy of these readings shall be plus or minus 2 percent of full scale.

J. All switchboard main circuit breaker trip units shall be provided with an Arcflash Reduction Maintenance System Technology capability. Delete this requirement when the switchboard is feed through main switchgear that has provision for arc flash maintenance mode on the switchboard feeder breaker. The Arcflash Reduction Maintenance System shall allow the operator to enable a maintenance mode using a 5 position switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. A blue LED on the trip unit shall indicate the trip unit is in the maintenance mode.

2.06 MOLDED CASE CIRCUIT BREAKERS – 800 A AND BELOW

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

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

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

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

E. Circuit breakers 800 ampere through 1,200 ampere frame shall have microprocessor-based rms sensing trip units.

2.07 QUICK-MAKE/QUICK-BREAK FUSIBLE SWITCHES

A. Protective devices shall be quick-make/quick-break fusible switches. Fusible switches 30 amperes through 600 amperes frames shall be furnished with rejection Class “R” or “J” type fuse clips unless otherwise scheduled. Fusible switches 800 amperes through 1200 amperes shall be furnished with Class L fuse clips. Switches shall incorporate safety cover interlocks to prevent opening the cover with the switch in the ON position or prevent placing the switch in the ON position with the cover open. Provide defeater for authorized personnel. Handles shall have provisions for padlocking and shall clearly indicate the ON or OFF position. Front cover doors shall be padlockable in the closed position.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 26_29_13

CONTROL PANELS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish all labor, equipment, and materials for control panels as indicated on the Drawings and specified herein. The panel supplier shall be a UL listed panel shop and all panels shall be UL-508 certified and labeled.

B. Control panel equipment shall be coordinated to provide all the specified control as indicate in the elementary diagrams or specified herein.

C. The Contractor shall be responsible for coordinating and interfacing with equipment and instrumentation supplied under other sections of the Contract Documents that are an integral part of the plant control systems. This interfacing shall be incorporated in the detailed systems drawings and data sections to be submitted by the Contractor prior to rough-in work.

1.02 SUBMITTALS

A. The Contractor shall submit to the Engineer for approval complete shop drawings, wiring diagrams, data, and operation and maintenance manuals of all equipment to be furnished under this section.

B. Coordination and Shop Drawings: Prepare and submit coordination drawings for installation of products and materials fabricated. Coordination and shop drawings shall be prepared using a computer aided drafting system compatible with Autodesk Autocad version 2012 or greater. Coordination and shop drawings shall be submitted on hard copy and electronic CD-Rom (dwg) format.
   1. Submit component interconnect drawings showing the interconnecting wiring between each component including equipment supplied under other sections requiring interfacing with the control system. Diagrams shall show all component and panel terminal board identification numbers, and external wire and cable numbers. Note, this diagram shall include all intermediate terminations between field elements and panels (e.g., terminal junction boxes, pull boxes, etc.). Diagrams' devise designations, and symbols shall be in accordance with NEMA ICS 1-101.
   2. Panel Wiring Diagrams: Elementary diagrams shall be similar to those diagrams shown in the Drawings, but with the addition of all auxiliary devices such as additional relays, alarms, fuses, lights, fans, heaters, etc.
   3. Panel wiring diagrams shall identify wire numbers and types, terminal numbers, tag numbers and PLC I/O identification (address) numbers. Wiring diagrams shall show all circuits individually; no common diagrams shall be allowed.

4. Submit arrangement and construction drawings for consoles, control panels, and for other special enclosed assemblies for field installation. Include dimensions, identification of all components, preparation and finish data, nameplates, enough other details to define the style and overall appearance of the assembly and a finish treatment. Drawings shall show the location of all front panel mounted devices to scale, and shall include a panel legend and a bill of materials. The panel legend shall list and identify all front of panel devices by their assigned tag numbers, all nameplate inscriptions, service legends and annunciator inscriptions. The bill of materials shall list all devices mounted within the panel that are not listed in the panel legend, and shall include the tag number, description, manufacturer and complete model number for each service.
5. Submit installation, mounting, and anchoring details for all components.

C. Operation, Maintenance and Repair Manuals:
1. Submit operation and maintenance manuals.

1.03 CODES AND STANDARDS

A. Equipment, materials, and workmanship shall comply with the latest revisions of the following codes and standards.
1. Instrumentation: Instrument Society of America (ISA).
2. National Electrical Code (NEC).
3. Wiring: ISA S5.3 and S5.4, latest issue.
4. Control Panels and equipment: NEMA, UL and ANSI.
5. Control Logic: Joint Industrial Council (JIC).
6. UL508A and UL508A-SB.

PART 2 PRODUCTS

2.01 GENERAL

A. Control panels shall be UL508A/SB compliant. Control panels shall be marked with a short circuit current rating (SCCR). The SCCR shall be equal to or more than the short circuit current available at the panel line terminals and in no case be less than 10,000A SCCR. The panel designer shall verify the available short circuit required.

B. The electrical control equipment shall be mounted within a pad-lockable NEMA Type 4X dead-front enclosure constructed of not less than 304 stainless steel and shall be equipped with a 3-point latch with all hardware and exterior components construction of 300 series stainless steel (except control panels in air conditioned spaces and electrical room may be NEMA 1 painted steel). The enclosure shall be equipped with an inner dead front door and shall incorporate a removable, aluminum or stainless steel back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. All hardware shall be stainless steel. Provide safety hardware to hold the door in an open position. Provide a folding shelf on the door for convenient temporary support of a laptop computer.

C. Components: All motor branch circuit breakers; motor starters and control relays shall be of highest industrial quality, securely fastened to the removable back panels with screws and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.

D. A circuit breaker shall be provided on each control panel as a means of disconnecting power to the control panel. The circuit breaker operating handle shall be installed on the right side of the cabinet not in the door. The door shall be interlocked from opening when the circuit breaker is in the on position. The circuit breaker operating handle shall have an interlock defeat mechanism for qualified personnel to gain access to the panel without shutting off power.

E. Control transformers shall be installed where shown to provide 120V ac and 24V ac for control circuits. Transformers shall be fused on the primary and secondary circuits. The transformer secondary shall be grounded on one leg.

F. All control panel wiring shall be identified at both ends with type written heat shrinkable wire markers with the numbering system shown on the control submittal drawings.
   1. Control wiring shall be stranded copper, minimum size #14 AWG (except for shielded instrumentation cable may be #16 AWG), with 600 volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation.
   2. Wire shall be guided within control and terminal cabinets by cable supports (duct). Instrumentation and control field cables on the unprotected side of SPD devices within the cabinet shall not run in parallel to the cables on the protected side of the SPD device. Separate cable supports (duct) will be provided.
   3. All conductors shall be neatly led to terminations. All connections of stranded wire to screw type terminal blocks shall be by insulated spade lugs, crimp fastened to wire. Provide stranded wire crimp ferrules for all stranded wire connections not requiring spade lugs for screw type terminal blocks.

G. The control panel shall be provided with nameplates identifying each component, selector switches, pilot lights, etc. Nameplates shall be permanently affixed using an epoxy process. Nameplates shall be laminated plastic, engraved white letters with a black background.

H. Corrosion Inhibitor Emitter: Provide an industrial corrosion inhibitor emitter on all exterior mounted control panels that will protect internal components of the control panel from corrosion one year. Provide one spare emitter for each control panel.

I. Terminal strips shall be provided for all signals as indicated on the drawings plus all spare conductors as specified. Terminal strips shall be switch type with integral fuses equal to Allen Bradley 1492-H6. Wiring from the control panel to the terminal strips shall be factory installed. All spare conductors shall be terminated and identified. All terminals over 200V phase to phase shall be covered with approved plastic shields.

J. Relays:
   1. Control circuit switching shall be accomplished with relays. These relays, for interfacing and control applications, shall be the compact general purpose plug-in type having low coil inrush and holding current characteristics. A neon status-indicating light shall be provided with each relay. Contact arrangements shall be as noted or shown, and shall be rated for not less than 10 amperes at 120V ac or 28V dc. Coil voltage shall be as noted or shown. Non-latching relays shall have a single coil. Latching relays shall have two coils, unlatching being accomplished by energizing one coil, and latching being accomplished by energizing the other coil. Relays shall have plain plastic dust covers, test buttons, and mounting sockets with screw terminals and holddown springs. Relays shall be UL recognized. Relays shall be Potter and Brumfield, Struthers-Dunn, or equal.
   2. Time delay functions shall be accomplished with time delay relays. Units shall be adjustable time delay relays with the number of contacts and contact arrangements as shown. A neon status-indicating light shall be provided with each relay. Contacts shall be rated for 10 amperes at 120V ac. Integral knob with calibrated scale shall be provided for adjustment of time delay. Initial setting shall be as shown with time delay range approximately three times the initial setting. Time delay rangeability shall be at least 10:1. Operating voltage shall be 120V ac, plus 10 percent, -15 percent at 60-Hz. Operating temperature shall be -20 degrees F to 165 degrees F. Repeat timing accuracy shall be plus or minus 10 percent over the operating range. Units shall be Amerace Corp., Control Products Division, Agastat Series 7000, Cutler-Hammer Series D87, or equal.
   3. All relays shall have a screw terminal interface with the wiring. Terminals shall have a permanent, legible identification. Relays shall be mounted such that the terminal identifications are clearly visible and the terminals are readily accessible.

K. Front Panel Operating Controls and Instruments:
   1. All operating controls and instruments shall be securely mounted on the control compartment door. All controls and instruments shall be clearly labeled to indicate function.
   2. Indicator lamps shall be LED full voltage push to test type and mounted in NEMA 4X (800H) modules, as manufactured by Allen Bradley or SKPI as manufactured by Square D. Lamp modules shall be equipped to operate at 24 or 120 volt input. Lamps shall be easily replaceable from the front of the control compartment door without removing lamp module from its mounted position. Units shall be heavy-duty, oiltight, push to test industrial type with screwed on prismatic glass lenses in colors as shown, and shall have factory engraved legend plates. LED's shall be high illumination type (5ma at 130V ac).

3. Selector switches shall be heavy-duty, oiltight, industrial type selector switches with contacts rated for 120V ac service at 10 amperes continuous. Units shall have standard size, black field, legend plates with white markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements and spring return function (if any) as shown. Units shall be single-hole mounting, accommodating panel thickness from 1/16-inch minimum to 1/4-inch maximum. Units with up to four selection positions shall be Allen Bradley 800H, Square D Type K, Cutler-Hammer Type T, or equal. Units with up to 12 selection positions shall be Rundel-Idec Standard Cam Switch, Electroswitch 31, or equal.

L. Process Meters

1. Provide digital programmable process meters with a loop powered display designed for a 4-20MA current loop. Provide minimum 0.5" high, 4-1/2 digit LED display to indicate amplitude of current in the current loop. In general, a loop current of 4ma corresponds to a display indication of 0 percent and a loop current of 20ma corresponds to a display indication of 100 percent. The meter shall be provided with programmable internal scaling adjustment. Provide units with NEMA-4X faceplate rating constructed of silicone coated Lexan and gasketed for NEMA 4 requirements; circuit boards coated for moisture resistance. Provide panel meters for each analog process variables; Pressure, level and flow as indicated Yokogawa or approved equal.

PART 3 EXECUTION

3.01 MOUNTING OF EQUIPMENT AND ACCESSORIES

A. Install and mount equipment in accordance with the Contract Documents, and installation detailed shop drawings. Mount equipment so that they are rigidly supported, level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock and vibration; and freedom from interference with other equipment, piping, and electrical work.

B. Mount local equipment in cabinets or existing panels as specified. Mount associated terminals on a common panel or rack; all terminals over 200V phase to phase shall be covered with plastic shields.

C. Provide services of panel manufacturer to test the completed system after installation to assure that all components are operating with the specified range and all interlocks are functioning properly. Panel manufacturer shall certify functional operation and calibration in written startup report. Perform field tests on all completed control assemblies to demonstrate conformance to specifications and functional compatibility.

END OF SECTION

SECTION 26_29_23

VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 FURNISHING OF EQUIPMENT

A. Unless specifically noted otherwise, variable frequency motor drives for all equipment requiring them shall be furnished under this section. The drive manufacturer shall furnish all required controls as specified herein and as functionally required by the instrumentation and controls section.

B. The manufacturer shall be Square D Altivar 660 Process Drive series. No equal.

C. Provide Altivar 660 drives with necessary modifications to provide a two second power loss ride through.

D. The manufacturer of 1 phase drives for chemical pumping systems shall be Square D. Provide Altivar 12 series for 1/4HP, 120V, 1 phase drives.

E. Provide all drives with conventional analog and digital control interface for control and Ethernet/IP network communications for monitoring to the plant control system.

F. Provide equipment purchased from the manufacturer's representative authorized to represent the manufacturer in the projects territory, Lee County Florida.

G. The manufacturer shall factory fabricate the drive cabinets to match the plan lineup and available space indicated.

1.02 DESCRIPTION OF SYSTEM

A. Factory-assembled, metal-enclosed VFD motor control units for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place. Where shown on Drawings, furnish and install VFD units in freestanding NEMA 1 gasketed, ventilated and filtered motor control cabinets as herein specified. The motor control shall be supplied from a 3-phase, 3-wire 60 cycle power system as shown. A U.L. label shall be provided on each section indicating compliance with UL Standards. The adjustable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of ETL, UL, ANSI, and NEMA.

B. VFD Motor Control Units shall include all protective devices and equipment as listed on Drawings or as included in these Specifications, with necessary interconnections, instrumentation, and control wiring.

C. The VFD manufacturer shall be responsible for providing a system for the specific installation intended, including considerations of conductor distances from the drive to the motor. Each VFD drive shall include an output dv/dt filter system within the VFD cabinet to limit voltage peak and voltage rise time at the motor terminals. The filters must limit the voltage rise time and voltage peak at the motor terminals to those required by NEMA MG1-1993, Section IV, Part 30 with voltage peak less than 1,000 volts and rise time greater than 2 microseconds.

1.03 QUALITY ASSURANCE

A. Reference Standards:
   1. American National Standard Institute (ANSI):
      a. ANSI Y32.2-1975, Graphic Symbols for Electrical and Electronic Diagrams.
      b. ANSI Z55.1-1967 (R1973) Gray finishes for Industrial Apparatus and Equipment.
   2. National Electrical Manufacturers Association (NEMA):
      a. NEMA ICS-1, 2, 3, 4, 5, 6, controls and systems.
   3. National Fire Protection Association (NFPA):
      a. NFPA 70-2017, National Electric Code (NEC).
      b. NFPA-70E-2018 Standard for Electrical Safety in the Workplace.
   4. Underwriters' Laboratories, Incorporated (UL):
      a. UL Electrical Construction Materials List, motor controllers motor-control centers (NJAV), (HJOT) and (NLDX).

1.04 SUBMITTALS

A. Product Data:
   1. Layouts showing concrete pad dimensions, conduit entrance and available space, bus duct connections, electrical ratings, nameplate nomenclature, and single-line diagrams in accordance with ANSI Y32.2 indicating connections and controls with numbered terminals.
   2. Frame sizes and Interrupting Capacity of unit.
   3. Horsepower rating and rated voltage of unit.
   4. Manufacturer's written recommendation for storage and protection, installation instructions and field test requirements.
   5. Manufacturer's instructions for tightening bus connections, performing cleaning, and operating and maintaining motor control unit.
   6. Submit written verification that overall dimensions are within the maximum dimensions indicated on plans.
   7. Submit manufacturer’s recommended spare parts list.

B. Shop Drawings:
   1. Complete master wiring diagrams, elementary schematics and control schematics shall be submitted for approval before proceeding with manufacture. Suitable outline drawings shall be furnished as part of this submittal. Standard or typical pre-printed sheets or Drawings simply marked to indicate applicability to this Contract will not be acceptable. Shop Drawings shall be job specific.
   2. A complete Drawing indicating each point of interface with the process control system and the type of signal provided or accepted at each point.
   3. A complete drive programmer’s manual.

4. A Drawing showing the layout of the VFD local control panel indicating every device mounted on the door with complete identification.
5. Provide Shop Drawings on 11-inch by 17-inch paper and drawn with a computer aided design (CAD) package. The computer aided design package shall be Autocad or converted to Autocad format. Submittals shall include hard copy and CD-ROM media electronic copies (dwg format).

1.05 WARRANTY

A. The equipment manufacturer shall provide a one year warranty or the manufacturer's standard warranty, whichever is greater, from initial startup and demonstration of the complete automatic controlled drive pump system to the engineer. The equipment manufacturer shall guarantee that the equipment furnished is suitable for the purpose intended and free from defects of design, material and workmanship. In the event the equipment fails to perform as specified, the equipment manufacturer shall promptly repair or replace the defective equipment without any costs to the Owner (including labor, transportation, handling and shipment costs). Warranty shall not cover damage to the equipment caused by external sources and operator errors; however the units shall be protected from power line surges and electrical fault conditions and therefore the warranty shall apply to power line transient surge, ground faults, line to line faults, EMI and RFI interference and other external electrical disturbance caused damage.

B. The VFD manufacturer shall maintain as part of a national network, engineering service facilities within 150 miles of the Project to provide startup service, emergency service calls, repair work, and service contracts.

1.06 SPARE PARTS:

A. Provide spare parts as follows: One complete set of VFD inverter fans and VFD enclosure fans.

B. Provide a list of manufacturer's recommended spare parts. The owner may purchase additional spare parts separate from or as an added cost to the project.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide 75hp and above VFD's as manufactured by Square D Altivar 660 Process Drive series with clean power drive. Provide 20hp and below VFD's as manufactured by Square D Altivar 320 Process Drive series with clean power drive. Provide clean power controller utilizing a front end MTE Matrix broadband filter with harmonic cancellation techniques. The VFD shall contain a built in cut-out circuit to automatically take the filter offline on low power loads. Provide Ethernet communications capability. Provide hard wired control where shown on the drawings.

B. The VFDs shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a three step operation. Adjustable Current Source VFDs are not acceptable. IGBT type Transistors shall be used in the inverter section. GTOs and SCRs are not

acceptable. The VFDs shall be current regulated. VFDs permitting instantaneous over current trips other than for output short circuit are not acceptable.

C. All VFDs shall utilize a vector torque control strategy to regulate motor flux to optimize motor torque without the need for encoders. VFDs requiring voltage, dwell and current adjustments to achieve improved torque control are not acceptable.

D. The manufacturer shall supply variable frequency drives compatible with the pump motors for operation of these motors at motor full load amps. The drives shall vary the output frequency from minimum to maximum pump speed typically 6-60hz.

E. The drive shall be of sufficient capacity and provide a quality of output waveform so as to achieve full rated and continuous output of the pump motor. All drives shall be factory built-up units complete with all necessary and specified components, as hereinafter defined, which shall be supplied by the drive manufacturer as a unit. Each built-up drive shall be tested by the drive manufacturer prior to shipment from the factory and a certificate of the test provided.

2.02 ENVIRONMENTAL CONDITIONS

A. The drive shall accept plant power nominal AC voltage of 480V ac +10 percent -10 percent, 3 phase, 60 Hertz ± 3 percent.

B. The operating ambient condition shall have a temperature range of 0 to 40 degrees Celsius with a relative humidity of up to 95 percent (non-condensing).

2.03 CONSTRUCTION TECHNIQUES

A. The drive shall be of modular design to provide for ease and speed of maintenance including removal of modules, with one maintenance technician.

B. All components shall be mounted in a NEMA type 1 gasketed, ventilated and filtered enclosure properly sized to dissipate the heat generated by the power electronics. The enclosure shall be painted with corrosion resistant coatings with finish paint of manufacturer’s standard color. Either top or bottom entry of cables shall be permitted.

C. The DC bus shall be filtered by series inductor & capacitors to provide ripple free dc.

D. Circuit breakers: The operating mechanism shall be designed so that the door can be padlocked in the "Off" position. Protection for the VFD's power circuit shall be provided by use of circuit breakers and type "J" input fuses.

E. A relay shall be provided that energizes and provides 120V power to a motor space heater when the drive is not running.

F. The drive shall meet any one of the following standards; CSA, ETL, UL.

G. All VFD's must be tested/run under load until rated operating temperatures is achieved.

H. Provide VFDs with shock hazard shielding methods for all exposed terminals, bus bars and termination points. The low voltage terminals, buss bars, lugs etc. shall be physically guarded, insulated and/or isolated to insure safety to maintenance personnel and for reduced arc flash hazard.

I. Provide VFDs with approved ventilation air filter frame mounting and hardware assemblies.

J. The VFD shall be furnished with a diagnostic indicator to show low bus/line and high bus/line voltage conditions, timed current overload and inverter output fault. Drive ready and Drive run status indication shall be standard.

2.04 ACCESSORIES

A. The unit shall include an incoming, UL listed, circuit breaker. A three position switch (hand-off-auto) mounted on the controller door provides manual selection of local or auto control. The "Hand" position allows manual local keypad run/stop and speed control of the VFD; the speed control shall be via a keypad mounted on the door calibrated from 0-100 percent speed. The door of the VFD cabinet shall contain but not be limited to the following devices:
   1. Circuit breaker operating handle - mechanically interlocked with the door.
   2. Key Pad and alpha numeric displays providing programming and manual control of the drive.
   3. VFD fault indicating light.
   4. Hand off auto switch.
   5. Power On indicating light.
   6. VFD Run indicating light.
   7. Motor High Temperature indicating light.
   8. Process parameter control indicating light (Ex: Low Level shutdown).

B. The Altivar 320 unit shall include a dial and escape button mounted on the unit drive to navigate the menus and set drive speed control calibrated from 0-100% speed. The unit shall contain but not be limited to the following devices:
   1. Integrated Alpha numeric displays providing programming and manual control of the drive.
   2. VFD fault indicating light.
   3. VFD Run indicating light.

C. Provide a UPS with manual bypass to hold the 120V ac control relays active during a momentary power outage. Size UPS for a minimum of 60 second run time.

D. Provide 24V dc logic module and 24V dc power supply within the drive to hold the drive logic active during power interruptions.

E. Regardless of VFD manufacturer provide Square D power and energy monitor model PM820 with optional Ethernet module on the supply side of the drive as indicated on the drawings. Connect via Ethernet/IP back to PLC cabinet. Power monitor is not required for 120V drives or plant drives less then 20HP. Power monitor required on all wellfield drives.

2.05 OPERATING CHARACTERISTICS

A. The variable frequency drive shall convert 3 phase, 60 Hertz input power to an adjustable frequency and voltage (from 6 Hertz to 60 Hertz with a frequency stability of +/- 1 percent of setting) for controlling the speed of AC induction motors. The converter will be of the voltage source design using current controlled PWM techniques. The input power factor of the drive shall be a minimum of .95 at all speeds and loads.

B. The output voltage shall vary proportionally with the output frequency to maintain a constant volts/Hertz value up to nominal frequency. Above nominal frequency, the output voltage shall remain constant.

C. The modulating control scheme shall closely approximate actual sine wave current throughout the speed range of the drive. The regulator shall be fully digital with microprocessor control of frequency, voltage, and current. The frequency resolution of the drive shall be .01 Hertz. All drive adjustments and custom programming shall be capable of being stored in a non-volatile memory (EEPROM).

D. Current limit: A current limit circuit shall be provided to limit motor current to a preset adjustable maximum level by reducing the drive operating speed or acceleration rate when the limit is reached. Range of adjustment shall be from 50 to 115 percent.

E. The power unit's logic common shall be at ground potential.

F. Short circuit and ground fault protection. The VFD shall have an instantaneous electronic trip circuit to protect the VFD from output line-to-line and line-to-ground short circuits. The VFD must be capable of withstanding without damage to the VFD, short circuits at 480V plus 10 percent (528V). Opening of the VFD's input and/or output line switches during drive operation shall not result in damage to the drive.

G. The VFD shall be capable of providing 110 percent motor name plate service factor current for one minute. The VFD shall include an instantaneous overcurrent trip. The VFD shall not restart after electronic overcurrent trip until manually reset. Except for overcurrent, the drive will first attempt to restart on the inverter up to a maximum of three times on "Auto-Restart" before faulting out and waiting for operator reset.

H. Power loss ride-through. The VFD shall be capable of continued operation during an intermittent loss of power for 2.0 second (120 cycles). The essential drive and pump relay logic integrated within the drive shall be powered through the 24VDC VFD power source during the power interruption for the 2 second duration. The VFD drive will resume normal operation within 0.5sec if power is reapplied during the 2 second ride through duration.

I. Auto restart after power outage. The VFD shall be capable of starting into a spinning motor. The VFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFDs shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor in the preset method of starting.

J. Transient and surge voltage protection. Transient and surge voltage protection shall be provided through use of Metal Oxide Varistors (MOV's) and phase-to-ground filter capacitors.

K. Auto restart after fault. The VFD shall automatically attempt to restart after a malfunction or an interruption of power. If the drive reaches the limit of restarts without successfully restarting and running for 90 seconds, the restart circuit shall lockout and drop out the fault relay. Two Form C contacts shall be provided.

L. Motor overload protection. Provide electronic motor overload and single phase protection integral to the inverter.

M. Frequency jump points: Provide three selectable frequency jump points in 1.0hz increments, to be used to avoid critical resonance frequencies of the mechanical system.

N. Application programming dedicated to pumps.
   1. The VFD shall provide Pump Control & Monitoring Functions for Centrifugal pump characteristics and configurations.
      a. Pump monitoring function in order to define data relevant for pump (acceleration, low speed, high speed, etc.)
      b. Application Units function in order to define units used in applications.
      c. Pump Cyclic Start Protection in order to protect the pump against too many restarts in a dedicated time period.
      d. Multi-pump functions.
   2. The VFD shall provide Pump Protection Functions
      a. Anti-Jam function in order to remove automatically clogging substances from the pump impellers.
      b. Pipe Cleaning function in order to start pump regularly to avoid sedimentation in pump impeller
      c. Cavitation Pump Protection
      d. Inlet protection in order to avoid system dry running.
   3. The VFD shall provide Application control functions
      a. Stop and Go function in order to reduce consumption of VFD in case of pump inoperation.
      b. Pipe Fill function in order to manage a smooth control during pipe filling and to lessen the effects of water hammer.
      c. Sleep wake-up function in order to manage periods of the application when process demand is low and when it is not needed.
      d. Low demand function in order to define periods of the application when process demand is low in order to save energy.
   4. The VFD shall provide Pump curve input to help optimize pump performance.
      a. Input and storage of the pump characteristics including 5 points of the pump curve.
      b. A best efficiency point (BEP) function in order to run in optimum conditions and detect deviation from this point.

2.06 CONTROLS

A. Provide an operator panel with keypad and 2-line 20-character alphanumeric display. The display provides indication of any selected drive functions; speed, load, motor volts, motor amps, diagnostic information, programming functions, etc. The

keypad provides a means of programming and manually controlling the drive. Programming only keypads are not acceptable. The key pad shall be used to input the following setup adjustments:

1. Minimum speed, 1 to 85 percent.
2. Maximum speed, 50 to 100 percent.
3. Linear accel, 2-25 seconds.
4. Maximum output voltage, adjustable.
5. Volts/Hertz, adjustable.
6. Local setpoint reference.
7. Current Limit Setpoint.
8. Selectable carrier frequencies, V/Hz, and critical frequency avoidance lockout.
9. Multiple attempt restarts.

B. Remote Controls: The VFD drives shall be hardwired to the plant control system as detailed on the single line drawing. The VFD drives shall have a dedicated Ethernet connection to the plant control system with all parameters within the drive accessible to the control system. As a minimum provide the following inputs and outputs for remote operator control from the plant computer system.

1. Drive Digital inputs:
   a. Start/Stop.
   b. Drive Reset.
2. Drive Digital outputs:
   a. VFD in remote and Ready.
   b. Drive running.
   c. VFD internal fault.
   d. VFD external fault
3. Analog inputs/outputs:
   a. Motor speed feedback output.
   b. Remote speed setpoint input.

C. Internal Control Wiring: Each control wiring conductor shall have heat shrink identification labels on each end of termination. Terminations shall be made to screw terminal strips. All points of terminal strips are to be labeled to match conductor labeling.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine area to receive motor-control units to assure adequate clearance for motor control unit installation. Check that concrete pads are level and free of irregularities for motor control centers.

B. All workmanship utilized in the manufacture and installation of this system shall be of the highest quality and performed in a manner which is consistent with all accepted practices for industrial controls.

C. The supplier shall construct and verify proper operation of the assembled system under simulated conditions with motors of similar characteristics; before shipment to the site.

3.02 INSTALLATION

A. Install motor control units in accordance with manufacturer's written instructions, and NEC.

B. The installing contractor shall guarantee that installation of the system is in accordance with the manufacturer's instructions.

C. Provide rubber insulation mats on floor in front of motor control center for entire length equipment. Mats to be minimum 3 feet wide or equal to isle width. Provide OSHA approved insulating mats meeting OSHA regulation 1910.137 with 30,000 volt insulating strength (Matworks or equal, 800 336-4604).

3.03 STARTUP SUPERVISION AND TRAINING

A. The system supplier shall provide a factory trained and authorized service technician to inspect all final connections and check the system prior to startup of the pump drive system. The service technician shall coordinate with the systems integrator for complete functional check-out of the system. The factory authorized person shall provide written certification that the installation meets or exceeds all factory recommendations for proper operation.

B. Copies of the Operating and Maintenance manuals shall be prepared specifically for this installation and shall include all required specification sheets, Drawings, equipment lists, descriptions, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

C. A factory representative who has complete knowledge of proper operation and maintenance shall be provided for training to instruct representatives of the Owner and the Engineer in proper operation and maintenance. Training subjects shall include, operator training, system repair, maintenance and detailed software training. Training shall be conducted after system startup, testing, and control tuning procedures are complete, and before final completion. If there are difficulties in operation of the equipment due to the installation or fabrication, additional instruction days shall be provided as deemed necessary by the engineer and at no cost to the Owner.

END OF SECTION

SECTION 26_36_00

AUTOMATIC TRANSFER SWITCH (UTILITY TO UTILITY ATS)
AUTOMATIC TRANSFER SWITCH WITH BYPASS ISOLATION

PART 1 GENERAL

1.01 GENERAL

A. Automatic transfer switches shall be furnished as shown on plans, with full load current and voltage rating as shown, normal and emergency. The transfer switch shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure NEMA ICS 6 or 3R that is constructed in accordance with Underwriters' Laboratories, Inc., Standard UL-1008. Provide transfer switches by the genset manufacturer or as indicated on the Drawings. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95 percent (non-condensing).

B. Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.

C. Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents. Contractor to verify available fault currents. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

D. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position. Transfer switches shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms. Transfer switches over 1000 amperes shall be equipped with manual operators for service use only under de-energized conditions. The transfer switch shall be configurable to control the operation time from source to source (program transition; delayed transition operation). Sync checked two position transfer switches without delayed transition are not acceptable

E. The transfer switch shall be capable of transferring successfully in either direction with 90 percent of rated voltage applied to the switch terminals. Transfer switches that are designated on the Drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100 percent of the current designated on the switch rating. Transfer switch shall be provided with copper long barrel Hi-Press lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the Drawings.

F. Operator Panel: Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch The operator panel shall be provided with the following features and capabilities.
   1. High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control. High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch (when used) enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.
   2. “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation. “TEST” pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load. “RESET/LAMP TEST” pushbuttons that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
   3. The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via the operator display panel.
   4. Analog AC meter display panel, to display 3-phase AC Amps, 3-phase AC Volts, Hz, KW load level, and load power factor. The display shall be color-coded, with green scale indicating normal or acceptable operating level, yellow indicating conditions nearing a fault, and red indicating operation in excess of rated conditions for the transfer switch.

G. Engine starting contacts shall be provided in transfer switch to start the generating plant if any phase of the normal source drops below 85 percent of rated voltage, after an adjustable time delay period of 1-120 seconds. Provide loss of normal source circuit with phase sequence sensing capability that verifies phase angle relationship of source voltage.

H. The transfer switch shall transfer to emergency as soon as the generator source voltage and frequency have reached 90 percent of rated. After restoration of normal power on all phases to 95 percent of rated voltage, adjustable time delay period of 2-25 minutes shall delay transfer to normal power until it has had time to stabilize. If the emergency power source should fail during the time delay period, the time delay shall be by-passed, and the switch shall return immediately to the normal source. Whenever the switch has retransferred to normal, the engine-generator shall be allowed to operate at no load for an adjustable period of time (10 minutes initially) to allow it to cool before shut-down. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
   1. Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98 percent of the normal voltage level and dropout in a range of 75 to 98 percent of normal voltage level).
   2. Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98 percent of the normal

voltage level and dropout in a range of 75 to 98 percent of pickup voltage level).

3. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance, loss of single phase, phase rotation, over voltage conditions (adjustable for dropout over a range of 105 to 135 percent of normal voltage, and pickup at 95-99 percent of dropout voltage level), over or under frequency conditions.
4. Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150 percent of rated phase current for more than an adjustable time period of 10 to 60 seconds.

I. The transfer switch shall include a test switch to simulate normal power failure with actual load transfer. A remote contact from the plant control system shall be accepted by the ATS to provide generator start and load control testing. Pilot lights shall be included on the cabinet door to indicate the main switch closed on normal (green) or emergency (Red); a yellow pilot light shall indicate the emergency power source running.

J. The transfer switch shall include two auxiliary contacts on the main operating shaft indicating closed on normal and two auxiliary contacts indicating closed on emergency. In addition, two sets of relay contacts shall be provided to operate upon loss of the normal power supply. All relays, timers, control wiring and accessories to be front accessible. Auxiliary contacts shall be provided for remote plant control system monitoring.

K. Include an exerciser with transfer switch for exercising generator in loaded condition every 168 hours for a period adjustable to 15 minute increments from 20 minutes minimum. Include automatic return to normal should the genset fail to provide load during the exercise run, if normal power is available. Provide programmed transition controls with adjustable time delay option to limit inductive load inrush currents. Switches without adjustable programmed transition are not acceptable.

L. Provide for utility to utility ATS dry maintained contact input/output from the facility control system. I/O List to the plant controls:

<u>Digital inputs:</u>
ATS not in Auto
Preferred source Supplying Load
Alternate source Supplying Load
Power Failure

1.02 TWO SOURCE MANUAL BYPASS: (BYPASS ISOLATION)

A. Where shown on the Drawings, provide integral to the transfer switch assembly a transfer switch bypass and associated isolation equipment. The bypass-isolation switch shall provide a means for manually bypassing the transfer switch from either source (Normal or Emergency) to the load, while under load if necessary, and to isolate the transfer switch from both sources for maintenance or repair. Designs that bypass to only one source are not acceptable.

B. Bypass-isolation switch equipment shall be UL Listed per Standard 1008, CSA Approved; with continuous current rating, voltage and frequency ratings, and

withstand and closing ratings equal to the transfer switch ratings at the specified conditions of ambient temperature, humidity. The bypass-isolation and transfer switches shall be mechanically held in each position. Switching mechanisms shall be break before make on all poles, including the neutral pole on four pole switches. The switch mechanism shall be an over center toggle device which provides stored energy contact operation during both opening and closing. The speed of contact operation shall be independent of the force applied to the operating handles, which permit manual operation under load. Bypass switch shall be a fully rated manually operated switch, rated for the same loads as the automatic transfer switch.

C. Bypass switch shall provide bypass to either normal or emergency source by use of a door-mounted keyed source selector switch and a permanently mounted external-operating handle.

D. Positive mechanical interlocks shall prevent all possible source to source interconnections. Designs which depend on electrical interlocks to prevent source to source interconnections are not acceptable.

E. A drawout isolation mechanism shall provide closed-door isolation of the transfer switch, using a permanently mounted, external handle. The isolation mechanism shall be interlocked so that either the transfer switch must be bypassed or the transfer switch must be open, before the mechanism will permit isolation of the transfer switch. Mechanisms that do not allow for drawout and removal for servicing are not acceptable.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 QUALITY ASSURANCE/TESTS

A. As a precondition for approval, transfer switch, complete with timers relays and accessories shall be listed by Underwriters' Laboratories, Inc. in their Electrical Construction Materials Catalog under Standard UL-1008 (automatic transfer switches) and approved for use on emergency systems.

B. When conducting temperature rise tests to paragraph 99 of UL-1008 the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.

C. Electrical Field Tests: Field testing shall be preformed prior to substantial completion.
   1. Perform insulation resistance tests phase-to-phase and phase-to-ground with switch in both source positions.
   2. Perform a contact resistance test across all main contacts.
   3. Verify settings and operation of control devices in accordance with the specifications provided by the manufacturer.
   4. Calibrate and test all relays and timers including voltage and frequency sensing relays, in phase monitor (synchronism check), engine start and cool-down timers, transfer and retransfer timers, etc.

5. Perform automatic transfer tests: Simulate loss of normal power. Test Return to normal power. Simulate loss of emergency power. Simulate all forms of single phase conditions. Monitor and verify correct operation and timing of the following simulations: Normal voltage-sensing relays: Engine start sequence: Time delay upon transfer: Alternate voltage-sensing relays: Automatic transfer operation: Interlocks and limit switch function: Time delay and retransfer upon normal power restoration: Engine cool-down and shutdown feature.
6. System Function Tests: Perform system function tests upon completion of equipment tests. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.

D. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.

E. Test all interlock devices.

F. Record the operation of alarms and indicating devices.

3.02 SHOP DRAWINGS

A. Submit Shop Drawings and product data clearly indicating:
1. Cabinet dimensions.
2. All applicable options and accessories.
3. Wiring diagrams.
4. Interrupting or withstanding current rating.
5. All electrical characteristics and data as required showing compliance with these specifications.
6. Digital Metering device and wiring.

END OF SECTION

SECTION 26_36_13

SAFETY SWITCHES AND DISCONNECTS

PART 1 GENERAL (NOT USED)

PART 2 PRODUCTS

2.01 GENERAL

A. All single throw disconnect switches and double throw manual transfer switches shall be heavy-duty horsepower rated type. Safety switches shall be rated for the available fault current where installed. Provide enclosed molded case switch type disconnects where required to meet high available fault current areas (above 10kaic). Switches shall be fusible only where required to meet equipment nameplate requirements.

B. Switches shall be 240-volt rated on systems up to and including 120/208V and 600V rated on higher voltage systems. All switches for motors shall be horsepower rated. All switches shall be NEMA 4X stainless steel enclosure except switches mounted in air-conditioned spaces. As an alternate to NEMA 4X stainless steel enclosure provide NEMA 4X switches with aluminum enclosure as manufactured by Bryant. As an alternate to NEMA 4X stainless steel enclosures provide polyglass enclosures for 30 amp (10 hp) switches in the chemical areas equal to Hubbell Circuit-Lock.

C. Provide and install lugs on disconnect switch as required to accept conductors called for on Drawings.

D. Provide Switches with an externally operated handle; quick make quick break mechanism; the handle shall be interlocked with the switch cover by means of a defeatable interlock device. The switch shall be lockable in the "off" position with a padlock. Switches shall have arch suppressors, pin hinges and be horsepower rated at 600-volts.

E. All disconnect switches shall be furnished from the manufacturer with (2) normally open and (2) normally closed interlock contacts. Motor space heater shall be wired through one set of contacts. The other contact shall be wired through the local off/remote motor switch at the disconnect location.

F. Double throw non-fused safety switches may be used for manual power transfer where shown on the Drawings and in areas up to 10,000A available short circuit current. In areas above 10k amps use double throw molded case manual transfer switches rated for the available fault currents.

2.02 SUBMITTALS

A. Submit product data on all major types of disconnects.

PART 3 EXECUTION

3.01 INSTALLATION

A. All three phase motors shall be provided with field mounted disconnects if they are not mounted within site of the three phase feeder breaker or control device they are wired from.

B. With the safety switch in the open position, both the motor heater and power circuits shall be open as well.

C. Provide all motor disconnects with an auxillary Off/Remote maintained hand switch to disable the control power circuit.

END OF SECTION

SECTION 26_41_00

LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

A. Description of Systems:
   1. A Lightning Protection System shall be placed on the structures by experienced installers in compliance with provisions of Code for Lightning Protection Systems as adopted by the National Fire Protection Association and Underwriters' Laboratories. Intent of the lightning protection systems shall be to protect the structures against damage by lightning. All equipment to that result shall be included whether or not specifically called for herein. Installers shall be Underwriters Laboratories certified as Master Label installers or of equal qualifications as approved by Engineer.
   2. Provide complete and upgraded lightning protection systems as noted on the drawings. Provide bonding and grounding systems and interconnection to the site lightning protection and grounding systems as shown on the drawings and as specified. All systems shall be in conformance to NFPA-780, UL-96, UL96-A and as shown on the contract drawings.
   3. Materials shall comply in weight, size and composition with the requirements of Underwriters' Laboratories and the National Fire Protection Code relating to this type of installation, and shall be U.L. labeled.
   4. All installations shall be performed to meet Underwriters Laboratories Master Label standards. Provide a UL Master Label or Lightning Protection Institute (LPI) certification for all protected structures to the extent the structures are eligible under the standards of UL 96A. If the structure is not eligible under the standards of UL 96A, provide a Letter of Findings for the installation at completion of work.

1.02 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Shop Drawings: Shop drawings shall be submitted before work is started. Drawings shall include full layout of cabling and points, and connections. The drawing shall show the type, size and location of all equipment, grounds and cable routing. The drawing shall show all grounds and air terminals that are shown on the contract drawings. See additional requirements for shop drawings in section 26 05 02.
   2. Product Data: Product Data shall be submitted on all equipment to show compliance with this section of the specifications and shall include manufacturer's written recommendations for installation. Provide a sample of the air terminal to be used with the shop drawing submittal.

1.03 SYSTEM DESIGN

A. The system shall be an effective, aesthetically acceptable streamer-delaying lightning protection system to the standards of Underwriters Laboratories UL 96 & UL 96A. The purpose of the system shall be to reduce the likelihood of a direct

strike to the protected structure by delaying the formation of streamers from that structure. Secondarily the system shall be designed in such a manner that it affords protection to the structure upon which it is installed in the event a direct lightning strike to the structure does occur.

B. The system components shall not require mounting in a specific configuration or impose any other mounting limitations which may interfere with utility use of structure space or otherwise preclude or limit the intended use of the structure.

C. All components shall be attached to the structure in such a manner as to reduce the possibility of corrosion between dissimilar metals. If installed on a metallic or otherwise electrically conductive structure, the system shall be electrically bonded to the structure upon which it is installed through mounting clamps and brackets, with additional bonding to grounded objects and to the structure, as required or as indicated on the drawings.

D. The system shall be composed of components that meet the requirements of Underwriters Laboratories UL 96. Aluminum and Stainless Steel components shall be employed on structures and portions of structures subject to corrosive elements, where the use of copper components could be rendered ineffective, due to the surrounding environment. No dissimilar metals shall be allowed to be in contact. In areas where chemical conditions may deteriorate the specified materials faster than the life expectancy of the material, the LP installer shall bring these conditions to the attention of the engineer prior to installation.

E. Air Terminals shall be mounted on all outside corners of each structure, around the perimeter of each structure at intervals not to exceed twenty (20) feet, and on the interior of each structure in such a manner that no two Air Terminals are separated by a distance of more than fifty (50) feet. In the event this is not practical, such as on a large open tank, Air Terminal spacing around the perimeter shall be decreased to not more than fifteen (15) feet, with a total number around the perimeter not less than the total of the normally required perimeter Air Terminals, plus the additional number of Air Terminals if Air Terminals had been installed on the interior at intervals not greater than fifty (50) feet.

F. Each Air Terminal shall be provided with two (2) contiguous paths to ground. On structures with handrails, exposed structural members, or other conductors, provide a bond to structural conductors from the lightning protection system. Handrails shall not be used as a main lightning protection conductor. Provide a continuous lightning protection conductor parallel with handrails and bond from it to each handrail section and a minimum of 10’ on center. In the case of a structure or a portion of the structure where the structure itself is electrically conductive, such as a light pole, tower, etc, that structure or portion of the structure itself may be employed as part of the lightning protection system, provided it meets the minimum requirements of UL 96 or UL 96A, and down conductors are specifically not required on such structures.

PART 2 PRODUCTS AND INSTALLATION

2.01 AIR TERMINALS

A. Air Terminals shall be of the streamer delaying type. Each air terminal shall have a minimum of five hundred dissipater electrode wires, none of which exceed ten thousands of an inch diameter. All air terminals shall complying with the weight and construction requirements for Class II lightning protection systems. Electrode material shall be high quality 316 series stainless steel and shall have proper base support for surface on which they are attached, and shall be securely anchored to this surface. Terminals shall project a minimum of 18" above top of object to which attached and have a minimum 3/16” ball shaped tip. Air terminal point must be 3/16 or greater to meet current UL standards.

B. Streamer-delaying Air Terminals shall be manufactured by Altec Global or equal.

2.02 CONDUCTORS

A. Roof conductors shall consist of rope lay aluminum conductor complying with the weight and construction requirements for Class II lightning protection systems. Aluminum Conductor: TLP #A508 Braided, No. 4/0 Size, 214 pounds per 1000’, 30 strand of 5/8” diameter wire, 192,000 circular mils. Conductors shall be coursed to interconnect with air terminals, and in general, provide a two-way minimum path to ground. The angle of any turn shall not exceed 90 degrees, and shall provide an approximately horizontal or downward course. Down conductors shall be bare stranded copper and transition to tinned copper at 18” minimum above grade. Down conductors shall be installed in PVC conduit and hidden within the structure. Approved bi-metal transitions from aluminum conductors for bonding of aluminum roof structures (exhaust fans, etc.) to copper down conductor sections shall be provided. Radius of bends shall not be less than 8 inches.

1. Provide tinned copper grounding system. Transition to bare copper down conductors 18” AFG or AFF.

B. Counterpoise loop ground conductors shall be tinned copper and be a minimum size equal to the main roof conductor size (115,000cm) or 2/0.

2.03 FASTENER

A. A. Conductor fasteners shall be of the same material as the conductor, having ample strength to support conductor. Where fasteners are to be mounted in masonry or structural work, they shall be furnished to the Masonry or Structural Contractor so they may be installed during construction of the project.

B. All fasteners shall be of a heavy-duty double bolted type typically used for Class II lightning protection systems. Conductor to conductor connections shall be through heavy-duty pressure type bolted fasteners. Splice and bimetal connections shall be through four bolt pressure type heavy-duty connectors. Crimp fasteners shall not be used.

C. Dissimilar metals shall not be allowed to be in contact. Aluminum fittings shall be mounted on aluminum where necessary, and bonded to the main system using bi-metal connectors. Lead coating shall not be acceptable as a bi-metal transition.

D. All mechanical termination points and lugs shall have an anti-corrosive coating applied. In areas subject to chemical corrosion (odor control, degasifiers, chem. Rooms, etc.) apply Glyptal 1201 red enamel coating after termination is made. In other less corrosive areas apply Permatex battery protector sealer (SA-9) or Glyptal 1201 or equal.

E. Lugs for copper cable shall be high copper alloy terminals or stainless steel equal to Burndy type QDA Qiklug. Lugs of aluminum alloy are not acceptable.

2.04 GROUND CONNECTIONS

A. Ground rods shall be installed in the quantities as indicated on the drawings and as required by NFPA-780. Ground rods shall be placed a minimum of two (2) feet from building foundations. In addition to above artificial grounds, one down conductor of each two-path system shall be connected to water piping system with approved water pipe type strap connector. All ground rods shall be 5/8" X 20' minimum copperweld type. All connections made below grade shall be exothermically welded (cadweld) connection and placed in a ground rod inspection well as detailed.

B. Soil type in the area is primarily sand with rock layer below. The rock layers on site will require drilling of ground rod holes. All ground rods shall be installed vertically. After drilling and installation of rod, back fill with sand and hydro compact around rod to provide low resistance to ground.

2.05 GROUND ROD & GROUND SYSTEM TESTING

A. The contractor shall utilize a clamp on ground loop tester during construction to check the system for high resistance connections. The resistance at any point below the air terminal shall be less than 5 ohms. The resistance at grade level on the down conductors should be less than 2 ohms. The contractor shall investigate and correct high resistance readings within the system. Demonstrate to the engineer’s satisfaction with witness testing, provision of a low resistance installation meeting this specification.

B. Provide three point fall of potential ground testing on a minimum of one ground rod on each facility prior to connection to the counterpoise system. As an alternate provide ground rod selective method testing with appropriate ground testers. The complete ground system shall be three point fall of potential tested after completion of work. The system shall be tested at a minimum of three points spaced around the site using the “Tagg Slope” technique. Total grid system grounds should be less than one ohm.

2.06 INSTALLATION

A. Installation shall be made in an inconspicuous manner with conductors coursed to conceal equipment as much as possible. Down conductors shall be concealed within structure, and shall be run in 1" PVC conduit. Surface mount down conductors to existing structures in a neat and workmanlike manner. Seal conduit ends utilizing No.155 transitional fitting. All metallic equipment within 6 feet of any lightning conductor shall be bonded to conductor. System shall also be tied to the main service electrical ground and other ground systems in the area.

2.07 COORDINATION

A. The installer shall coordinate the lightning protection work to insure a correct, neat, and unobtrusive installation. In normally accessible areas, catwalks, equipment platforms, etc., provide installation without trip hazard. Provide embedded conduit sleeves across access ways for ground conductors. In retrofit projects provide flat copper strap to ground or bond across access ways.

B. Any electrical service grounding system and metallic water service piping to the structure shall be electrically bonded to the lightning protection system.

C. The contractor shall coordinate his work in such a manner as to not interfere with the normal operation of the structure upon which the installation is performed.

2.08 MATERIAL MANUFACTURERS

A. Equipment shall be as manufactured by Altec Global Lightning Protection or equal.

END OF SECTION

SECTION 26_43_00

SURGE PROTECTIVE DEVICES (SPDS)

PART 1 GENERAL

1.01 SCOPE

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

1.02 RELATED SECTIONS

A. Section 26_23_00, Automatic Transfer and Power Distribution Switchgear.

B. Section 26_24_13, Switchboards.

C. Section 26_24_16, Panelboards.

D. Section 26_24_19, Motor Control Centers.

1.03 REFERENCES

A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 4th Edition).

1.04 SUBMITTALS

A. The following information shall be submitted to the Engineer:
   1. Provide verification that the SPD complies with the required ANSI/UL 1449 4th Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).
   2. For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

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

C. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed and shall incorporate all changes made during the manufacturing process

1.05 QUALIFICATIONS

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

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

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

1.06 OPERATION AND MAINTENANCE MANUALS

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

1.07 MANUFACTURERS

A. Eaton / Cutler-Hammer products.

B. Square-D products.

C. General Electric products.

D. EDCO.

E. APT.

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

1.08 SYSTEM APPLICATION

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

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

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

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

PART 2 PRODUCTS

2.01 VOLTAGE SURGE SUPPRESSION – GENERAL

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

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

   5. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.
   6. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

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

B. SPD Design:
   1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
   2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV.
   3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
   4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
   5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
      a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
         1) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
         2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
         3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

b. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
c. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

6. Overcurrent Protection:
   a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
7. Safety Requirements:
   a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free.
   b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit.
   c. Sidemount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Sidemount SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.02 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

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

7. The complete panelboard including the SPD shall be UL67 listed.

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

C. Switchgear, Switchboard, MCC and Busway Requirements:
   1. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
   2. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, and busway.
   3. The SPD shall be factory installed inside the switchgear, switchboard, MCC, and/or bus plug at the assembly point by the original equipment manufacturer.
   4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
   5. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
   6. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.
   7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.03 ENCLOSURES

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

2.04 POWER SUPPRESSORS FOR ELECTRONIC EQUIPMENT

A. Each item of electronic equipment provided under this contract and connected by line cord or direct wired to the building electrical system shall be provided with a three-stage single or multi-phase hybrid suppressor. Fusing shall be provided which removes the protective elements from the circuit upon failure. Visual indication or loss of output power shall be used to notify the user of device failure.

B. Suppressors shall be rated for a minimum of 125 percent of their continuous electrical load. Suppressors for cord connected equipment shall be equipped with standard NEMA cordsets one of which includes a molded grounding receptacle and the other, a molded grounding plug. Suppressor shall be installed in series with the power cord for the protected equipment. Where several items of equipment are grouped within the same cluster of equipment, one suppressor may be used in conjunction with properly sized grounding plugstrip to serve the equipment.

C. Suppressors for direct wired equipment shall be identical in internal design to the unit described for cord connected applications, however, protected screw terminals suitable for termination of solid copper wire shall be used for wiring terminations. One suppressor may be used to support several equipment cabinets provided all cabinets are located within the same equipment cluster and the maximum connected load shall not exceed eighty percent of the rated suppressor capacity.

D. Suppressors shall be constructed with a phenolic non-flammable exterior housing with provisions for mounting to the interior of equipment racks, cabinets, or to the exterior of free-standing equipment. Suppressors shall be constructed as three-stage devices. The first stage shall include a high-energy varistor clamp between line and neutral and from neutral to ground. The second stage shall consist of series air-core inductor installed in the line conductor(s) to properly coordinate the action of the first and third stages. The third, fast acting, hard clamping stage shall consist of a network of silicon avalanche bipolar surge suppression diodes between the neutral and line conductor(s).

E. Minimum suppressor performance characteristics shall be as follows:
   1. Maximum single impulse line-to-neutral current withstand: 15,000 Amperes (8 x 20 us waveform)
   2. Maximum single impulse neutral-to-ground current withstand: 10,000 Amperes (8 x 20 us waveform).
   3. Pulse lifetime rating Category B worst case current waveform (8 x 20 us @ 3000 Amperes): 1200 occurrences.
   4. Pulse lifetime rating for 200 Ampere (8 x 20 us waveform): 10,000 occurrences.
   5. Worst case response time: Five Nanoseconds.
   6. Worst case (Maximum Single Impulse Current Conditions) clamping voltage: 400 percent of nominal phase-to-ground RMS voltage.
   7. Initial breakdown voltage: 200 percent of nominal phase-to-ground RMS voltage.

2.05 SUPPRESSORS FOR CONDUCTOR PAIR PROTECTION

A. Suppression devices for conductor pair protection shall be provided in multi-circuit pluggable packages suitable for the circuitry to be protected. Units for protection of data circuits which utilize standard connector configurations shall be equipped with connectors which install in series with the data cable to the protected equipment. Units intended for use with multiple wiring pairs shall be equipped with an accessory terminal blocks or strips suitable for the type of wiring being used. Single pair units shall be configured as encapsulated units with wire leads or screw-terminal wiring terminations. Suppressors installed outside of terminal or equipment cabinets (except at designated terminal boards) shall be provided with a housing to afford physical protection for the surge suppression modules.

B. Suppression for each pair shall consist of a three-element gas tube first stage, an isolating element in series with each conductor of the pair, and a silicon avalanche second stage. Second stage clamping shall be provided across the pair for differential mode protection and from each side of the pair to ground for common mode protection. Resistive limiting elements may be used on low current circuits where the effect of voltage drop across the series resistance has no effect on circuit operation. Inductive series elements shall be used on higher current circuits to effectively pass direct or low frequency alternating currents while limiting passage of fast risetime surge waveforms. Silicon avalanche devices shall be designed for surge suppressor applications and shall be polarized or bipolar as appropriate for each circuit.

C. Minimum performance criteria (each circuit) shall be as follows:
   1. Maximum single impulse conductor-to-ground or conductor to conductor current withstand: 10,000 Amperes (8 x 20 us waveform).
   2. Pulse lifetime rating Category B worst case current waveform (8 x 20 us @ 3000 Amperes): 10 occurrences.
   3. Pulse lifetime rating for 100 Ampere (10 x 1000 us waveform): 1,000 occurrences.
   4. Worst case response time: Five Nanoseconds.
   5. Worst case (Maximum Single Impulse Current) clamping voltage: 200 percent of normal operating voltage amplitude and polarized or bipolar as appropriate for each circuit type.
   6. Initial breakdown voltage: 150 percent of normal operating voltage peak amplitude plus or minus five percent.
   7. Capacitance: Capacitance for DC or low frequency lines shall not exceed 2000 picofarads measured line to line or line to ground at the rated diode breakdown voltage. Suppressors intended for use on high frequency or high baud rate circuits shall be designed for use on such lines. Capacitance of such units shall be equated to equivalent cable feet based on the type of cabling used for the particular circuit. The sum of equivalent cable feet for suppressors and actual cable footage shall not exceed manufacturers recommended maximum values for the system on which these devices are installed.
   8. Circuit compensation: Any additional circuit compensation (gain or equalization) required to compensate for the insertion of surge suppression devices shall be provided as part of this Contract.

PART 3 EXECUTION

3.01 BONDING AND GROUNDING CONDUCTORS AND MATERIALS

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

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

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

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

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

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

3.02 SEGREGATION OF WIRING

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

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

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

3.03 INSTALLATION OF SUPPRESSORS

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

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

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

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

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

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

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

3.04 WARRANTY

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

END OF SECTION

SECTION 26_50_00

LIGHTING FIXTURES

PART 1 PART 1 GENERAL

1.01 DESCRIPTION

A. Description of System:
   1. Light fixtures furnished under this Division shall be furnished complete with lamps and all necessary trim and mounting hardware, and installed as shown on the Drawings.
   2. Light fixtures shall be neatly and firmly mounted, using standard supports for outlets and fixtures. See special mounting requirements as detailed on the Drawings.
   3. Lamps shall be included in the system guarantee for a period of ninety (90) days after final acceptance of the building.

1.02 CODES

A. The Work of this section shall comply with the current editions of the following codes:
   1. National Electrical Code (NEC), NFPA 70.
   2. Florida Building Code (FBC).

1.03 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the Work of this section:
   1. UL Underwriters Laboratories.
   2. CBM Certified Ballast Manufacturer's Association.

1.04 SUBMITTALS

A. Shop Drawings and manufacturers data shall be submitted for the following items:
   1. Luminaire data shall show full-size cross sections. Indicate finished dimensions, metal thickness, U.L. Label, finish, lens/louver thickness and materials.
   2. Show mounting details, including hung ceiling construction.
   3. Indicate type of ballast and manufacturers and ballast quantity and location. Include information as to power factor, input watts and ballast factor.
   4. Indicate lamps to be utilized and quantity.
   5. Include a complete listing of all luminaries on a single sheet. This listing shall contain the luminaire type, manufacturer’s catalog number, applied voltage, lamps, ballast type and luminaire quantities.
   6. The Engineer reserves the right to require submittal of a complete sample fixture for any fixture type.
   7. For exterior post/pole mounted light fixtures, clearly indicate hand hole and lightning protection ground lug mounted to post/pole at hand hole inside post/pole.

8. Signed and sealed shop drawings and calculations shall be submitted for all exterior pole mounted fixtures. The seal must be of a registered professional engineer certifying that the foundation and pole/fixture assembly meets or exceeds the wind load criteria of the most current Florida Building Code. The foundation details shown on the plans are for bidding purposes only; the contractor shall provide the foundation and pole assembly necessary for compliance as submitted at no additional cost to Owner.
9. Product data shall be submitted showing manufacturer's written recommendations for storage and protection, and installation instructions.

PART 2 PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Luminaires
   1. Acceptable manufacturers are listed in the lighting fixture schedule shown on the Drawings.
   2. The designations indicated on the lighting fixture schedule are a design series reference (not necessarily a complete catalog number) and do not necessarily represent the number, size, voltage, wattage, type of lamp, ballast, finish trim, ceiling type, mounting hardware of special requirements as specified hereinafter on as required by the particular installation(s) and code. Contractor shall verify these requirements and order fixtures as required to give proper installation per the contract documents and per codes.

B. Ballasts:
   1. It is preferred that all ballasts shall be of the same manufacturer. Every effort shall be made to eliminate ballasts from multiple manufacturers. Ballasts within luminaires of a given type must however be of the same manufacturer. Multiple manufacturers will not be permitted.
   2. Approved Manufacturers:
      a. Motorola.
      b. Advance Transformer Co.
      c. Magnetek.
      d. General Electric.

C. Lamps:
   1. All lamps shall be of the same manufacturer. Multiple manufacturers are not permitted.
   2. Approved Manufacturers:
      a. General Electric.
      b. Philips.
      c. Osram Sylvania.

2.02 MATERIALS

A. All lighting fixtures mounted outdoors subject to dampness and insects shall have gasketing material between lens door and frame to completely seal interior of fixture. Knockouts and holes in fixtures housing shall be closed and sealed. All fixtures shall be complete with lamps, shielding brackets, concrete bases, anchor bolts, and all necessary fittings and accessories for a complete installation.

B. Plastic Lenses and diffusers:
   1. Virgin acrylic unless otherwise noted. Install and leave with no finger prints or dirt marks on the lens or diffuser. Lenses shall be provided on all recessed metal halide luminaires.
   2. Minimum unpenetrated thickness for Parabolic or conical element diffuser: 0.085 inch.
   3. Minimum nominal thickness: 0.125 inch.

C. Parabolic Luminaire Care: Parabolic luminaires to be installed with mylar cover over louvers. Cover shall be U.L. listed for temporary lighting. Upon completion of work, remove mylar cover with white gloves and blow clean reflectors.

D. Finish: Porcelain or baked enamel finish matte white on interiors with minimum tested reflectance of 90 percent matte white finish or as specified in visible exterior. Thoroughly clean base metal and painted after fabrication.

E. Sockets: Incandescent lamp sockets - porcelain housings over copper screw shells, with medium base sockets rated at 660 watts and 250 volts. Insulating joint in pull chains. Fluorescent lampholder - white, rotor lock, heat-resistant plastic rated 660 watts and 600 volts. Fluorescent industrial sockets - heavy-duty, multi-socket, metal-clad, spring-loaded. Provide heavy-duty sockets for H.I.D. luminaires where mounted less than 8'-0" AFF.

F. Luminaire Wiring: Minimum individual luminaire wiring - number 18 gauge with insulation at rated operating temperature of 105 degrees Centigrade or higher. Terminate wiring for recessed luminaires, except fluorescent units, in an external splice box.

G. Ballasts:
   1. Ballasts for F32T8 lamps shall be:
      a. High frequency solid state electronic.
      b. Electronic Program start
      c. 50 F minimum starting temperature unless otherwise noted
      d. Minimum 1.15 ballast factor
      e. Maximum total harmonic distortion (THD) less than 10%
      f. High power factor, minimum 95 %
      g. Sound rated A
   2. High-power factor (over 90 percent). Certified Ballast Manufacturers' Certification, ballast case temperature not to exceed 90 degrees Centigrade during normal operation in 30 degrees Centigrade ambient temperature. Ballast voltage: 120 or 277 volts, as required by circuiting. Ballast shall be provided with the best sound rating available.
   3. Built-in self-resetting thermal actuated device will remove ballast from line when excessive ballast temperature is reached. U.L. Class P, CBM certified 100 percent output.
   4. The conductors between ballasts and lampholders shall have an approved insulation for 1,000 volts. This includes conductors to and from remote ballasts.
   5. High-intensity discharge ballasts shall be constant wattage autotransformer type with built-in thermal protection, minimum power factor of 80 percent. 12" min. leads.

6. Provide ballasts with voltage characteristics to match that of all related circuitry indicated on the Drawings. No extra compensation will be allowed for failure to properly coordinate ballast voltage with circuitry.
7. Ballasts for control of lamps in one housing or fixture unit may control lamps of an adjoining unit, except as otherwise noted.
8. Guarantee ballast for one full year and one year prorated as per standard manufacturer's warranty against defects for a period of 2 years. Guarantee to include replacing defective ballast with new ballast.
9. Provide dimming ballasts as shown on the drawing for fixtures controlled by individual dimming or dimming systems.
10. LED drivers for interior luminaires shall employ an auto resetting thermal management system to turn off the LED array when normal operating temperatures are exceeded. Exterior drivers shall employ a step reduction circuit to reduce lumen output in order to maintain proper operating temperatures, but will not allow an “off” condition for thermal management.

H. Lamps:
1. Provide a complete set of new lamps in each fixture.
2. Unless noted otherwise lamps must conform to the following:
    a. Fluorescent: T-8, 41k color. Minimum of 80 CRI and 3100 lumens.
    b. Incandescent: "A" lamps to be inside frosted rated at 130 volts.
    c. Compact Fluorescent: triple Twin tube, 4-pin
    d. HID: Metal Halide, clear, universal base, open rated.
    e. LED: Minimum of 50,000 hrs life at no less than 70 percent initial lumen rating. 40k color. Minimum of 80 CRI. Color variation shall not exceed a 3 step MacAdam ellipse.

I. Luminaires installed recessed in a metal pan ceiling shall have a flange type trim to overlap abutment of adjacent pans.

J. Where utilized as raceways, luminaires shall be suitable for use as raceways. Provide feed through splice boxes where necessary.

K. Where ceiling mounted fixtures are called for in the Light Fixture Schedule and on the drawings, this contractor shall provide fixture trims and supports as required to match type of ceiling system which will be furnished. No ceiling fixtures shall be ordered until the Ceiling System Installer has given written approval of the method and location of fixture hanging and fixture type. Fixtures supported by suspended ceiling systems shall be securely fastened to the ceiling framing member by mechanical means, such as bolts, screws, or rivets. Clips identified for use with the type of ceiling frame member(s) and fixture(s) shall also be permitted. Where fixtures are supported by the suspended ceiling system; the ceiling system shall have a minimum (2) opposite corners tied to structure at each fixture location; this contractor shall be responsible for doing this work or for having the ceiling contractor perform it. All supports shall meet current FBC standards.

L. All exterior post/pole mounted light fixtures shall have a hand hole at the base, lightning protection in hand hole and ground conductor connected to ground rod at base. Hand hole shall provide easy access to light fixture fusing and lightning protection ground lug. Lightning protection ground lug shall be provided inside post/pole, electrically in contact with pole, for connection to ground rod. Provide and install ground wire from ground lug to ground rod, concealing ground wire through post/pole base. Anchor bolts to be galvanized.

M. All interior and exterior light fixtures shall not have any labels exposed to normal viewing angles. This includes manufacturer labels and U.L. labels. All labels shall be concealed within the body of the fixture and/or luminaire. No manufacturers name or logo shall appear on the exterior of any light fixtures unless approved in writing by Engineer.

N. All light fixtures shall adhere to U.L. Test Standard #1571 and Section #410-65C of the National Electric Code. All manufacturers shall provide the required thermal protection as required.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install luminaires in mechanical and unfinished areas after ductwork and piping installation. Adjust fixture locations to provide the best lighting for equipment access and service locations. Locate fixtures 8 feet 6 inches above floor, or at suitable locations within space on walls but not lower than 7'-0" AFF.

B. The Contractor shall protect luminaires from damage during installation of same and up to time of final acceptance. Any broken luminaires, glassware, plastics, lamps, etc., must be replaced by the Contractor with new parts, without any additional expense to the Owner.

C. The contractor shall verify prior to ordering fixtures that each fixture scheduled has correct type trim and support arrangement for the proposed ceiling construction.

D. Install all fixtures in accordance with manufacturer’s written instructions and the NEC.

E. Pendant mounted units shall comply with the following:
   1. Each stem shall have a brass or steel swivel or other self-aligning device of type approved by the Engineer. The entire luminaire mounting (hickey, aligner, swivel, stem, etc.) shall be submitted to and approved by the Engineer before installation.
   2. An insulated malleable iron bushing shall be placed at luminaire end of stem through which wire passes.
   3. A pendant support using an approved sliding clevis bracket which firmly grips an indentation in rigid sides of the wiring channel will be acceptable.
   4. Connections between outlet boxes and luminaires shall be by means of approved flexible raceways. The application of raceways directly between luminaires is unacceptable.

F. Where luminaires are mounted upon surface-mounted outlet boxes in surface mounted conduit runs, this Contractor shall furnish and install a luminaire canopy sufficiently deep to permit exposed conduits to pass through. Canopy shall have proper openings cut by luminaire manufacturer through which conduits may pass. Submit sample of canopy for approval before installation.

G. Ceiling surface mounted fluorescent fixtures installed in exposed ceiling areas are to be suspended from ceiling structure with all-thread rods and 1-1/2-inch by 1-1/2-inch Kindorf channels, full length of fixture/row. Mount outlet box at structure with flexible connection to fixture.

H. Ducseal shall be installed to seal all conduits entering exterior light fixtures from underground.

I. Install exit light as indicated on the drawings but not higher than 10'0" AFF. Size and color of lettering shall comply with local codes.

J. Outdoor lighting shall be aimed in periods of darkness in front of the owner/engineer.

3.02 COORDINATION WITH AMBIENT CONDITIONS

A. The Contractor is responsible for coordinating the characteristics and the U.L. labeling of the luminaires and their components with the ambient conditions which will exist when the luminaires are installed. No extra compensation will be permitted for failure to coordinate the luminaires with their ambient conditions. These areas of coordination include but are not limited to the following:
   1. Wet location labels.
   2. Damp location labels.
   3. Low temperature ballasts.
   4. Dimming ballasts.
   5. Very low heat rise ballasts.
   6. Explosion proof.
   7. Plenums and air handling spaces.
   8. Fire rated ceilings.
   9. Low density ceilings.
   10. Insulated ceilings.

3.03 CLEAN-UP

A. Luminaires:
   1. Clean free from dust and dirt. Wash lens and glassware using cleaner such as “Windex” and dry with absorbent paper. Clean plastic per manufacturer’s recommendations; do not wipe. Lenses which are kept in original containers until immediately prior to final inspection may not require cleaning. Clean “Alzak” aluminum surfaces (reflectors, fixture cones and the like) per mfr’s recommendations being careful to remove finger prints and smudges.
   2. It is the contractor’s responsibility to remove any U.L. labels or manufacturer’s labels from areas of fixture exposed to view and relocate label to non-obtrusive area on fixture.

END OF SECTION

DIVISION 31 – EARTHWORK

SECTION 31 23 16

EXCAVATION - EARTH AND ROCK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Requirements for performing opencut excavations to the widths and depths necessary for constructing structures, pipelines and conduits including excavation of any material necessary for any purpose pertinent to the construction of the Work.

B. Related Work Specified in Other Sections Includes:

1. Section 31 40 00 - Shoring, Sheeting and Bracing
2. Section 31 23 23 - Backfilling

1.2 DEFINITIONS

A. Earth: "Earth" includes all materials which, in the opinion of the ENGINEER, do not require blasting, barring, wedging or special impact tools for their removal from their original beds, and removal of which can be completed using standard excavating equipment. Specifically excluded are all ledge and bedrock and boulders or pieces of masonry larger than one cubic yard in volume.

B. Rock: "Rock" includes all materials which, in the opinion of the ENGINEER, require blasting, barring, wedging and/or special impact tools such as jack hammers, sledges, chisels, or similar devices specifically designed for use in cutting or breaking rock for removal from their original beds and which have compressive strengths in their natural undisturbed state in excess of 300 psi. Boulders or masonry larger than one cubic yard in volume are classed as rock excavation.

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Dewatering Excavation Plan: Develop an excavation dewatering plan that considers site ground and groundwater conditions, the type and arrangement of the equipment to be used and the proper method of groundwater disposal. Prepare the dewatering plan before beginning excavations below groundwater. Maintain one copy of the dewatering plan at the project site to be available for inspection while all dewatering operations are underway.

1.4 SITE CONDITIONS

A. Actual Conditions: Make any geotechnical investigations deemed necessary to determine actual site conditions.

B. Underground Utilities: Locate and identify all existing underground utilities prior to the commencement of Work.

C. Quality and Quantity: Make any other investigations and determinations necessary to determine the quality and quantities of earth and rock and the methods to be used to excavate these materials.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 GENERAL

A. Clearing: Clear opencut excavation sites of obstructions preparatory to excavation. Clearing in accordance with Section 31 10 00, includes removal and disposal of vegetation, trees, stumps, roots and bushes, except those specified to be protected during trench excavation.

B. Banks: Shore or slope banks to the angle of repose to prevent slides or cave-ins in accordance with Section 31 40 00.

C. Safety: Whenever an excavation site or trench is left unattended by the CONTRACTOR or when an area is not within 100 feet of observation by the CONTRACTOR, the excavation site or trench shall be filled and/or, at the OWNER's discretion, protected by other means to prevent accidental or unauthorized entry. Such protection shall include barricades and other protection devices requested by the ENGINEER or OWNER, including temporary fencing, snow fencing, or temporary "structure" tape. Such safety items shall not relieve the CONTRACTOR of any site safety requirements or liabilities established by Federal, State and local laws and agencies, including OSHA, but is intended as additional safety measures to protect the general public.

D. Hazardous Materials: If encountered, take care of hazardous materials not specifically shown or noted in accordance with Section 01 57 00.

E. During excavation and any site work, storm water pollution prevention measures shall be taken to ensure that water quality criteria are not violated in the receiving water body and all state and local regulatory requirements are met.

3.2 STRUCTURE EXCAVATION

A. Excavation Size: Provide excavations of sufficient size and only of sufficient size to permit the Work to be economically and properly constructed in the manner and of the size specified.

B. Excavation Shape: Shape and dimension the bottom of the excavation in earth or rock to the shape and dimensions of the underside of the structure or drainage blanket wherever the nature of the excavated material permits.

C. Compaction: Before placing foundation slabs, footings or backfill, proof roll the bottom of the excavations to detect soft spots.

1. For accessible areas, proof roll with a ten wheel tandem axle dump truck loaded to at least 15 tons or similarly loaded construction equipment.

2. For small areas, proof roll with a smooth-faced steel roller filled with water or sand, or compact with a mechanical tamper.

3. Make one complete coverage, with overlap, of the area.

4. Overexcavate soft zones and replace with compacted select fill in accordance with Part 3, Section 3.9.

3.3 TRENCH EXCAVATION

A. Preparation: Properly brace and protect trees, shrubs, poles and other structures which are to be preserved. Unless shown or specified otherwise, preserve all trees and large shrubs. Hold damage to the root structure to a minimum. Small shrubs may be preserved or replaced with equivalent specimens.

B. Adequate Space: Keep the width of trenches to a minimum, however provide adequate space for workers to place, joint and backfill the pipe properly.

1. The minimum width of the trench shall be equal to the outside diameter of the pipe at the joint plus 8-inches for unsheeted trench or 12 inches for sheeted trench.

2. The maximum width of trench, measured at the top of the pipe, shall not exceed the outside pipe diameter plus 2 feet, unless otherwise shown on the drawing details or approved by the ENGINEER. Trench walls shall be maintained vertical from the bottom of the trench to a line measured one foot above the top of the pipe. From one foot above the top of the pipe to the surface the trench walls shall conform with OSHA Regulations.

3. In sheeted trenches, measure the clear width of the trench at the level of the top of the pipe to the inside of the sheeting.

4. Should the maximum trench widths specified above be exceeded without written approval, provide concrete cradle or encasement for the pipe as directed. No separate payment will be made for such concrete cradle or encasement.

C. Depth:

1. Excavate trenches to a minimum depth of 8 inches below the bottom of the pipe or the bottom of encasement for electrical ducts, unless otherwise shown, specified or directed, so that bedding material can be placed in the bottom of the trench and shaped to provide a continuous, firm bearing for duct encasement, pipe barrels and bells.

2. Standard trench grade shall be defined as the bottom surface of the utility to be constructed or placed within the trench. Trench grade for utilities in rock or other non-cushioning material shall be defined as additional undercuts backfilled with #57 stone compacted in 6-inch lifts, below the standard 8-inches minimum trench undercut. Excavation below trench grade that is not ordered in writing by the ENGINEER shall be backfilled to trench grade and compacted.

D. Unstable or Unsuitable Materials: If unstable or unsuitable material is exposed at the level of the bottom of the trench excavation, excavate the material in accordance with the subsection headed "Authorized Additional Excavation".

1. Material shall be removed for the full width of the trench and to the depth required to reach suitable foundation material.

2. When in the judgment of the ENGINEER the unstable or unsuitable material extends to an excessive depth, the ENGINEER may advise, in writing, the need for stabilization of the trench bottom with additional select fill material, crushed stone, washed shell, gravel mat or the need to provide firm support for the pipe or electrical duct by other suitable methods.

3. Crushed stone, washed shell and gravel shall be as specified in Section 31 23 23.

4. Payment for such trench stabilization will be made under the appropriate Contract Items or where no such items exist, as a change in the Work.

E. Length of Excavation: Keep the open excavated trench preceding the pipe or electrical duct laying operation and the unfilled trench, with pipe or duct in place, to a minimum length which causes the least disturbance. Provide ladders for a means of exit from the trench as required by applicable safety and health regulations.

F. Excavated Material: Excavated material to be used for backfill shall be neatly deposited at the sides of the trenches where space is available. Where stockpiling of excavated material is required, the Contractor shall be responsible for obtaining the

sites to be used and shall maintain his operations to provide for natural drainage and not present an unsightly appearance.

G. Water: Allow no water to rise in the trench excavation until sufficient backfill has been placed to prevent pipe or duct flotation.

3.4 SHORT TUNNEL EXCAVATION

A. Short Tunnel Requirements: In some instances, trees, shrubs, utilities, sidewalks and other obstructions may be encountered, the proximity of which may be a hindrance to opencut trench excavation. In such cases, excavate by means of short tunnels in order to protect such obstructions against damage.

1. Construct the short tunnel by hand, auger or other approved method approximately 6 inches larger than the diameter of pipe bells or outer electrical duct encasement.

2. Consider such short tunnel work incidental to the construction of pipelines or conduits and all appurtenances. The need for short tunnels will not be grounds for additional payment.

3.5 EXCAVATION FOR JACKING AND AUGERING

A. Jacking and Augering Requirements: Allow adequate length in jacking pits to provide room for the jacking frame, the jacking head, the reaction blocks, the jacks, auger rig, and the jacking pipe. Provide sufficient pit width to allow ample working space on each side of the jacking frame. Allow sufficient pit depth such that the invert of the pipe, when placed on the guide frame, will be at the elevation desired for the completed line. Tightly sheet the pit and keep it dry at all times.

3.6 ROCK EXCAVATION

A. Rock Excavation: Excavate rock within the boundary lines and grades as shown, specified or required.

1. Rock removed from the excavation becomes the property of the CONTRACTOR. Transport and dispose of excavated rock at an off site disposal location. Obtain the off site disposal location.

2. Remove all shattered rock and loose pieces.

B. Structure Depths: For cast-in-place structures, excavate the rock only to the bottom of the structure, foundation slab, or drainage blanket.

C. Trench Width: Maintain a minimum clear width of the trench at the level of the top of the pipe of the outside diameter of the pipe barrel plus 4 feet, unless otherwise approved.

D. Trench Depth: For trench excavation in which pipelines or electrical ducts are to be placed, excavate the rock to a minimum depth of 8 inches below the bottom of the pipe or duct encasement. Provide a cushion of sand or suitable crushed rock. Refill the excavated space with pipe bedding material in accordance with Section 31 23 23. Include placing, compacting and shaping pipe bedding material in the appropriate Contract Items.

E. Manhole Depths: For manhole excavation, excavate the rock to a minimum depth of 8 inches below the bottom of the manhole base for pipelines 24 inches in diameter and larger and 6 inches below the bottom manhole base for pipelines less than 24 inches in diameter. Refill the excavated space with pipe bedding material in accordance with Section 31 23 23. Include placing, compacting and shaping pipe bedding material for manhole bases in the appropriate Contract Items.

F. Over-excavated Space: Refill the excavated space in rock below structures, pipelines, conduits and manholes, which exceeds the specified depths with 2,500 psi concrete, crushed stone, washed shell, or other material as directed. Include refilling of over-excavated space in rock as part of the rock excavation.

G. Other Requirements: Follow, where applicable, the requirements of the subsections on "Trench Excavation" and "Structure Excavation".

H. Payment: Rock excavation, including placing, compacting and shaping of the select fill material, will be paid for under the appropriate Contract Items or where no such items exist, as a change in the Work.

I. Blasting: Perform authorized blasting by authorized and qualified workers as approved as to the number, length, placing and direction, and loading of holes. Do not use charges which will make the excavation unduly large or irregular, nor shatter the rock upon or against which masonry is to be built, nor injure masonry or existing structures at the site or in the vicinity.

1. Cover each blast with a woven wire cable mat weighted with heavy timbers. Blasting will not be permitted within 25 feet of existing or of the completed pipeline or structure. Control blasts in tunnels so that the material surrounding the tunnel base proper is not loosened or displaced.

2. Discontinue blasting whenever it is determined that further blasting may injure or damage adjacent rock, masonry, utility lines, or other structures. In such cases, excavate the remaining rock by barring, wedging, or other approved methods.

3. Where sewers, gas, water, steam, or other utility ducts or lines, catch basin connections, or other structures have been exposed during excavation, adequately protect such structures from damage before proceeding with the blasting. Promptly repair any structure damaged by blasting at no addition to the Contract Price.

4. Take due precautions to prevent accidental discharge of electric blasting caps from current induced by radar, radio transmitters, lightning, adjacent powerlines, dust storms or other sources of extraneous electricity.

5. Keep a sufficient quantity of explosives on hand to avoid delay to the Work on the site when rock excavation is in progress. At no time keep a quantity in excess of that which will be required for use within the following 12 hours.

6. Store, handle and use such explosives in conformity with all laws, ordinances, and regulations of the County or governing body governing the storage and use of explosives at the construction site.

7. Provide a magazine keeper to keep accurate daily records and account for each piece of explosive, detonator and equipment from time of delivery at the magazine until used or removed from the site. Abandon no explosives or blasting agents.

8. Take sole responsibility for the methods of handling, use, and storage of explosives and any damage to persons or property resulting therefrom. Approval of these methods or failure to order that blasting be discontinued does not relieve the CONTRACTOR of any of this responsibility.

3.7 FINISHED EXCAVATION

A. Finish: Provide a reasonably smooth finished surface for all excavations, which is uniformly compacted and free from irregular surface changes.

B. Finish Methods: Provide a degree of finish which is ordinarily obtainable from blade-grade operations, except as otherwise specified in Section 31 23 23.

3.8 PROTECTION

A. Traffic and Erosion: Protect newly graded areas from traffic and from erosion.

B. Repair: Repair any settlement or washing away that may occur from any cause, prior to acceptance. Re-establish grades to the required elevations and slopes.

C. It shall be the CONTRACTOR's responsibility to acquaint himself with all existing conditions and to locate all structures and utilities along the proposed utility alignment in order to avoid conflicts. Where actual conflicts are unavoidable, work shall be coordinated with the facility owner and performed so as to cause as little interference as possible with the service rendered by the facility disturbed. Facilities or structures damaged in the prosecution of the work shall be repaired and/or replaced immediately, in conformance with current standard practices of the industry, or according to the direction of the owner of such facility, at the CONTRACTOR's expense.

D. Other Requirements: Conduct all Work in accordance with the environmental protection requirements specified in Division 1.

3.9 AUTHORIZED ADDITIONAL EXCAVATION

A. Additional Excavation: Carry the excavation to such additional depth and width as authorized in writing, for the following reasons:

1. In case the materials encountered at the elevations shown are not suitable.

2. In case it is found desirable or necessary to go to an additional depth, or to an additional depth and width.

B. Refill Materials: Refill such excavated space with either authorized 2500 psi concrete or compacted select fill material, in compliance with the applicable provisions of Section 31 23 23.

C. Compaction: Where necessary, compact fill materials to avoid future settlement. As a minimum, unless otherwise specified or directed, backfill layers shall not exceed 6-inches in thickness for the full trench width and compaction shall equal 95% of maximum density, or 98% if under paved area of roadway, as determined by using ASTM D 1557. Compaction density tests shall be made at all such backfill areas with spacing not to exceed 100 feet apart and on each 6-inch compacted layer.

D. Payment: Additional earth excavations so authorized and concrete or select fill materials authorized for filling such additional excavation and compaction of select fill materials will be paid for under the appropriate Contract Items or where no such items exist, as a change in the Work.

3.10 UNAUTHORIZED EXCAVATION

A. Stability: Refill any excavation carried beyond or below the lines and grades shown, except as specified in the subsection headed "Authorized Additional Excavation", with such material and in such manner as may be approved in order to provide for the stability of the various structures.

B. Refill Materials: Refill spaces beneath all manholes, structures, pipelines, or conduits excavated without authority with 2500 psi concrete or compacted select fill material, as approved.

C. Payment: Refill for unauthorized excavation will not be measured and no payment will be made therefor.

3.11 SEGREGATION STORAGE AND DISPOSAL OF MATERIAL

A. Stockpiling Suitable Materials: Stockpile topsoil suitable for final grading and landscaping and excavated material suitable for backfilling or embankments separately on the site in approved locations.

B. Stockpile Locations: Store excavated and other material a sufficient distance away from the edge of any excavation to prevent its falling or sliding back into the excavation and to prevent collapse of the wall of the excavation. Provide not less than 2 feet clear space between the top of any stockpile and other material and the edge of any excavation.

C. Excess Materials: CONTRACTOR shall be responsible to transport and dispose of surplus excavated material and excavated material unsuitable for backfilling or embankments at an off site disposal location secured by the CONTRACTOR.

3.12 REMOVAL OF WATER

A. Water Removal: At all times during the excavation period and until completion and acceptance of the WORK at final inspection, provide ample means and equipment with which to remove promptly and dispose of properly all water entering any excavation or other parts of the WORK.

B. Dry Excavations: Keep the excavation dry.

C. Water Contact: Allow no water to rise over or come in contact with masonry and concrete until the concrete and mortar have attained a set and, in any event, not sooner than 12 hours after placing the masonry or concrete.

D. Discharge of Water: Dispose of water pumped or drained from the Work in a safe and suitable manner without damage to adjacent property or streets or to other work under construction.

E. Protection: Provide adequate protection for water discharged onto streets. Protect the street surface at the point of discharge.

F. Sanitary Sewers: Discharge no water into sanitary sewers.

G. Storm Sewers: Discharge no water containing settleable solids into storm sewers.

H. Repair: Promptly repair any and all damage caused by dewatering the Work.

END OF SECTION

SECTION 31 23 23

BACKFILLING

PART 1 GENERAL

1.1 SUMMARY

A. General Requirements: Backfill all excavation to the original surface of the ground or to such other grades as may be shown or required. For areas to be covered by topsoil, leave or stop backfill (12) inches below the finished grade or as shown. Obtain approval for the time elapsing before backfilling against masonry structures. Remove from all backfill, any compressible, putrescible, or destructible rubbish and refuse and all lumber and braces from the excavated space before backfilling is started. Leave sheeting and bracing in place or remove as the work progresses.

B. Equipment Limitations: Do not permit construction equipment used to backfill to travel against and over cast-in-place concrete structures until the specified concrete strength has been obtained, as verified by concrete test cylinders. In special cases where conditions warrant, the above restriction may be modified providing the concrete has gained sufficient strength, as determined from test cylinders, to satisfy design requirements for the removal of forms and the application of load.

C. Related Work Specified in Other Sections Includes:

1. Section 31 23 16 - Excavation – Earth and Rock

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM D 1557 - Standard Test Methods for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures Using 10 lb Rammer and 18 in Drop

1.3 SUBMITTALS

A. The Contractor shall notify the Engineer of the off-site sources of bedding and backfill materials, and submit to the Engineer the testing results of a representative sample weighing approximately 50 pounds. All fees associated with testing shall be paid for by the Contractor.

PART 2 PRODUCTS

2.1 BACKFILL MATERIAL - GENERAL

A. General: Backfill with sound materials, free from waste, organic matter, rubbish, boggy or other unsuitable materials.

B. General Materials Requirements: Conform materials used for backfilling to the requirements specified. Follow common fill requirements whenever drainage or select fill is not specified. Determine and obtain the approval of the appropriate test method where more than one compaction test method is specified.

C. Frozen Materials: Do not use frozen material for backfilling.

2.2 DRAINAGE FILL

A. Materials for Drainage Fill: Use clean gravel, crushed stone, or other suitable material conforming to the gradation specified for drainage fill. Clay and fine particles are unacceptable in drainage fill. Provide drainage fill of a grade between the following limits:

U.S. Standard Sieve	Percent Passing By Weight
1-1/2 inch	100
1 inch	95-100
1/2 inch	45-65
#4	5-15
#16	0-4

2.3 SELECT FILL

A. Materials for Select Fill: Use clean gravel, crushed stone, washed shell, or other granular or similar material as approved which can be readily and thoroughly compacted to 95 percent of the maximum dry density obtainable by ASTM D 1557.

1. Allowed Materials: Grade select fill between the following limits:

U.S. Standard Sieve	Percent Passing By Weight
2 inch	100
1-1/2 inch	90-100
1 inch	75-95
1/2 inch	45-70
#4	25-50

#10	15-40
#200	5-15

2. Unallowed Materials: Very fine sand, uniformly graded sands and gravels, sand and silt, soft earth, or other materials that have a tendency to flow under pressure when wet are unacceptable as select fill.

2.4 COMMON FILL

A. Materials for Common Fill: Material from on-site excavation may be used as common fill provided that it can be readily compacted to 90 percent of the maximum dry density obtainable by ASTM D 1557, and does not contain unsuitable material. Select fill may be used as common fill at no change in the Contract Price.

B. Granular Materials On-Site: Granular on-site material, which is fairly well graded between the following limits may be used as granular common fill:

U.S. Standard Sieve	Percent Passing by Weight
3 inch	100
#10	50-100
#60	20-90
#200	0-20

C. Cohesive Materials On-Site: Cohesive site material may be used as common fill.

1. The gradation requirements do not apply to cohesive common fill.

2. Use material having a liquid limit less than or equal to 40 and a plasticity index less than or equal to 20.

D. Material Approval: All material used as common fill is subject to approval. If there is insufficient on-site material, import whatever additional off-site material is required which conforms to the specifications and at no additional cost.

2.5 UTILITY PIPE BEDDING

A. Class A (special utility bedding). Should special bedding be required due to depth of cover, impact loadings or other conditions, Class A bedding shall be installed, as shown in Section 6 of the Lee County Utilities Operations Manual.

B. Class B (minimum utility bedding). The bottom of the trench shall be shaped to provide a firm bedding for the utility pipe. The utility shall be firmly bedded in

undisturbed firm soil or hand shaped unyielding material. The bedding shall be shaped so that the pipe will be in continuous contact therewith for its full length and shall provide a minimum bottom segment support for the pipe equal to 0.3 times the outside diameter of the barrel.

PART 3 EXECUTION

3.1 ELECTRICAL DUCT AND PRECAST MANHOLE BEDDING

A. Bedding Compaction: Bed all electrical ducts and precast manholes in well graded, compacted, select fill conforming to the requirements except as otherwise shown, specified, or required. Extend electrical duct bedding a minimum of 6 inches below the bottom of the duct encasement for the full trench width. Compact bedding thickness no less than 6 inches for precast concrete manhole bases.

B. Concrete Work Mats: Cast cast-in-place manhole bases and other foundations for structures against a 2500 psi concrete work mat in clean and dry excavations, unless otherwise shown, specified or required.

C. Bedding Placement: Place select fill used for bedding beneath electrical ducts and precast manhole bases, in uniform layers not greater than 9 inches in loose thickness. Thoroughly compact in place with suitable mechanical or pneumatic tools to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

D. Use of Select Fill: Bed existing underground structures, tunnels, conduits and pipes crossing the excavation with compacted select fill material. Place bedding material under and around each existing underground structure, tunnel, conduit or pipe and extend underneath and on each side to a distance equal to the depth of the trench below the structure, tunnel, conduit or pipe.

3.2 PIPE BEDDING AND INITIAL BACKFILL

A. Hand Placement: Place select fill by hand for initial pipe backfill from top of bedding to 1 foot over top of pipes in uniform layers not greater than 6 inches in loose thickness. Tamp under pipe haunches and thoroughly compact in place the select fill with suitable mechanical or pneumatic tools to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

B. Stone Placement: Do not place large stone fragments in the pipe bedding or backfill to 1 foot over the top of pipes, nor nearer than 2 feet at any point from any pipe, conduit or concrete wall.

C. Unallowed Materials: Pipe bedding containing very fine sand, uniformly graded sands and gravels, sand and silt, soft earth, or other materials that have a tendency to flow under pressure when wet is unacceptable.

3.3 BEDDING PLACEMENT AND BACKFILL FOR PIPE IN SHORT TUNNEL

A. Bed pipelines or electrical ducts placed in short tunnels in select fill or 2500 psi concrete. Completely fill the remainder of the annular space between the outside of the pipe wall and the tunnel wall with select fill, suitable job-excavated material, or 2500 psi concrete, as approved. Suitably support pipelines or ducts in short tunnels to permit placing of backfill suitably tamped in place.

3.4 TRENCH BACKFILL

A. General: Backfill material shall be clean earth fill composed of sand, clay and sand, sand and stone, crushed stone, or an approved combination thereof. Backfilling shall be accomplished under two specified requirements: First Lift, from trench grade to a point 12 inches above the top of the utility, and, Second Lift, from the top of the First Lift to the ground surface. Where thrust blocks, encasements, or other below-grade concrete work have been installed, backfilling shall not proceed until the concrete has obtained sufficient strength to support the backfill load.

B. First Lift: Fine material shall be carefully placed and tamped around the lower half of the utility. Backfilling shall be carefully continued in compacted and tested layers not exceeding 6 inches in thickness for the full trench width, until the fill is 12 inches above the top of the utility, using the best available material from the excavation, if approved. The material for these first layers of backfill shall be lowered to within 2 feet above the top of pipes before it is allowed to fall, unless the material is placed with approved devices that protect the pipes from impact. The "First Lift" shall be thoroughly compacted and tested before the "Second Lift" is placed. Unless otherwise specified, compaction shall equal 98% of maximum density, as determined by ASTM D 1557. The "First Lift" backfill shall exclude stones, or rock fragments larger than the following:

Pipe Type	(Greatest Dimension-Inches) Fragment Size (Inches)
Steel	2
Concrete	2
Ductile Iron	2
Plastic	1
Fiberglass	1

C. Second Lift: The remainder of the trench, above the "First Lift", shall be backfilled and tested in layers not exceeding 6 inches. The maximum dimension of a stone, rock, or pavement fragment shall be 6 inches. When trenches are cut in pavements or areas to be paved, compaction, as determined by ASTM D 1557, shall be equal to 98% of maximum density, with compaction in other areas not less than 95% of maximum density in unpaved portions of the Rights-of-Way or 90% of maximum density in other areas.

As an alternative, or if required under roadways, Flowable Fill may be substituted. If Flowable Fill is to be used, a fabric mesh shall be installed between the “first lift” and

the Flowable Fill. Flowable Fill shall be in accordance with Section 4.7.AH of the Lee County Utilities Operations Manual.

D. Compaction Methods: The above specified compaction shall be accomplished using accepted standard methods (powered tampers, vibrators, etc.), with exception that the first two feet of backfilling over the pipe shall be compacted by hand-operated tamping devices. Flooding or puddling with water to consolidate backfill is not acceptable, except where sand is the only material utilized and encountered and the operation has been approved by the OWNER.

E. Density Tests: Density tests for determination of the above specified compaction shall be made by an independent testing laboratory and certified by a Florida Registered, Professional ENGINEER at the expense of the Developer or CONTRACTOR. Test locations will be determined by the OWNER but in any case, shall be spaced not more than 100 feet apart where the trench cut is continuous. If any test results are unsatisfactory, the CONTRACTOR shall re-excavate and re-compact the backfill at his expense until the desired compaction is obtained. Additional compaction tests shall be made to each site of an unsatisfactory test, as directed, to determine the extent of re-excavation and re-compaction if necessary.

Copies of all density test results shall be furnished on a regular basis by the ENGINEER, to Lee County Utilities. Failure to furnish these results will result in the project not being recommended for acceptance by Lee County

F. Dropping of Material on Work: Do trench backfilling work in such a way as to prevent dropping material directly on top of any conduit or pipe through any great vertical distance. Do not allow backfilling material from a bucket to fall directly on a structure or pipe and, in all cases, lower the bucket so that the shock of falling earth will not cause damage.

G. Distribution of Large Materials: Break lumps up and distribute any stones, pieces of crushed rock or lumps which cannot be readily broken up, throughout the mass so that all interstices are solidly filled with fine material.

3.5 STRUCTURE BACKFILL

A. Use of Select Fill: Use select fill underneath all structures, and adjacent to structures where pipes, connections, electrical ducts and structural foundations are to be located within this fill. Use select fill beneath all pavements, walkways, and railroad tracks, and extend to the bottom of pavement base course or ballast.

1. Place backfill in uniform layers not greater than 8 inches in loose thickness and thoroughly compact in place with suitable approved mechanical or pneumatic equipment.

2. Compact backfill to not less than 95 percent of the maximum dry density as determined by ASTM D 1557.

B. Use of Common Fill: Use common granular fill adjacent to structures in all areas not specified above, unless otherwise shown or specified. Select fill may be used in place of common granular fill at no additional cost.

1. Extend such backfill from the bottom of the excavation or top of bedding to the bottom of subgrade for lawns or lawn replacement, the top of previously existing ground surface or to such other grades as may be shown or required.

2. Place backfill in uniform layers not greater than 8 inches in loose thickness and thoroughly compact in place with suitable equipment, as specified above.

3. Compact backfill to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

C. Use of Clay: In unpaved areas adjacent to structures for the top 1 foot of fill directly under lawn subgrades use clay backfill placed in 6-inch lifts. Compact clay backfill to not less than 90 percent of the maximum dry density as determined by ASTM D 1557.

1. Use clay having a liquid limit less than or equal to 40 and a plasticity index less than or equal to 20.

3.6 COMPACTION EQUIPMENT

A. Equipment and Methods: Carry out all compaction with suitable approved equipment and methods.

1. Compact clay and other cohesive material with sheep's-foot rollers or similar equipment where practicable. Use hand held pneumatic tampers elsewhere for compaction of cohesive fill material.

2. Compact low cohesive soils with pneumatic-tire rollers or large vibratory equipment where practicable. Use small vibratory equipment elsewhere for compaction of cohesionless fill material.

3. Do not use heavy compaction equipment over pipelines or other structures, unless the depth of fill is sufficient to adequately distribute the load.

3.7 BORROW

A. Should there be insufficient material from the excavations to meet the requirements for fill material, borrow shall be obtained from pits secured and tested by the CONTRACTOR and approved by the OWNER. Copies of all test results shall be submitted to Lee County Utilities.

3.8 FINISH GRADING

A. Final Contours: Perform finish grading in accordance with the completed contour elevations and grades shown and blend into conformation with remaining natural ground surfaces.

1. Leave all finished grading surfaces smooth and firm to drain.

2. Bring finish grades to elevations within plus or minus 0.10 foot of elevations or contours shown.

B. Surface Drainage: Perform grading outside of building or structure lines in a manner to prevent accumulation of water within the area. Where necessary or where shown, extend finish grading to ensure that water will be carried to drainage ditches, and the site area left smooth and free from depressions holding water.

3.9 RESPONSIBILITY FOR AFTERSETTLEMENT

A. Aftersettlement Responsibility: Take responsibility for correcting any depression which may develop in backfilled areas from settlement within one year after the work is fully completed. Provide as needed, backfill material, pavement base replacement, permanent pavement, sidewalk, curb and driveway repair or replacement, and lawn replacement, and perform the necessary reconditioning and restoration work to bring such depressed areas to proper grade as approved.

3.10 INSPECTION AND TESTING OF BACKFILLING

A. Sampling and Testing: Provide sampling, testing, and laboratory methods in accordance with the appropriate ASTM Standard Specification. Subject all backfill to these tests.

B. Compaction density tests shall be made at all such backfill areas with spacing not to exceed 100 feet apart and on each 6-inch compacted layer.

C. Correction of Work: Correct any areas of unsatisfactory compaction by removal and replacement, or by scarifying, aerating or sprinkling as needed and recompaction in place prior to placement of a new lift.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 31 40 00

SHORING, SHEETING AND BRACING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Work required for protection of an excavation or structure through shoring, sheeting, and bracing.

B. Related Work Specified in Other Sections Includes:

1. Section 31 23 16 - Excavation - Earth and Rock
2. Section 31 23 23 - Backfilling

1.2 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. CONTRACTOR's Submittals: All sheeting and bracing shall be the responsibility of the CONTRACTOR to retain qualified design services for these systems, and to be completed with strict adherence to OSHA Regulations. Submit complete design calculations and working drawings of proposed shoring, sheeting and bracing which have been prepared, signed and sealed by a Licensed Professional Engineer experienced in Structural Engineering and registered in the State of Florida, before starting excavation for jacking pits and structures. Use the soil pressure diagram shown for shoring, sheeting and bracing design. ENGINEER's review of calculations and working drawings will be limited to confirming that the design was prepared by a licensed professional engineer and that the soil pressure diagram shown was used.

1.3 REFERENCES

A. Design: Comply with all Federal and State laws and regulations applying to the design and construction of shoring, sheeting and bracing.

B. N.B.S. Building Science Series 127 "Recommended Technical Provisions for Construction Practice in Shoring and Sloping Trenches and Excavations.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Do work in accordance with the U.S. Department of Labor Safety and Health Regulations for construction promulgated under the Occupational Safety Act of 1970 (PL 91-596) and under Section 107 of the Contract Work Hours and Safety Standards Act (PL 91-54), and the Florida Trench Safety Act. The

CONTRACTOR shall also observe 29 CFR 1910.46 OSHA's regulation for Confined Space Entry.

PART 2 PRODUCTS

2.1 MANUFACTURERS AND MATERIALS

A. Material Recommendations: Use manufacturers and materials for shoring, sheeting and bracing as recommended by the Licensed Professional Engineer who designed the shoring, sheeting, and bracing.

PART 3 EXECUTION

3.1 SHORING, SHEETING AND BRACING INSTALLATION

A. General: Provide safe working conditions, to prevent shifting of material, to prevent damage to structures or other work, to avoid delay to the work, all in accordance with applicable safety and health regulations. Properly shore, sheet, and brace all excavations which are not cut back to the proper slope and where shown. Meet the general trenching requirements of the applicable safety and health regulations for the minimum shoring, sheeting and bracing for trench excavations.

1. CONTRACTOR's Responsibility: Sole responsibility for the design, methods of installation, and adequacy of the shoring, sheeting and bracing.

B. Arrange shoring, sheeting and bracing so as not to place any strain on portions of completed work until the general construction has proceeded far enough to provide ample strength.

C. If ENGINEER is of the opinion that at any point the shoring, sheeting or bracing are inadequate or unsuited for the purpose, resubmission of design calculations and working drawings for that point may be ordered, taking into consideration the observed field conditions. If the new calculations show the need for additional shoring, sheeting and bracing, it should be installed immediately.

D. Monitoring: Periodically monitor horizontal and vertical deflections of sheeting. Submit these measurements for review.

E. Accurately locate all underground utilities and take the required measures necessary to protect them from damage. All underground utilities shall be kept in service at all times as specified in Division 1.

F. Driven Sheeting: Drive tight sheet piling in that portion of any excavation in paved or surface streets City collector and arterial streets and in State and County highways below the intersection of a one-on-one slope line from the nearest face of the excavation to the edge of the existing pavement or surface.

G. Sheeting Depth: In general drive or place sheeting for pipelines to a depth at elevation equal to the top of the pipe as approved.

1. If it is necessary to drive sheeting below that elevation in order to obtain a dry trench or satisfactory working conditions, cut the sheeting off at the top of the pipe and leave in place sheeting below the top of the pipe.

2. Do not cut the sheeting until backfill has been placed and compacted to the top of the pipe.

H. Sheeting Removal: In general, remove sheeting and bracing above the top of the pipe as the excavation is refilled in a manner to avoid the caving in of the bank or disturbance to adjacent areas or structures. Sheeting shall be removed as backfilling progresses so that the sides are always supported or when removal would not endanager the construction of adjacent structures. When required to eliminate excessive trench width or other damages, shoring or bracing shall be left in place and the top cut off at an elevation 2.5 feet below finished grade, unless otherwise directed.

1. Carefully fill voids left by the withdrawal of the sheeting by jetting, ramming or otherwise.

2. No separate payment will be made for filling of such voids.

I. Permission for Removal: Obtain permission before the removal of any shoring, sheeting or bracing. Retain the responsibility for injury to structures or to other property or persons from failure to leave such shoring, sheeting and bracing in place even though permission for removal has been obtained.

J. Preload internal braces to 50 percent of the design loads.

K. Proof test tie backs to 133 percent of the design loads and lock off tie backs at 75 percent of the design loads.

3.2 SHEETING LEFT IN PLACE FOR PROTECTION

A. Ordered Left in Place: In addition to sheeting specified or shown to be left in place, the Engineer may order, in writing, any or all other shoring, sheeting or bracing to be left in place for the purpose of preventing injury to the structures, pipelines or to other property or to persons.

1. Cutoff sheeting left in place at the elevation shown or ordered, but, in general, at least 2.5 feet below the final ground surface.

2. Drive up tight any bracing remaining in place.

B. Right to Order: Do not construe the right to order shoring, sheeting and bracing left in place as creating any obligation to issue such orders.

END OF SECTION

DIVISION 32 – EXTERIOR IMPROVEMENTS

SECTION 32 10 01

PAVEMENT REPAIR AND RESTORATION

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required and remove and replace pavements over trenches excavated for installation of pipelines as shown on the drawings and/or specified herein.

1.2 GENERAL

A. All damage, as a result of work under this project, done to existing pavement, driveways, paved areas, curbs and gutters, sidewalks, shrubbery, grass, trees, utility poles, utility pipe lines, conduits, drains, catch basins, or stabilized areas or driveways and including all obstructions not specifically named herein, shall be repaired in a manner satisfactory to the ENGINEER. Bid prices shall include the furnishing of all labor, materials, equipment, and incidentals necessary for the cutting, repair, and restoration of the damaged areas unless pay items for specific types of repair are included in the Bid Form.

B. Keep the surface of the backfilled area of excavation in a safe condition and level with the remaining pavement until the pavement is restored in the manner specified herein. All surface irregularities that are dangerous or obstructive to traffic are to be removed. The repair shall conform to applicable OWNER or State requirements for pavement repair and as described herein.

C. All materials and workmanship shall be first class and nothing herein shall be construed as to relieve the CONTRACTOR from this responsibility. The OWNER reserves the right to require soil bearing or loading tests or materials tests, should the adequacy of the foundation or the quality of materials used be questionable. Costs of these tests shall be borne by the OWNER, if found acceptable; the costs of all failed tests shall be borne by the CONTRACTOR.

D. All street and road repair shall be made in accordance with the details indicated on the drawings and in accordance with the applicable requirements of these Specifications and meeting the permit requirements and approval of the governing Department of Transportation agencies.

E. Pavement or roadway surfaces cut or damaged shall be replaced by the CONTRACTOR in equal or better condition than the original, including stabilization, base course, surface course, curb and gutter or other appurtenances. The CONTRACTOR shall obtain the necessary permits prior to any roadway work.

Additionally, the CONTRACTOR shall provide advance notice to the appropriate authority, as required, prior to construction operations.

1.3 QUALITY ASSURANCE

A. Applicable provisions of the latest version of the Florida Department of Transportation "Standard Specifications for Road and Bridge Construction", and Supplemental Specifications hereunder govern the work under this Section. The Florida Department of Transportation will hereafter be referred to as FDOT.

PART 2 PRODUCTS

2.1 MATERIALS

A. All materials utilized in flexible base pavement and base course shall be as specified in the latest version of the Florida Department of Transportation "Standard Specifications for Road and Bridge Construction".

PART 3 EXECUTION

3.1 CUTTING PAVEMENT

A. Cut and remove pavement as necessary for installing the new pipelines and appurtenances and for making connections to existing pipelines.

B. Before removing pavement, the pavement shall be marked for cuts nearly paralleling pipelines and existing street lines. Asphalt pavement shall be cut along the markings with a jackhammer, rotary saw, or other suitable tool, leaving a uniform and straight edge with minimum disturbance to the remaining adjacent surface.

C. No pavement shall be machine pulled until completely broken and separated along the marked cuts.

D. The pavement adjacent to pipeline trenches shall neither be disturbed nor damaged. If the adjacent pavement is disturbed or damaged, irrespective of cause, remove the damaged pavement and shall replace it at his own expense.

3.2 GENERAL RESTORATION

A. The restoration of existing street paving, driveways, etc., shall be restored, replaced or rebuilt using the same type of construction as was in the original. Be responsible for restoring all such work, including sub-grade and base courses where present. Obtain and pay for such local or other governmental permits as may be necessary for the opening of streets. Meet any requirements other than those herein set forth which

may effect the type, quality and manner of carrying on the restoration of surfaces by reason of jurisdiction of such governmental bodies.

B. In all cases, maintain, without additional compensation, all permanent replacement of street paving, done by him under this Contract until accepted by the OWNER, including the removal and replacement of such work wherever surface depressions or underlying cavities result from settlement of trench backfill.

C. Complete all the final resurfacing or re-paving of streets or roads, over the excavations and relay paving surfaces of roadbed that have failed or been damaged prior to acceptance by the OWNER. Backfilling of trenches and the preparation of sub-grades shall conform to the requirements of Section 31 23 23.

D. All re-paving or resurfacing shall be done in accordance with Florida Department of Transportation Specifications, to which the following requirement of trench backfill will be added: Where pipeline construction crossed paved areas such as streets, the top 24 inches of trench below the road bases or concrete slabs shall be backfilled with compacted A-4 or better matter that will provide a bearing value of not less than 75 when tested by the Florida Department of Transportation Soil Bearing Test Methods.

3.3 PRIME AND TACK COATS

A. The work shall consist of the application of bituminous prime and tack coats on the previously prepared base course in accordance with Section 300 of the FDOT Specifications.

3.4 WEARING COURSE

A. The work shall consist of the construction of plant-mixed hot bituminous pavement to the thickness indicated in the drawings conforming to Type III asphaltic concrete in accordance with Section 333 of the FDOT Specifications. The requirements for plant and equipment are specified in Section 320 and the general construction requirements for asphaltic concrete pavement are contained in Section 330 of the FDOT specifications.

3.5 TESTING

A. All field testing shall be performed by an independent laboratory employed by the OWNER. All materials shall be tested and certified by the producer. Tests repeated because sub-grade or base does not meet specified compaction shall be at the CONTRACTOR's expense.

3.6 MISCELLANEOUS RESTORATION

A. Sidewalks cut or damaged by construction shall be restored in full sections or blocks to a minimum thickness of four inches. Concrete curb or curb gutter shall be restored to the existing height and cross section in full sections or lengths between joints. Concrete shall be as specified on the drawings. Grassed yards, shoulders and

parkways shall be restored to match the existing sections with grass seed or sod of a type matching the existing grass.

3.7 CLEANUP

A. After all repair and restoration or paving has been completed, all excess asphalt, dirt, and other debris shall be removed from the roadways. All existing storm sewers and inlets shall be checked and cleaned of any construction debris.

END OF SECTION

(NO TEXT FOR THIS PAGE)

SECTION 32 16 00

SIDEWALKS, DRIVEWAYS AND CURBS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Sidewalks, sidewalk ramps, driveways, curbs and drive approaches complete with concrete materials, concrete curing compounds, joint materials, field quality control and appurtenances.

1.2 REFERENCES

A. Reference Standards: Conform the work for this Section to the applicable portions of the following standard Specifications.

1. ASTM - American Society of Testing and Materials
2. AASHTO - American Association of State Highway and Transportation Officials
3. FDOT - Florida Department of Transportation - Standard Specifications for Road and Bridge Construction.
4. FAC - Florida Accessibility Code.
5. ADAAG - American with Disabilities Act Accessibility Guidelines
6. UFAS - Uniform Federal Accessibility Standards

1.3 SUBMITTALS

A. Reports: Written permission for the use of all local disposal sites Furnish copies to the ENGINEER.

1.4 JOB CONDITIONS

A. Environmental Requirements:

1. Temperature: Comply with the requirements for concrete installation due to outside ambient air temperatures as specified under Article 3.3.I of this Section.

B. Protection:

1. Protection Against Rain: Comply with the requirements for protecting new work against damage from Rain, as specified under Article 3.3.I of this Section.

2. Protection Against Cold Weather: Comply with the requirements for protecting new work against damage from cold weather, as specified under Article 3.3.I of this Section.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete: Use 2,500 psi concrete except as modified herein.

B. Ready-Mixed Concrete: Use ready-mixed concrete which conforms to ASTM C94, Alternate 2.

C. Water: Use water for mixing and curing concrete reasonably clean and free from oil, salt, acid, alkali, chlorides, sugar, vegetable, or other substances injurious to the finished product. Waters from sources approved by the local Health Department as potable may be used without test. Test water requiring testing in accordance with the current Method of Test for Quality of Water to be Used in Concrete, AASHTO T-26.

D. Concrete Curing Compounds: Use white membrane curing compound for curing concrete which conforms to AASHTO M148, Type 1 clear, or Type 2 while per FDOT Section 925.

E. Premolded Joint Filler: Use fiber joint filler which conforms to ASTM D1751. Use filler of the thickness, as specified herein, or as directed by the ENGINEER.

F. Steel Hook Bolts: Use hook bolts which conform to ASTM A706, or for Grade 60 of ASTM A615, A616, or A617. Use 5/8-inch diameter hook bolts self tapping.

G. Joint Sealant: Use hot-poured type joint sealant which conforms to ASTM D1190.

PART 3 EXECUTION

3.1 CONTRACTOR'S VERIFICATION

A. Excavation and Forming: Prior to the installation of any concrete, examine the excavation and forms for the proper grades, lines, and levels required to receive the new work. Ascertain that all excavation and compacted subgrades are adequate to receive the concrete to be installed.

1. Correct all defects and deficiencies before proceeding with the work.

B. Existing Improvements: Investigate and verify location of existing improvements to which the new work is to be connected.

1. Making necessary adjustment in line and grade to align the new work with the existing improvements must be approved by the ENGINEER prior to any change.

3.2 PREPARATION

A. Forms: Use wood or metal forms, straight and free from warp, clean, and sufficient strength to resist springing during the process of depositing concrete against them.

1. Use full depth of the concrete forms.

3.3 INSTALLATION

A. Sidewalks, Sidewalk Ramps, Driveways and Driveway Approaches: Construct all sidewalks and sidewalk ramps six (6) inches thick. Construct sidewalks five (5) feet wide unless otherwise noted on the Plans or directed by the ENGINEER, and slope per ADA requirements. Normally, sidewalks will be located within the right-of-way, parallel the property lines, at a distance of 1-foot from the property line.

1. Construct alleys, driveways and approaches six (6) inches thick. Construct the width of the driveways and driveway approaches as shown on the Plans or as directed by the ENGINEER.

B. Removal of Existing Curb for Sidewalk Ramps and Driveway Approaches: Conform construction of sidewalk ramps within street intersections where curbed pavement existing to the current FDOT Roadway and Traffic Design Standards.

1. Saw cut, to full depth of pavement, and remove a minimum of an 18-inch wide curb and gutter section where there is no proper curb drop for the sidewalk ramp or driveway approach. When mountable curbs are present, remove a 24-inch wide curb and gutter section for the construction of sidewalk ramps, as specified above.

2. Remove curb and gutter as determined by the ENGINEER in the field but remove curb and gutter at least as wide as the proposed sidewalk ramp plus 1-foot on each side.

3. Replace the removed curb and gutter section with materials, equal to what was removed and seal joint with hot poured rubber asphalt.

C. Install 5/8 inch diameter self tapping hook bolts, in the existing concrete pavement as indicated on the Plans prior to placing concrete for the removed curb and gutter section.

D. Placement of Forms: Use wood forms, straight and free from warp, of nominal depth for sidewalk sections less than 25 feet in length.

1. Stake forms to line and grade in a manner that will prevent deflection and settlement.

2. When unit slab areas are to be poured, place slab division forms such that the slab division joints will be straight and continuous.

3. Set forms for sidewalk ramps to provide a grade toward the centerline of the right-of-way in accordance with current standards. Use a uniform grade, except as may be necessary to eliminate short grade changes.

4. Oil forms before placing concrete. Leave forms in place at least 12 hours after the concrete is placed. Place forms ahead of the pouring operations to maintain uninterrupted placement of concrete.

5. The use of slip form pavers can be allowed when approved by the ENGINEER in lieu of the construction system described above.

E. Joints: Construct transverse and longitudinal expansion and plane-of-weakness joints at the locations specified herein, or as indicated on the Plans or as directed by the ENGINEER.

1. Place the transverse expansion joints for the full width and depth of the new work. Use transverse expansion joints placed against an existing pavement a minimum of six (6) inches deep but no less than the thickness of the concrete being placed.

2. Conform longitudinal expansion joints to the requirements as transverse expansion joints.

3. Construct joints true to line with their faces perpendicular to the surface of the sidewalk. Install the top slightly below the finished surface of the sidewalk. Construct transverse joints at right angles to the centerline of the sidewalk and construct longitudinal joints parallel to the centerline or as directed by the ENGINEER.

4. Place transverse expansion joints, 1/2-inch thick, through the sidewalk at uniform intervals of not more than 50 feet and elsewhere as shown on the Plans, or as directed by the ENGINEER.

5. Place expansion joints, 1/2-inch thick, between the sidewalk and back of abutting parallel curb, buildings or other rigid structures, concrete driveways and driveway approaches. When directed by the ENGINEER, place the expansion joint between sidewalks and buildings 1-foot from the property line and parallel to it.

6. Form plane-of-weakness joints every five (5) feet. Form joints by use of slab divisions forms extending to the full depth of the concrete or by cutting joints in the concrete, after floating, to a depth equal to 1/4 the thickness on the sidewalk. Construct cut joints not less than 1/8-inch or more than 1/4-inch in width and finish smooth and at right angles to the centerline on the sidewalk.

F. Placing and Finishing Concrete: Place all concrete on a prepared unfrozen, smooth, leveled, rolled and properly compacted base. Place concrete on a moist surface with no visible water present.

1. Deposit the concrete, in a single layer to the depth specified. Spade or vibrate and compact the concrete to fill in all voids along the forms and joints. Strike off the concrete with a strike board until all voids are removed and the surface has the required grade and cross section as indicated on the Plans, or as directed by the ENGINEER.

2. Float the surface of the concrete just enough to produce a smooth surface free from irregularities. Round all edges and joints with an edger having a 1/4-inch radius.

3. Broom the surface of sidewalks, driveways and approaches to slightly roughen the surface.

4. Texture the surface of the sidewalk ramps with a coarse broom transversely to the ramp slope, and coarser roughen than the remainder of the sidewalk. Contract the ramp slope in color (using a brick-red dye or approved equal) from the remainder of the sidewalk. Comply with minimum color contract and slope requirements from FAC, UFAS, ADAAG, Local Government Standards, or as directed by the ENGINEER.

G. Curing: After finishing operations have been completed and immediately after the free water has left the surface, completely coat and seal the surface of the concrete (and sides if slip-forming is used) with a uniform layer of white membrane curing compound. Do not thin the curing compound. Apply the curing compound at the rate of one gallon per 200 square feet of surface.

H. Barricades: Place suitable barricades and lights around all newly poured sidewalks, sidewalk ramps, driveways, driveway approaches and curb and gutter sections in order to protect the new work from damage from pedestrians, vehicles and others until the concrete has hardened.

1. Leave barricades in place for a minimum of two (2) days, except for driveway approaches and curb and gutter sections. Leave barricades in place for a minimum of three (3) days.

2. Remove and replace any concrete that suffers surface or structural damage at no additional cost.

I. Protection:

1. Against Rain: Protect new concrete from the effects of rain before the concrete has sufficiently hardened. Have available on the job site at all times enough

burlap or 6-mil thick polyurethane film to cover and protect one day's work. Stop work and cover completed work when rain appears eminent. As soon as the rain ceases, uncover the concrete and burlap drag the surface where necessary. Apply curing compound to any areas where the compound has been disturbed or washed away.

2. Against Cold Weather: If concrete is placed between December 15 and February 15, have available on the site sufficient amount of clean, dry straw or hay to cover one (1) day's production. If the temperature reaches 40 degrees F and is falling, place the hay or straw 12 inches thick, immediately after the curing compound is applied.

3. Concrete Temperature Limitations: Do not place concrete when the temperature of the concrete at the point of placement is above 90 degrees F.

J. Cleanup: After the concrete has gained sufficient strength, but no sooner than within 12 hours, remove the fixed forms and backfill the spaces on both sides with sound earth of topsoil quality. Compact, level and leave backfill in a neat condition.

K. Gutters and Curbs: Construct gutters and curbs in accordance with Section 520 FDOT Standard Specifications for Road and Bridge Construction, latest edition, including supplements.

3.4 FIELD QUALITY CONTROL

A. Concrete Delivery Ticket: Use a ticket system for recording the transportation of concrete from the batching plant to point of delivery. Issue this ticket to the truck operator at the point of loading and give to the ENGINEER upon delivery.

B. Concrete Delivery Rejection: Remove concrete not permitted for inclusion in the work by the ENGINEER from the site. Rejection of concrete will be determined through Field Quality Control and elapsed time from mixer charging to delivery.

C. Concrete Testing at Placement: Perform tests of each batch of concrete delivered, each 50 cubic yards, or whenever consistency appears to vary. The sampling and testing of slump, air content and strength will be performed at no cost to the CITY.

1. Sampling: Secure composite samples in accordance with the Method of Sampling Fresh Concrete, ASTM C172.

2. Slump Test: Test in accordance with ASTM C143. Use the least slump possible consistent with workability for proper placing of the various classifications of concrete.

a. Place structural concrete for walls and slabs, by means of vibratory equipment, with a slump of four (4) inches.

b. A tolerance of up to 1-inch above the indicated maximum will be allowed for individual batches provided the average for all batches or the most recent ten (10) batches tested, whichever is fewer, does not exceed the maximum limit.

3. Air Content: Determine air content of normal weight concrete in accordance with Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method, ASTM C23 1, or by the volumetric method, ASTM C 173, for each strength test.

4. Compressive Strength: Make two (2) strength tests of three (3) samples each for each 50 cubic yards, or fraction thereof, of each mix design of concrete placed in any one (1) day.

   a. Handling Samples: Mold and cure three (3) specimens from each sample in accordance with Method of Making and Curing Concrete Test Specimens in the Field, ASTM C31. Record any deviations from the requirements of this Standard in the test report.

   b. Testing: Test specimens in accordance with Method of Test for Compressive Strength of Cylindrical Concrete Specimens, ASTM C39. Test one (1) specimen at seven (7) days for information and test two (2) at 28 days for acceptance. Use the average of the strengths of the two (2) specimens tested at 28 days. Discard results if one (1) specimen in a test manifests evidence of improper sampling, molding or testing, and use the strength of the remaining cylinder. Should both specimens in test shown any of the above defects, discard the entire test.

   c. Acceptance of Concrete: The strength level of the concrete will be considered satisfactory so long as the averages of all sets of three consecutive strength test results equal or exceed the specified 28-day strength and no individual strength test results falls below the specified 28-day strength by more than 500 psi. If the strength test is not acceptable, perform further testing to qualify the concrete.

   d. Concrete Temperature: Determine the temperature of concrete sample for each strength test.

D. Reductions due to deficiencies in thickness or compressive strength are additive, that is, if an area is deficient by 3/8 inch and under strength by 200 psi, the total reduction is 20% plus 02% or 40% reduction.

END OF SECTION

SECTION 32 90 01

LANDSCAPING WORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Soil, soil preparation, soil tests, excavation, planting, seeding, sodding, pruning, edging, fertilizing and maintenance.

B. Related Work Specified in Other Sections Includes:

1. Section 31 23 16 - Excavation, Earth and Rock
2. Section 31 23 23 - Backfilling

1.2 REFERENCES

A. Codes and standards referred to in this Section are:

1. ASTM C 33 - Specification for Concrete Aggregates

1.3 SUBMITTALS

A. General: Provide all submittals, including the following, as specified in Division 1.

B. Soil Tests: Submit soil test results.

C. Maintenance Instruction Manual: Upon completion of the landscaping work and prior to final payment, furnish a landscaping maintenance manual. Include complete and detailed instructions on the recommended maintenance procedure to be followed for maintaining lawns and each species of plant material. Include a schedule of all planted and seeded materials and all pertinent growing and maintenance information and requirements for watering, fertilizing, lime applications, spraying, cultivating, pruning and weed control.

1.4 DELIVERY, STORAGE AND HANDLING

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

B. Top Soil: Deliver top soil in a dry state without enough moisture to allow it to be packed or squeezed into a ball.

C. Balled and Bare Root Plants: Immediately after delivery, set all balled plants on the ground with the balls well protected with soil. Water and properly maintain all plants until planting. Plant or heel in bare rooted plants which cannot be planted immediately upon delivery. No materials heeled in for more than a week may be used. Before the roots are covered, open bundler and separate the plants.

D. Grass Seed: Deliver grass seed in standard size bags of the vendor, showing weight, analysis and name of vendor. Store the seed so as not to impair its effectiveness.

E. Sod: Deliver sod to the site in fresh condition and within two days of the time it has been dug.

F. Fertilizer: Deliver fertilizer mixed as specified, in standard size bags, showing weight, analysis and the name of the manufacturer. Store the fertilizer in a weatherproof storage place in a manner that will keep it dry without affecting its effectiveness.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Seeding and Sodding: Sow grass seed between August 15th and October 15th unless sowing between March 15th and June 1st is permitted. Sow seed when the wind velocity is below 5 mph. Place sod between August 15th and October 15th or between March 15th and June 1st, or during the season or seasons which are normal for such work as determined by weather conditions and accepted practice in the locality and as approved.

B. Planting: Unless otherwise directed, plant deciduous material from March 1st to June 1st and from September 1st to December 1st. Plant evergreen material from April 1st to June 1st and from September 1st to November 1st.

1.6 WARRANTY

A. General: Apply the warranty to all seeded, sodded and planted areas. Have the warranty period commence after the final acceptance of all landscaping work exclusive of all replacement plant materials.

B. Plant Material: Warranty plant materials for a period of one year.

C. Seeded Areas: Warranty seeded lawn areas to the time of establishment of an acceptable uniform stand of grass.

D. Sod: Warranty sod to 30 days following the first cutting.

1.7 MAINTENANCE

A. General: Maintain all seeded, sodded and planted areas during the warranty period.

B. Grass Areas: Maintain all seeded and sodded areas to well establish a uniform stand of weed-free grass. Reseed or resod areas failing to develop a uniform stand.

C. Trees, Shrubs and Ground Covers: Cultivate trees, shrubs and ground covers and weed and water when necessary, but not less than twice a month, to prevent plant material from dying. Replace any plant material which is found to be dead or dying during the warranty period to original specifications upon request. Include the full cost of replacing dead or dying plant material in the Contract Amount. No separate payment will be made for replacements. Maintain plant material to be alive, in good growing condition and free of weeds.

D. Replacement: Replace plant material and resod or reseed only during the specified planting seasons and warranty the replacement material for the same period of time as the original material.

PART 2 PRODUCTS

2.1 SOIL

A. Topsoil: Provide a natural friable top soil of the region, rich in organic matter, without any material toxic to plant growth and of uniform quality, free of large roots, sticks, hard clay, weeds, brush, stones over 1-inch in maximum dimension or other litter or waste products. Provide topsoil containing no decomposed stone, salts or alkali, and not less than 15 parts per million of available nitrates, 3 parts per million of available phosphorus, 15 parts per million of potash, and having a pH of not less than 6.0 nor more than 7.2 at a depth of 8 inches below the surface of the field from which it is removed. Provide topsoil with a mechanical analysis as follows:

Sieve	Percentage Passing
1 inch	100

1/4 inch	97-100
No. 100	40- 60

B. Planting Soil: Prepare planting soil by mixing 10 parts of topsoil with fertilizer and 1 part of peat moss.

2.2 GRASS SEED AND SOD

A. Grass Seed: Provide a fresh, clean, new crop of grass seed the same as existed prior to construction or as approved by the Engineer and shall be ninety—nine (99) percent minimum purity, either (80) percent minimum germination and one (1) percent maximum week seed, labeled in accordance with U.S. Department of Agriculture Rules and Regulations under Federal Seed Act in effect. Seed which has become wet, mold, or otherwise damaged in transit or storage shall not be acceptable. Tag each sack in accordance with the agricultural seed laws of the United States and the State of Florida. Show on each tag the producer's guarantee as to the year grown, the percentage of purity, the percentage of germination and the tests by which the percentages were determined. Provide seed for this project having a test date within 6 months of the date of sowing.

B. Sod: Provide nursery-grown St. Augustine or Argentine Bahia sod, free of weeds, a minimum of 1-inch thick of dense growth and cut with sharp edges in 18-inch widths and not less than 3 feet long. Sod which has been grown on peat or which has been dug more than two days previous to delivery or which has been allowed to have the roots dry out or on which the grass has turned brown will not be accepted.

2.3 PLANT MATERIALS

A. General: Provide plant materials that are true to species or variety, sound, healthy, vigorous acclimated plants free from defects, disfiguring knots, sun-scaled injuries, abrasions of the bark, plant diseases and insect eggs, borers and all other forms of infestations. Provide material that has normal, well-developed branch systems and vigorous root systems and that is freshly dug, nursery-grown stock grown under the same climatic conditions as the Project location. Provide material grown under climatic conditions similar to those in the locality of the project for at least 2 years and transplanted or root pruned at least in the last 3 years.

B. Plant Size: Dimension a plant as it stands in its natural position. Measure trees under 4 inches in caliper at a point 6 inches above the ground and trees more than 4 inches in caliper at a point 12 inches

above ground. Provide the stock of a fair average of the minimum and maximum sizes specified. Do not cut back large shrubs to sizes specified.

C. Balled, Burlapped and Platformed Plants: Dig balled and burlapped, as well as balled and platformed, plants with sufficient roots and a solid ball of earth securely held in place by burlap and stout natural fiber rope. Manufactured balls are not acceptable. Provide balled and platformed plants with sturdy platforms of a size equal to the diameter of the horizontal midsection of the ball of earth.

D. Bare-Rooted Plants: Dig bare-rooted plants with sufficient root spread and depth to ensure full recovery and development of the plants. Cover roots for these plants with a uniformly thick coating of mud by being puddled immediately after they are dug.

E. Inspection: Submit plants to inspection for approval at the place of growth, for conformity to specification requirements as to quality, size and variety. In addition to the place of growth inspection, submit plants to inspection for approval upon delivery at the project site or during the progress of the work, for size and condition of balls or roots, diseases, insects, and latent defects or injuries. Remove rejected plants immediately from the site. Do not substitute plants for those specified unless approved.

2.4 COMMERCIAL FERTILIZER

A. Provide all commercial mixture fertilizer uniform in composition, free flowing, conforming to state and federal laws and suitable for application with equipment designed for that purpose. Provide fertilizer with organic, inorganic or combined elements with the following composition by weight:

1.	Nitrogen	12 percent
2.	Phosphorus pentoxide	8 percent
3.	Potash	8 percent

2.5 ACCESSORIES

A. Tree Wrap: Provide new, clean, plain, 8-ounce weight burlap material 6 inches wide for wrapping tree trunks.

B. Weed Barrier Fabric: Provide Pro-5 fabric as manufactured by the DeWitt Co., or equal.

C. Gravel: Provide smooth river bed gravel of solid or mixed color range to be as selected and meeting the requirements of ASTM C 33 and graded according to Size No. 467, Table II.

D. Mulch: Provide ground corn cobs, wood chips, tree barks, buckwheat hulls or other approved materials for mulch.

E. Edging: Provide commercial hot-rolled steel edging plate, 4 inches wide and 1/8-inch thick. Fabricate edging in sections with loops pressed from or welded to the face of sections at 30-inch centers to receive 16-inch long tapered steel stakes. Provide edging finished with the manufacturer's standard paint.

2.6 TESTS

A. Sample: Submit a 10-ounce sample of the proposed topsoil to a testing laboratory in sealed containers to prevent contamination.

B. Analysis: Analyze the topsoil sample to determine the amount of lime necessary and the appropriate fertilizer mix and quantity required for planting, seeding and sodding.

PART 3 EXECUTION

3.1 GRADES

A. General: Existing and final contours shown depict finished grades after completion of landscaping work.

B. Lawn Grades: Grade lawns to meet walks, curbs and adjoining surfaces after uniform settlement of surfaces. Correct water pockets or ridges which appear after surface settlement takes place on or before the end of the guarantee period.

3.2 EXCAVATION FOR PLANTING

A. General: Obtain approval for all plant locations before excavation. Remove from the site all material that is surplus and unsuitable for backfill.

B. Ground Cover and Grass Areas: Excavate for ground cover and grass areas to the required depths for grass to receive 6 inches of topsoil and for groundcover to receive 6 inches of planting soil.

C. Plant Pits: Excavate plant pits with vertical sides and a circular outline.

1. Dig tree and evergreen pits at least twice the diameter of the ball, and deep enough to permit an 8-inch layer of compacted planting soil beneath the ball.

2. Dig shrub pits a minimum of twice the diameter of the ball and deep enough to allow 6 inches of compacted planting soil beneath the ball.

D. Drain: Install french drains for all trees, ornamental trees, and evergreens planted on berms and other locations where the grade permits, from bottom of planting pit to the finished grade with a trench 9 inches wide, filled with a 6-inch thick layer of 3/4-inch washed gravel. Cover the gravel layer with a filter mat before backfilling the trench with soil.

3.3 SOIL CONDITIONING

A. Disking: Before the application of topsoil, sodding or seeding, disk the area to be seeded, sodded or planted with groundcover to a depth of 6 inches. Continue the disking until the subsoil surface is sufficiently broken to provide a good bond between subsoil and topsoil. Spread 6 inches of planting soil over the disked area to a uniform depth and density.

B. Ground Limestone: Incorporate ground limestone, if required by the results of the soil test report, into the upper 3 inches of planting soil. Uniformly spread fertilizer and mix into the soil to a depth of 1-1/2 inches or as recommended by the manufacturer.

3.4 SEEDING AND SODDING

A. Seeding: Sow seed at the rate recommended by the seed producer. Evenly rake the surface after seeding with a fine-tooth rake. Mulch all newly seeded areas and cover with a minimum of 1/4-inch of straw or hay, approximately at the rate of 1 bale per 1,000 square feet, then thoroughly wet.

B. Sodding: Lay sod in such a manner that the surface is smooth and even and all edges abut one another tightly. Water and roll sod so that a bond is produced between the prepared topsoil and the sod. On slopes greater than 3 to 1, stake installed sod with approved wooden sod stakes at a minimum rate of three stakes per square yard of sod.

3.5 PLANTING

A. Layout: Outline locations for trees, shrubs, evergreens and bed and stake for approval. Obtain location approval prior to commencing planting operations.

B. Setting Plants: Set plants plumb and straight with the crown at finished grade. Compact soil around the base of the ball, and fill the void 3/4 of the way up from the bottom. Water each plant immediately. After the water has completely drained, fill the plant pits to finished grade. Properly spread out roots of bare root plants and carefully work topsoil among them. Cut off any broken or frayed roots with a clean cut. Form a shallow basin, the size of the ball with a ridge of soil to facilitate watering. After that operation is completed, apply a second watering immediately. Finish all planting pits and beds within a period of 3 days following installation. Construct tree saucers, cultivate and outline planting pits with a neat edge, when necessary.

C. Mulching: Immediately after planting operations are completed, cover all tree and shrub pits with mulch to a minimum depth of 2 inches. Limit mulch for trees to saucer diameter and, for shrubs, the entire shrub bed.

D. Pruning: Prune each tree and evergreen with clean, sharp tools in accordance with standard horticultural practice to preserve the natural character of the plant. Remove suckers and all dead, broken or badly bruised branches.

E. Wrapping: Wrap the tree trunks of all trees with burlap tree wrapping securely tied with suitable cord at top and bottom and at 2-foot intervals along the trunk. Overlap the wrapping 2 inches top and bottom and entirely cover the trunk from the ground to the height of the second branch, neat and snug.

F. Guying: Guy trees as necessary to be plumb and straight through final inspection. Remove guy wires at completion of project.

G. Watering: During planting, thoroughly saturate the soil around each plant with water and as many times later as seasonal conditions require until the end of the guarantee period.

3.6 EDGING

A. General: Establish a neat edge where planting areas meet grass areas, with spade or edging tools, immediately after all planting and seeding is completed. Establish good flowing curves as shown. Maintain edging until the end of the guarantee period.

3.7 GRAVELED AREAS

A. General: Lay a weed barrier in accordance with the manufacturer's recommendations and top with a 4-inch layer of gravel. Edge graveled areas with metal edging.

END OF SECTION

SECTION 32 92 00

LAWN RESTORATION

PART 1 GENERAL

1.1 DESCRIPTION OF REQUIREMENTS

A. The work in this section consists of furnishing all labor, material and equipment to replace and maintain all areas disturbed during construction by establishing a stand of grass, within the areas called for by the furnishing and placing grass sod, or seeding, or seeding and mulching.

1.2 REFERENCE DOCUMENTS

A. The materials used in this work shall conform to the requirements of Florida Department of Transportation Standard Specifications for Road and Bridge Construction as follows:

1. Sod - Section 981-2
2. Fertilizer - Section 982
3. Water - Section 983

1.3 SUBMITTALS

A. Submit certifications and identification labels for all sodding supplied as specified in Section 01 33 00.

PART 2 PRODUCTS

2.1 SODDING

A. Types: Sod may be of either St. Augustine or Argentine Bahia grass or as that disturbed, as established prior to construction. It shall be well matted with roots. When replacing sod in areas that are already sodded, the sod shall be the same type as the existing sod.

B. Sod shall be provided as required in accordance with Florida Department of Transportation Specifications 575 and 981. The CONTRACTOR shall furnish sod equal to and similar in type as that disturbed. Placement and watering requirements shall be in accordance with FDOT Specifications Section 575.

C. The sod shall be taken up in commercial-size rectangles, preferably 12-inch by 24-inch or larger, except where 6-inch strip sodding is called for.

D. The sod shall be sufficiently thick to secure a dense stand of live grass. The sod shall be live, fresh and uninjured at the time of planting. It shall have a soil mat of sufficient thickness adhering firmly to the roots to withstand all necessary handling. It shall be reasonably free of weeds and other grasses. It shall be planted as soon as possible after being dug and shall be shaded and kept moist from the time it is dug until it is planted.

E. Sod should be handled in a manner to prevent breaking or other damage. Sod shall not be handled by pitch forks or by dumping from trucks or other vehicles. Care shall be taken at all times to retain the native soil on the roots of each sod roll during stripping and handling. Sod that has been damaged by handling during delivery, storage or installation will be rejected.

2.2 FERTILIZER

A. Chemical fertilizer shall be supplied in suitable bags with the net weight certification of the shipment. Fertilizer shall be 12-8-8 and comply with Section 982 of the FDOT Standard Specification for Road and Bridge Construction.

B. The numerical designations for fertilizer indicate the minimum percentages (respectively) of (1) total nitrogen, (2) available phosphoric acid and (3) water soluble potash, contained in the fertilizer.

C. The chemical designation of the fertilizer shall be 12-8-8, with at least 50 percent of the nitrogen from a nonwater-soluble organic source. The nitrogen source may be a unreaformaldehyde source provided it is not derived from a waste product of the plastic industry.

2.3 EQUIPMENT

A. The device for spreading fertilizer shall be capable of uniformly distributing the material at the specified rate.

2.4 NETTING

A. Netting is fabricated of material similar to Geoscope Landscape Fabric or approved equal.

2.5 GRASSING

A. The CONTRACTOR shall grass all unpaved areas disturbed during construction which do not require sod. All grassing shall be completed in conformance with FDOT Specifications Sections 570 and 981. The grassed areas shall be mulched and fertilized in accordance with FDOT Specifications.

B. Grass seed shall be Argentine Bahia, 60 #/acre March 1 to November 1, 50 #/acre with 20 #/acre of rye grass seed November 1 to March 1. Argentine Bahia seed shall be a scarified seed having a minimum active germination of 40% and total of 85%.

C. Mulch material shall be free of weeds and shall be oat straw or rye, Pangola, peanut, Coastal Bermuda, or Bahia grass hay.

2.6 TOPSOIL

A. Topsoil stockpiled during excavation may be used. If additional topsoil is required to replace topsoil removed during construction, it shall be obtained off site at no additional cost to the OWNER. Topsoil shall be fertile, natural surface soil, capable of producing all trees, plants, and grassing specified herein.

2.7 MULCH

A. Mulch shall be fresh cypress mulch. Rate of application specified herein shall correspond to depth not less than 1-inch or more than 3-inches according to texture and moisture content of mulch material.

2.8 WATER

A. It is the CONTRACTOR'S responsibility to supply all water to the site, as required during seeding and sodding operations and through the maintenance period and until the work is accepted. The CONTRACTOR shall make whatever arrangements may be necessary to ensure an adequate supply of water to meet the needs for his work. He shall also furnish all necessary hose, equipment, attachments, and accessories for the adequate irrigation of lawns and planted areas as may be required. Water shall be suitable for irrigation and free from ingredients harmful to plant life.

PART 3 EXECUTION

3.1 SOD BED PREPARATION

A. Areas to be sodded and/or seeded shall be cleared no all rough grass, weeds, and debris, and brought to an even grade.

B. The soil shall then be thoroughly tilled to a minimum 8-inch depth.

C. The areas shall then be brought to proper grade, free of sticks, stones, or other foreign matter over 1-inch in diameter or dimension. The surface shall conform to finish grade, less the thickness of sod, free of water-retaining depressions, the soil friable and of uniformly firm texture.

3.2 INSPECTION

A. Verify that soil preparation and related preceding work has been completed.

B. Do not start work until conditions are satisfactory.

3.3 SOD HANDLING AND INSTALLATION

A. During delivery, prior to planting, and during the planting of sod areas, the sod panels shall at all times be protected from excessive drying and unnecessary exposure of the roots to the sun. All sod shall be stacked during construction and planting so as not to be damaged by sweating or excessive heat and moisture.

B. After completion of soil conditioning as specified above, sod panels shall be laid tightly together so as to make a solid sodded lawn area. On mounds and other slopes, the long dimension of the sod shall be laid perpendicular to the slope. Immediately following sod laying the lawn areas shall be rolled with a lawn roller customarily used for such purposes, and then thoroughly watered.

C. Sod shall be placed at all areas where sod existed prior to construction, on slopes of 3 horizontal on 1 vertical (3:1) or greater, in areas where erosion of soils will occur, and as directed by the ENGINEER. On areas where the sod may slide, due to height and slope, the ENGINEER may direct that the sod be pegged, with pegs driven through the sod blocks into firm earth, at suitable intervals.

3.4 SOD MAINTENANCE

A. The sod shall produce a dense, well established growth. The CONTRACTOR shall be responsible for the repair and re-sodding of all eroded or bare spots until project acceptance. Repair to sodding shall be accomplished as in the original work.

B. Sufficient watering shall be done by the CONTRACTOR to maintain adequate moisture for optimum development of the seeded and sodded areas. Sodded areas shall receive no less than 1.5 inches of water per week for at least 2 weeks. Thereafter, the CONTRACTOR shall apply water for a minimum of 60 days as needed until the sod takes root and starts to grow or until final acceptance, whichever is latest.

3.5 CLEANING

A. Remove debris and excess materials from the project site.

END OF SECTION

(NO TEXT FOR THIS PAGE)

DIVISION 40 – PROCESS INTEGRATION

SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE

A. Furnish complete with all accessories, additions and extension to an existing programmable logic control based monitoring and control system with its associated instrumentation as described herein and shown on the contract drawings. The system shall serve as a self-contained monitoring and control system for all aspects the reclaimed water interconnect system operation.

B. This Specification has been developed to establish minimum requirements. This system shall be designed, constructed, tested and documented in strict accordance with the guidelines of this document. All system construction and programming will be the responsibility of the control system integrator. All materials and labor shall be provided for a fully functional system including any items which are required for system operation but are not specifically addressed in this document or on the contract drawings.

C. This specification is intended to be used in conjunction with all drawings supplied and is not intended to be complete without reference diagrams on system configurations, etc. All bidders must conform to all areas of the documentation. It is the intent of this specification that the monitoring and control system contractor have single source responsibility for the complete control package for the project.

D. Interconnecting the new control system with existing field devices is required for total system responsibility. The control system integrator shall obtain from the County the required information on those primary elements, valves, valve actuators, and other control equipment or devices (both new and existing) that are required to be interfaced with, but that are not provided under, this section.

E. It shall be understood that some refinement and/or minor modification of the control strategies shall be necessary over the course of the project at no additional cost. Forums for informal discussions and clarifications have been provided in these documents. They include the Pre-submittal Conferences, Graphics/Reports Development meetings, Factory Testing, Field Development Phase and Startup. Note: All timer, level, position, analysis and flow rate values noted within the control strategies are provided for reference only and are subject to change based on final construction.

F. The overall requirements for the Process Instrumentation and Control System are included in other Division 40 sections.

1.02 CONTRACTOR QUALIFICATIONS AND ADDITIONAL RESPONSIBILITY

A. The contractor providing this system shall be an instrumentation and control systems contractor who is experienced in and regularly engaged in engineering, installation and service of systems of similar size and complexity within the water

treatment industry. The panel supplier shall be a UL listed panel shop and all panels shall be UL-508 certified. All panels shall utilize components in order to achieve a minimum of 10KA AIC rating.

B. The contractor shall assume total systems responsibility for all aspects of this system including installation, commissioning and start-up of the system, training of operating personnel and coordinating interfaces between this system and equipment provided by others. This responsibility shall include mounting and wiring of relays, transformers, disconnecting means, and other control devices as required forming a complete system.

C. The existing plant SCADA system human machine interface (HMI) software is Citect. The control system integrator shall be a qualified system integrator to implement the needed modifications to the Citect displays and database to monitor and control the new equipment and fully depict and allow full monitoring and remote interface with the new dewatering system equipment. SCADA interface shall follow standard County practices for Citect development and shall provide full interface with the new equipment as specified herein.

B. The control system integrator shall be able to offer personnel that have at least ten years of proven Citect experience as well as the programming of the type of PLC supplied under this project. Individual proposed for the Citect programming on plant workstations shall have at least three projects completed in the last 3 years using Citect software.

D. The control system integrator shall ensure the continued operation of the existing systems during tie-ins or interconnecting to the existing system. Provide temporary programming and equipment that may be required during construction to facilitate construction and testing as determined by the engineer.

E. The control system integrator shall assume full responsibility for all aspects of this system including components, devices, and systems not provided under this section, but that are directly interfaced by components or subsystems provided under this section such as VFDs, valve operators, chemical feed equipment, packaged local control panels.

1. Verify that the component, device, or system has been installed in accordance with the manufacturer's recommendations with respect to operation and control, coordinate installation, provide interfaces required.
2. Verify the calibration and adjustment of devices.
3. Verify proper control system interface and operation.
4. Start up and test to demonstrate proper control system interface and operation.
5. Provide the necessary modifications to the equipment, or other controls to properly interface and control the equipment.
6. Provide as built documentation of the existing controls and instrumentation devices and their integration into the total control and monitoring systems.

F. Where the term "verify" and "certify" are stated in this specification, the intent is that the control system integrator shall issue formal statements in writing to the engineer that the particular activity has been accomplished.

PART 2 PRODUCTS

2.01 FUNCTION BLOCKS

A. Systems integrator shall implement the use of function blocks within the control logic programming throughout. The function blocks shall prevent negative analog device readings, flag function blocks, provide out of range indication and shut down the process associated with the device. All analog signals shall be integrated using function blocks.

2.02 DATA ACQUISITION AND GENERAL CONTROL LOGIC/HMI

A. Not in AUTO Alarms: Before operating any field device, the PLC program shall check to see that the device has been switched to the AUTO mode. If the device is not in AUTO, the PLC shall set an error bit and suspend control of the device until it is switched to AUTO.

B. Equipment READY Logic: “Ready” shall be defined in the PLC program (if not already defined by field relay logic) as follows:

1. Field equipment is currently in Remote and/or Auto mode.
2. There are no fail conditions pending (including field E-Stop)
3. The equipment is not currently in Run mode.
4. No run inhibit conditions exist

Ready shall be interpreted as “being available for remote (auto or manual) operation”. HMI Auto mode cannot be achieved without the related equipment having a READY status.

C. No Response Alarm: If at any time a field device fails to respond to an output command from the PLC, the PLC shall set an error bit. The SCADA shall use the error bit to log a "No Response" alarm. PLC generated timeout failures shall be reset at the HMI. This shall be in the form of a screen button made visible when a timeout failure exists for the equipment currently in timeout.

D. Adjustable Timers: The preset values for all PLC timers shall be adjustable through the HMI software by the operator under security password clearance.

E. PLC Diagnostic Alarms: In addition to the alarm conditions shown on the P&IDs, each PLC shall monitor its CPU and I/O modules. When the CPU or any I/O module fails, the PLC shall generate a PLC FAIL alarm.

F. Process Variable Filtering: Each analog process variable being transmitted to the SCADA shall have adjustable digital filtering applied.

G. Flow Signal Dampening: Various flow meters are used to process water and

chemicals throughout the facility. The PLC shall be programmed to dampen the incoming analog signal. This shall be accomplished by averaging the flow signal over a (5) second period. Specifically, the PLC shall sample the flow every half second for 5 seconds to calculate the average flow.

H. Totalizer Current Average Value: The current average flowrate for each totalized value shall be provided for each flowrate input.

I. Historical Data Collection and Display: The control system shall historically collect, trend and record, in the HMI historical database, all analog input data represented on the Contract Drawings and I/O Schedule.

1. Daily Average: Daily average calculations shall be provided as required to support displays and reports.
2. Daily Totalizer Counter: Accumulate daily total over Hart, pulsed or alternate network signal. The totalizer shall be reset daily when the daily reports are produced.
3. Monthly Totalizer Counter: Accumulate daily total flow over Hart signal. The totalizer shall be reset monthly when the monthly reports are produced.
4. Cumulative Totalizer Counter: Accumulate total flow over Hart or pulsed signals.

Trends shall display the process variable, the transmitter tag, a clear description and the units for both axes. For variables which are controlled by the PLC, both the setpoint and the controlled process variable shall be displayed on the same trend. Where multiple variables are displayed, separate and distinct colors shall be used for each variable along with a color key with clear descriptions defining each variable.

J. Run Time: Each piece of equipment shall have a run timer, which accumulates time.

K. Number of starts: Accumulates each time a motor is called to start and a run confirmation is received.

L. Current Draw: The PLC shall monitor current draw in monitored equipment. The HMI shall Log changes in monitored equipment current draw

M. Out of Range: The PLC shall monitor each analog process variable being transmitted, if at any time the value deviates from the scaled 4-20mA range, the PLC shall set an error bit. The SCADA shall use the error bit to log an "Out of Range" alarm.

N. The HMI shall display the status or value of all PLC input and output points described in this section, detailed in the I/O schedule and shown on the P&ID drawings.

O. Operator entered setpoints shall be constrained to match PLC programmed setpoint ranges. If a value lower than the setpoint range is entered, the PLC program shall default to the lowest possible range value. If a value higher than the setpoint range is entered, the PLC program shall default to the highest possible range value.

P. Confirmed PLC setpoint entries become the default program values. Should a PLC reboot occur, the PLC program shall be automatically restored with last setpoint entries. No operator intervention shall be necessary to bring a freshly rebooted PLC online and operational.

Q. Alarm Logging: Alarms related to HMI displayed field equipment and facilities shall be displayed on the related system control screen as well as recorded in the historical alarm summary. Reference Specification Section 40 61 93 – Appendix B for additional requirements.

The entire system alarm history (read-only from the moment of system initialization) shall be made accessible at the HMI. An alarm configuration screen at the HMI shall allow an authorized operator to enable or disable any HMI alarm notification without the need to access the control system software back office tools.

R. Event Logging: An event log, separate from the alarm history, shall be made accessible at the HMI (read-only from the moment of system initialization). The event log shall date/time stamp and record any discrete change in status of the equipment monitored by the PLC (e.g. Local/Remote, Man/Auto, Run/Off, Open/Close, Intrusion, Control Setpoint Change, Start Sequence Change, Alarm Enable/Disable, Out-of-Service status change, etc.). Reference Specification Section 40 61 93 – Appendix C for additional requirements.

S. Loop tuning parameters: The HMI/PLC interface shall be configured to allow operators with supervisory level security clearance, access to all loop tuning parameters from the HMI for any control loop. Changing loop tuning parameters SHALL NOT require reconfiguring, reprogramming, or reloading of the PLC program. All changes to any loop tuning parameters shall be logged to the historical database event log.

T. Bumpless Auto/Manual Transition: Changing the HMI Auto/Manual control status of controlled equipment shall be a bumpless operation. Therefore a VFD operating in Auto mode at 78% of maximum speed shall maintain that speed and remain in operation when switched to manual control at the HMI. A similar adjustment to a modulating valve actuator should display identical behavior.

U. Out of Service: The control system shall have the facility to assign an “Out-of Service” tag to equipment monitored by the control system. During extended periods of maintenance and/or repair, an operator may make such an assignment so as to suppress associated alarms and inhibit HMI/PLC control functions.

V. Workstation Clocks: The Data Management Server (DMS) clock shall be automatically synchronized with all clocks on PLCs and Workstations. Synchronization shall be configured as an operating system service.

PART 3 EXECUTION

3.01 PRE-SUBMITTAL CONFERENCE

A. The control system integrator shall arrange and conduct a pre-submittal conference within 30 days after award of the contract. The purpose of the pre-submittal conference is to review and approve the manner in which the control system integrator intends to carry out its responsibilities for the shop drawing submittal on the work to be provided under this Section. The control system integrator, the general contractor or prime contractor, the County’s representative(s) and the engineer shall attend.

B. The control system integrator shall present the following for discussion at the conference.
   1. A list of equipment and materials required for the control system and the Manufacturer’s name and model number for each proposed item.
   2. A list of proposed clarifications to the contract documents along with a brief explanation of each. Resolution shall be subject to a separate formal submittal and review by the engineer.
   3. An exact one-to-one sample of each type of submittal specified herein.
   4. A detailed description of the file management system that will be used to track all programs developed for use under this project and the avenues through which the County’s selected staff may participate with control program development.
   5. A construction schedule for all system related activities from the pre-submittal conference through start-up and training. Dates of submittals, design, fabrication, programming, factory testing, deliveries, installation, field testing, and training shall be shown. The schedule shall be subdivided to show activities relative to each major item or group of items when everything in a given group is on the same schedule.
   6. An overview of the proposed training plan. The County's staff and engineer will review the overview and may request changes. All changes to the proposed training shall be resolved at the pre-submittal conference. The overview shall include the following for each proposed course.
      a. Course title and objectives.
      b. Prerequisite training and experience of attendees.
      c. Course content topic outline.
      d. Course duration.
      e. Course format - lecture, laboratory demonstration, etc.
   7. Based on equipment approved for supply, furnish a proposed list of status and control points to be transmitted over the 2-wire networks as required for each intelligent starter, VFD and valve actuator module as applicable.

A separate discussion shall be held to determine the number of points (any combination of analog, discrete and alarm points) that will be collected from the contract furnished power monitors and monitored by the plant control system (maximum of 30 points).

C. The control system integrator shall take minutes of the Conference, including all events, questions, resolutions and planned meeting schedules. An electronic draft version of the meeting minutes shall becirculated, to all in attendance, for comment prior to final distribution.

3.02 SUBMITTALS

A. Submit in accordance with Section 26 05 02 BASIC ELECTRICAL MATERIALS AND METHODS and as described herein.

B. SHOP DRAWINGS shall include:

1. A cover sheet consisting of a Bill of Material, purchase order number, manufacturer's job number, Owner's name, location, application and shipping address.
2. Mechanical layouts detailing the overall external dimensions of all enclosures. Include all pertinent information such as location of door handles, windows, lifting lugs and enclosure mounted items such as pump controller chassis and I/O modules (show cable connections on modules), relays, cooling fans, etc.
3. Details for mounting of the processor, I/O racks, relays, motor starters, disconnect switch, fuse blocks, wireways, etc. All materials shall be labeled to provide easy cross-reference to the Bill of Material listing.
4. Electrical drawings detailing all hardwiring, done by the supplier, to devices such as relays, pump controller modules, disconnect switches, fuse blocks, etc. Provide individual wire numbers and relay contact cross-reference designations.
5. A description of all input and output modules by name, rack, module and terminal location.
6. Complete master wiring diagrams, elementary schematics and control schematics shall be submitted for approval before proceeding with manufacture. Suitable outline drawings shall be furnished as part of this submittal. Standard or typical pre-printed sheets or drawings simply marked to indicate applicability to this contract will not be acceptable. Shop drawings shall be on standard 24" X 36" or 11" X 17" media; drawn with a computer aided design package. The computer aided design package shall be AUTOCAD version 2014 or converted to Autocad version 2014. Engineering plan backgrounds of the facility shown on the contract documents will be available to the contractor on request. Submittals shall include reproducible plots of the drawings on paper and CD-ROM electronic copies.
7. A complete drawing indicating each point of interface with the process control system and the type of signal provided or accepted at each point. This drawing shall depict the actual interface terminal block including all circuit designations.
8. A complete sequence of operation describing the control strategy in response to external signals and the signals which will be provided to the process control system during operation of the plant. All interlocks and limits which are internal to the operation of the controls shall be included in this description.

9. A drawing showing the layout of the control panels indicating every device with complete identification.
10. Analog and digital loop diagrams showing all I/O from the point of origin in the field device through the wiring systems to the PLC and HMI systems. Include all terminal block points and identification, color codes, tag names and numbers, etc. Include device range and calibration data for the analog device loop diagrams.
11. The last sheet(s) in the set shall describe all terminal block designations and individual terminal numbers.

C. SOFTWARE SUBMITTALS shall include:

1. Provide logic submittal diagrams in ISA format of all loops that are implemented in software and include a description of the control function and its control strategy, a listing of the scanned inputs and the outputs of the control function, operator inputs or outputs to and from the function and displays related to the function; failure contingencies and cross reference to other loop diagrams.
2. Generate a complete listing of all virtual discrete and analog points that are used to link modules. The virtual tag lists shall be developed and submitted to the engineer to facilitate operator interface programming.
3. A written overview description of each ladder logic program. These descriptions shall lead the user through the major subsections of the programs. They shall generally describe the programming methods and techniques that were used to implement the functional requirements of this specification.
5. Each element (input, output, or function block) shall be fully described in a 15 character minimum description. Ladder rungs shall have comments that describe the function of the rungs. Provide an average of one 120 character comment line per ladder rung.
6. Discrete and analog input/output lists and cross reference. Each input and output shall be capable of being given up to a 27-character alpha-numeric functional identification that is printed above the respective input or output in the program listing. The cross reference shall indicate each rung number where the input or output is used.
7. Internal coils list and cross-reference. Each coil shall be capable of being given a 27-character alphanumeric function identification that is printed above the respective coil and all of its contacts in the program listing. The cross-reference shall indicate each rung number where the respective coil or contact is used.
8. Data register list and cross-reference. This listing provides a listing of the data registers used and their locations(s) in the program.
9. A listing of all programmed special functions, including memory locations used and location in the program where the special functions can be found. Function descriptions shall also be shown in the special function printout for all pertinent memory locations used in each special function. Programmed values of all memory locations used shall also be shown.
10. Timers, counters, integer add and subtract, move, master control relay, and jump functions shall show all memory locations used and their programmed values.
11. Variable data memory storage record, indicating the memory location and

description of the variable data; i.e., tag number, timer number, counter number. Function listing; all identified DCS functions indicated on the drawings and specifications shall be listed and fully described.

12. These submittals shall be returned reviewed prior to software code development. This is a critical path item and should be given appropriate consideration by the controls contractor.

D. O&M MANUALS

1. Submittal Requirements
   a. CONTRACTOR shall provide the OWNER and engineer with an electronic copy of each of the preliminary O&M manual for review.
   b. Upon approval of the preliminary O&M the CONTRACTOR shall provide the OWNER with three hard copies of the final O&M manual. Award of final completion is contingent on the receipt of final O&M manuals.
   c. CONTRACTOR shall provide the OWNER with two electronic copies of the final O&M manual on CD. Award of final completion is contingent on the receipt of these CD's.
2. O&M manual shall include the approved shop drawing information as well as the following:
   a. As-Built drawings of all existing and new Control Panels and control panels turned to termination cabinet.
   b. Bill of Material listing for all components provided within the PLC panel (and any other panels provided) as well as provided external instrumentation devices, with cut sheets and operator's manual/user's reference books. Provide hard copy manuals and CD-Rom copy where available.
   c. Description of Operation, Local. Describe the control that takes place locally -- through the use of the local control panels and operator interface. The written description should be supported with pictorial representations such as the operator interface screens or portion of an electrical drawing.
   d. Description of Operation, SCADA. Describe the control that takes place at the Water Treatment Plant SCADA Server, similar to the local Operation Description listed above. Support the written description with pictorial representations -- screens from the Citect or pictures/images.
   f. Description of Operation Procedures. Describe Power up procedures, shut down procedures, troubleshooting procedures
   g. Complete documentation for the PLC and its programming. Include the RS Logix Report with: Processor Information listing, I/O configuration, channel configuration, program file list, data file list, complete ladder-logic printout, address assignment listings for all Data Files/Bits.
   h. Complete documentation concerning the Operator Interface and its database/address assignment.
   i. Complete documentation of the Citect Screens and its database/address assignment, similar to that above for the operator interface. Include configuration/setup listings that were used for the SCADA programming. Manual shall contain a copy

of the most current SCADA system project back up. It will also include the “citect.ini” file for all the automation computers.

j. Complete electronic copy (disk or CD-ROM) of the PLC ladder logic program. The licensed copy of the programming software as specified. The electronic copy shall contain the actual PLC program and not a PDF version of the program.

k. Complete electronic copy (disk or CD-ROM) of the operator interface program. The licensed copy of the programming software for the operator interface where required.

l. Complete electronic copy (disk or CD-ROM) of the Citect Screen files and any other configuration files that are specific to the configuration/setup for the facility. Include a copy of the most current 3D model files used for the SCADA screens in the native format of the software.

m. Alarms listings with clear descriptive messages. Alarm messages shall have the instruction address included in it.

n. A copy of the memory maps from PLC to PLC and all other devices such as power monitoring equipment. The electronic copy of the O&M manual shall contain the actual Excel file for the IO map and not a PDF version of the actual file.

o. Provide complete electronic file document library including AuotCAD files for all of the drawings, word processing files for all of the training and the sequence of operation.

p. System specifications.

o. Electrical power requirements.

q. Explanation of internal fault diagnostics.

r. Recommended spare parts list.

E. RECORD DRAWINGS

1. The control system integrator shall keep current a set of complete loop and schematic diagrams which shall include all field and panel wiring, piping and tubing runs, routing, mounting details, point-to-point diagrams with cable, wire, tube and termination numbers. These drawings shall include all instruments and instrument elements. One set of drawings electronically formatted in AutoCAD and 2 hard copies shall be submitted after completion of all functional testing tasks but prior to Performance Testing. All such drawings shall be submitted for review prior to acceptance of the completed work by the County.

F. TEST PROCEDURE SUBMITTAL

1. The control system integrator shall submit the proposed procedures to be followed during tests of the control system and its components.
2. Preliminary Submittal: Outlines of the specific proposed tests and examples of proposed forms and checklists.
3. Detailed Submittal: After approval of the Preliminary Submittal, the control system integrator shall submit the proposed detailed test procedures, forms, and checklists. This submittal shall include a statement of test objectives with the test procedures.

G. TRAINING SUBMITTALS:

1. Subsequent to the receipt of the County's and engineer's inputs made at the pre-submittal conference. The control system integrator shall submit a training plan that includes:
2. A re-submittal of the training plan overview from the pre-submittal conference with incorporation of all modifications agreed upon at that meeting.
3. Schedule of training courses including dates, duration, and location of each class.
4. Resumes of the instructors who will actually implement the plan.

3.03 ON-SITE SUPERVISION

A. The control system integrator shall furnish the services of an on-site resident engineer to supervise and coordinate all work including but not limited to installation, adjustment, testing and start up of the control system. The resident engineer must be present the entire time required to complete the operating system through performance testing and optimization. A team of engineering personnel, including personnel certified by the PLC manufacturer as approved installers of their product, shall be onsite to check all equipment, perform the tests indicated in this section and furnish and document startup services.

3.04 INSTALLATION

A. The work included in this section consists of furnishing, partial installation and placing in operation the instruments and appurtenances, necessary to provide the Owner with a fully operable system properly calibrated and installed.

B. All conduit shall be provided under division 26 without delay to the work of division 40.

C. The 4-20mA signal circuits, process equipment control wiring, signal wiring to field instruments, DCS input and output wiring and other field wiring and cables are either existing or to be provided under Division 26 as noted on the contract documents.

D. All DCS equipment cables, fiber optic cables, network cables and communication cables shall be provided under Division 40.

E. Locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the County exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the Systems integrator shall make such changes without additional cost to the County.

F. Special instructions for proper field handling, storage, and installation required by the Manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

D. Storage: Equipment shall not be stored outdoors. Equipment shall be stored in dry air-conditioned storage, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the control system integrator at no additional cost to the County. If any electronic equipment has been subject to possible water damage it shall be replaced as directed by the engineer.

G. Field-mounted components and assemblies shall be installed and connected according to the requirements below:

1. Installation personnel have been instructed on installation requirements of the Contract Documents.
2. Technical assistance is available to installation personnel at least by telephone.
3. Installation personnel have at least one copy of the approved shop drawings and data.
4. Bends shall be formed to uniform radii with the proper tool without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square-cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels requiring pipe or tubing entries.
5. Flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.
6. Power and signal wires shall be terminated with crimped type lugs.
7. Connectors shall be, as a minimum, watertight.
8. Wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature.
9. Wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the engineer. All wiring shall be protected from sharp edges and corners. Wires within cabinets shall be neatly bundled and routed in covered wireways.
10. Care is taken to avoid crossing power and signal wires at the field termination point.
11. Mounting stands and bracket materials and workmanship shall comply with requirements of the Contract Documents.
12. Verify the correctness of each installation, including polarity of electric power and signal connections and making sure all process connections are free of leaks. The
13. The County will not be responsible for any additional cost of rework attributable to actions of the control system integrator.

H. Systems integrator shall implement the use of function blocks within the control logic programming. The function blocks shall prevent negative analog device readings, flag function blocks, provide out of range indication and shut down the process associated with the device.

I. All workmanship utilized in the manufacture and installation of this system shall be of the highest quality and performed in a manner which is consistent with all accepted practices for industrial controls.

J. A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the engineer. The systems integrator shall sign the tag when calibration is complete. The engineer will sign the tag when the calibration and testing has been accepted.

3.05 WARRANTY

A. All products mentioned herein must be warranted by the supplier for a period of two (2) years from the date of system turnover; final acceptance.

B. An unconditional warranty shall be provided for all equipment supplied for two years from date of final acceptance of system by the owner. THIS WARRANTY SHALL INCLUDE ANY DAMAGES CAUSED BY LIGHTNING INDUCED ELECTRICAL SURGES; ONLY DAMAGES CAUSED BY DIRECT LIGHTNING STRIKES TO THE BUILDING STRUCTURE (AS DETERMINED BY THE ENGINEER) SHALL BE EXCLUDED FROM THE WARRANTY. Theft, fire, vandalism and floods shall be excluded from the warranty except for fire damage which originates at equipment which is provided as part of this work.

C. Contractor shall issue two copies of a written warranty to the owner. The warranty shall be a legal and binding document. Warranty shall include the start and end date of the warranty period. Warranty shall include the OWNER and CONTRACTOR'S name.

D. Warranty calls shall be broken into two categories, emergency and non-emergency. Whether the warranty call is emergency or non-emergency shall be dictated by the OWNER.

E. An emergency warranty call shall be responded to within 8 hours of the call, whether during business hours or not.

F. A non-emergency warranty call shall be responded to within 48 hours of the call, whether during business hours or not.

G. Telephone support for operating procedures and non-hardware problems shall be provided on an unlimited basis during the warranty period.

END OF SECTION

DESCRIPTION	SOURCE	TYPE	STATUS
EFFLUENT PUMP STATION			
Effluent Pump			
Pump 1	EPVFD 1	DI	RUN
Pump 1	EPVFD 1	DI	REMOTE
Pump 1	EPVFD 1	DI	IN LOCAL
Pump 1	EPVFD 1	DI	FAULT
Pump 1	EPVFD 1	DI	OVERTEMP
Pump 1	PLC-3	DO	START/STOP
Pump 1	PLC-3	AO	SPEED CMD
Pump 1	EPVFD 1	AI	SPEED FB
Pump 1	PLC-3	DO	RESET
Pump 2	EPVFD 2	DI	RUN
Pump 2	EPVFD 2	DI	REMOTE
Pump 2	EPVFD 2	DI	IN LOCAL
Pump 2	EPVFD 2	DI	FAULT
Pump 2	EPVFD 2	DI	OVERTEMP
Pump 2	PLC-3	DO	START/STOP
Pump 2	PLC-3	AO	SPEED CMD
Pump 2	EPVFD 2	AI	SPEED FB
Pump 2	PLC-3	DO	RESET
Pump 3	EPVFD 3	DI	RUN
Pump 3	EPVFD 3	DI	REMOTE
Pump 3	EPVFD 3	DI	IN LOCAL
Pump 3	EPVFD 3	DI	FAULT
Pump 3	EPVFD 3	DI	OVERTEMP
Pump 3	PLC-3	DO	START/STOP
Pump 3	PLC-3	AO	SPEED CMD
Pump 3	EPVFD 3	AI	SPEED FB
Pump 3	PLC-3	DO	RESET
Pump 4	EPVFD 4	DI	RUN
Pump 4	EPVFD 4	DI	REMOTE
Pump 4	EPVFD 4	DI	IN LOCAL
Pump 4	EPVFD 4	DI	FAULT
Pump 4	EPVFD 4	DI	OVERTEMP
Pump 4	PLC-3	DO	START/STOP
Pump 4	PLC-3	AO	SPEED CMD
Pump 4	EPVFD 4	AI	SPEED FB
Pump 4	PLC-3	DO	RESET
Common Discharge Pressure Transmitter	Existing PIT-5431	AI	Pressure
Ground Storage Tank Level	Existing LIT-5121	AI	Level
Ground Storage Tank Fill Flow Meter	Existing FIT	AI	Flowrate
Ground Storage Tank Fill Flow Meter	Existing FIT	AI	Flowtotal

Reuse Pumps

Pump 1	MCC1	DI	RUN
Pump 1	MCC1	DI	REMOTE
Pump 1	MCC1	DI	FAULT
Pump 2	MCC1	DI	RUN
Pump 2	MCC1	DI	REMOTE
Pump 2	MCC1	DI	FAULT

DIGESTORS

Sludge Transfer Pump

Pump 1	MCC1	DI	RUN
Pump 1	MCC1	DI	REMOTE
Pump 1	MCC1	DI	FAULT
Pump 1	PLC-3	DO	START/STOP
	Exsiting Check Valve	DI	CLOSED
Pump 2	MCC1	DI	RUN
Pump 2	MCC1	DI	REMOTE
Pump 2	MCC1	DI	FAULT
Pump 2	PLC-3	DO	START/STOP
	Exsiting Check Valve	DI	CLOSED

SWITCHGEAR AND GENERATOR

GENERATOR 1 RUNNING	GEN/ATS	DI	RUNNING/NOT RUNNING
GENERATOR 1 COMMON FAULT	GEN/ATS	DI	NORMAL/FAULTED
FUTURE GENERATOR 2 RUNNING	GEN/ATS	DI	RUNNING/NOT RUNNING
FUTURE GENERATOR 2 COMMON FAULT	GEN/ATS	DI	NORMAL/FAULTED
MCM 3320 BUS 1 COMMON FAULT	GEN/ATS	DI	NORMAL/FAULTED
MCM 3320 BUS 2 COMMON FAULT	GEN/ATS	DI	NORMAL/FAULTED
GENERATOR 1 NOT IN AUTO	GEN/ATS	DI	IN AUTO/NOT IN AUTO
FUTURE GENERATOR 2 NOT IN AUTO	GEN/ATS	DI	IN AUTO/NOT IN AUTO
SWITCHGEAR NOT IN AUTO	GEN/ATS	DI	IN AUTO/NOT IN AUTO
ATS BUS 1 IN TEST MODE	PLANT PLC	DO	IN TEST/NOT IN TEST
ATS BUS 1 IN TEST MODE	PLANT PLC	DO	IN TEST/NOT IN TEST
GENERATOR FUEL TANK LEVEL	LIT	AI	% FULL
START GENERATOR & TRANSFER BUS1	PLANT PLC	DO	START AND TRANSFER LOAD
START GENERATOR & TRANSFER BUS2	PLANT PLC	DO	START AND TRANSFER LOAD

BUS-1 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
BUS-1 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
BUS-1 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
BUS-1 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
BUS-1 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
BUS-1 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS

BUS-1 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
BUS-1 POWER FACTOR	BUS-1 CM4000	ENET	PF
52G1 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52G1 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52G1 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52G1 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52G1 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52G1 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52G1 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52G1 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52G1 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52G1 POWER FACTOR	BUS-1 CM4000	ENET	PF
52SM1 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52SM1 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52SM1 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52SM1 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52SM1 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52SM1 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52SM1 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52SM1 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52SM1 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52SM1 POWER FACTOR	BUS-1 CM4000	ENET	PF
52UM1 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52UM1 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52UM1 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52UM1 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52UM1 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52UM1 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52UM1 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52UM1 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52UM1 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52UM1 POWER FACTOR	BUS-1 CM4000	ENET	PF
52FB1 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52FB1 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB1 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52FB1 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52FB1 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52FB1 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52FB1 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52FB1 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52FB1 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52FB1 POWER FACTOR	BUS-1 CM4000	ENET	PF

52FB2 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52FB2 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB2 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52FB2 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52FB2 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52FB2 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52FB2 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52FB2 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52FB2 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52FB2 POWER FACTOR	BUS-1 CM4000	ENET	PF
52FB3 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52FB3 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB3 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52FB3 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52FB3 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52FB3 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52FB3 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52FB3 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52FB3 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52FB3 POWER FACTOR	BUS-1 CM4000	ENET	PF
52FB4 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52FB4 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB4 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52FB4 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52FB4 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52FB4 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52FB4 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52FB4 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52FB4 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52FB4 POWER FACTOR	BUS-1 CM4000	ENET	PF
52FB5 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52FB5 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB5 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52FB5 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52FB5 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52FB5 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52FB5 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52FB5 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52FB5 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52FB5 POWER FACTOR	BUS-1 CM4000	ENET	PF
52FB6 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52FB6 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB6 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS

52FB6 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52FB6 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52FB6 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52FB6 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52FB6 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52FB6 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52FB6 POWER FACTOR	BUS-1 CM4000	ENET	PF
52FB7 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52FB7 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB7 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52FB7 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52FB7 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52FB7 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52FB7 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52FB7 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52FB7 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52FB7 POWER FACTOR	BUS-1 CM4000	ENET	PF
52FB8 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52FB8 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB8 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52FB8 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52FB8 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52FB8 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52FB8 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52FB8 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52FB8 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52FB8 POWER FACTOR	BUS-1 CM4000	ENET	PF
52FB9 BREAKER STATUS	BUS-1 CM4000	ENET	OPEN/CLOSE
52FB9 BREAKER STATUS	BUS-1 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB9 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
52FB9 L-N VOLTAGE PHASE B	BUS-1 CM4000	ENET	VOLTS
52FB9 L-N VOLTAGE PHASE C	BUS-1 CM4000	ENET	VOLTS
52FB9 AMPERAGE PHASE A	BUS-1 CM4000	ENET	AMPS
52FB9 AMPERAGE PHASE B	BUS-1 CM4000	ENET	AMPS
52FB9 AMPERAGE PHASE C	BUS-1 CM4000	ENET	AMPS
52FB9 POWER CONSUMPTION KW	BUS-1 CM4000	ENET	KW
52FB9 POWER FACTOR	BUS-1 CM4000	ENET	PF
BUS-2 L-N VOLTAGE PHASE A	BUS-1 CM4000	ENET	VOLTS
BUS-2 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
BUS-2 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
BUS-2 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
BUS-2 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
BUS-2 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS

BUS-2 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
BUS-2 POWER FACTOR	BUS-2 CM4000	ENET	PF
52G2 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52G2 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52G2 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52G2 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52G2 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52G2 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52G2 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52G2 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52G2 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52G2 POWER FACTOR	BUS-2 CM4000	ENET	PF
52SM2 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52SM2 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52SM2 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52SM2 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52SM2 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52SM2 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52SM2 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52SM2 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52SM2 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52SM2 POWER FACTOR	BUS-2 CM4000	ENET	PF
52UM2 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52UM2 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52UM2 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52UM2 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52UM2 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52UM2 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52UM2 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52UM2 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52UM2 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52UM2 POWER FACTOR	BUS-2 CM4000	ENET	PF
52FB10 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52FB10 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB10 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52FB10 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52FB10 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52FB10 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52FB10 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52FB10 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52FB10 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52FB10 POWER FACTOR	BUS-2 CM4000	ENET	PF

52FB11 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52FB11 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB11 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52FB11 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52FB11 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52FB11 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52FB11 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52FB11 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52FB11 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52FB11 POWER FACTOR	BUS-2 CM4000	ENET	PF
52FB12 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52FB12 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB12 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52FB12 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52FB12 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52FB12 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52FB12 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52FB12 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52FB12 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52FB12 POWER FACTOR	BUS-2 CM4000	ENET	PF
52FB13 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52FB13 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB13 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52FB13 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52FB13 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52FB13 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52FB13 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52FB13 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52FB13 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52FB13 POWER FACTOR	BUS-2 CM4000	ENET	PF
52FB14 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52FB14 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB14 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52FB14 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52FB14 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52FB14 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52FB14 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52FB14 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52FB14 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52FB14 POWER FACTOR	BUS-2 CM4000	ENET	PF
52FB15 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52FB15 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB15 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS

52FB15 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52FB15 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52FB15 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52FB15 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52FB15 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52FB15 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52FB15 POWER FACTOR	BUS-2 CM4000	ENET	PF
52FB16 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52FB16 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB16 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52FB16 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52FB16 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52FB16 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52FB16 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52FB16 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52FB16 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52FB16 POWER FACTOR	BUS-2 CM4000	ENET	PF
52FB17 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52FB17 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB17 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52FB17 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52FB17 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52FB17 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52FB17 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52FB17 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52FB17 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52FB17 POWER FACTOR	BUS-2 CM4000	ENET	PF
52FB18 BREAKER STATUS	BUS-2 CM4000	ENET	OPEN/CLOSE
52FB18 BREAKER STATUS	BUS-2 CM4000	ENET	TRIPPED/NOT TRIPPED
52FB18 L-N VOLTAGE PHASE A	BUS-2 CM4000	ENET	VOLTS
52FB18 L-N VOLTAGE PHASE B	BUS-2 CM4000	ENET	VOLTS
52FB18 L-N VOLTAGE PHASE C	BUS-2 CM4000	ENET	VOLTS
52FB18 AMPERAGE PHASE A	BUS-2 CM4000	ENET	AMPS
52FB18 AMPERAGE PHASE B	BUS-2 CM4000	ENET	AMPS
52FB18 AMPERAGE PHASE C	BUS-2 CM4000	ENET	AMPS
52FB18 POWER CONSUMPTION KW	BUS-2 CM4000	ENET	KW
52FB18 POWER FACTOR	BUS-2 CM4000	ENET	PF

PLC-3

Utility Power Good	PLC-3	DI	STATUS
Power Supply Good*	PLC-3	DI	STATUS
Intrusion	PLC-3	DI	ALARM

* typical for all power supplies in PLC-3

SECTION 40 61 96

PROCESS CONTROL DESCRIPTIONS

PART 1 - GENERAL

1.01 SCOPE

A. Furnish complete with all accessories, additions and extension to an existing a programmable logic control based monitoring and control system with its associated instrumentation as described herein and shown on the contract drawings. The system shall serve as a self-contained monitoring and control system for all aspects of plant operation.

B. This Specification has been developed to establish minimum requirements. This system shall be designed, constructed, tested and documented in strict accordance with the guidelines of this document. All system construction and programming will be the responsibility of the control system integrator. All materials and labor shall be provided for a fully functional system including any items which are required for system operation but are not specifically addressed in this document or on the contract drawings.

C. This specification is intended to be used in conjunction with all drawings supplied and is not intended to be complete without reference diagrams on system configurations, etc. All bidders must conform to all areas of the documentation. It is the intent of this specification that the monitoring and control system contractor have single source responsibility for the complete control package for the project.

D. Interconnecting the new control system with existing field devices is required for total system responsibility. The control system integrator shall obtain from the City the required information on those primary elements, valves, valve actuators, and other control equipment or devices (both new and existing) that are required to be interfaced with, but that are not provided under, this section.

E. It shall be understood that some refinement and/or minor modification of the control strategies shall be necessary over the course of the project at no additional cost. Forums for informal discussions and clarifications have been provided in these documents. They include the Pre-submittal Conferences, Graphics/Reports Development meetings, Factory Testing, Field Development Phase and Startup. Note: All timer, level, position, analysis and flow rate values noted within the control strategies are provided for reference only and are subject to change based on final construction.

F. The overall requirements for the Process Instrumentation and Control System are included in other Division 40 sections.

1.02 RELATED WORK

A. Section 40 61 13, Process Control System General Provisions
B. Section 26 29 13, Control Panels.

PART 2 - PRODUCTS

2.01 PROCESS CONTROL DESCRIPTIONS (PCD)

PROCESS CONTROL DESCRIPTION PCD 01-1

Title: EFFLUENT PUMPS

Drawing: NA

DESCRIPTION: The intent of this project is to keep the existing control for the Effluent pumps the same as it is currently. The control logic will essentially be transferred from PLC-2 to the new Plant PLC-3 since the equipment controlling these pumps will now be in the switchgear building where PLC-3 is located.

In general the Effluent Pump Station control is as described here. The effluent pumps transfer the treated wastewater from the ground storage tank to either the the reclaim distribution system or to the deep Injection Well #1.

The effluent pumps shall operate in lead/lag1/lag2/lag3 fashion to maintain a minimum operating pressure in the common effluent header.

The system includes 4 effluent pumps, controlled by VFD.

A single pressure transmitter, PIT-5431, monitors and alarms the common manifold EFFLUENT header pressure.

LOCAL MANUAL CONTROL MODE: Manual pump control shall be via the VFD interface only (which shall be password protected). With the VFD HOR switch in Hand and the speed reference L/R switch in Local, a pump may be operated manually at the VFD interface by means of the integrated S/S controls; pump speed may be controlled by means of the integrated potentiometer.

LOCAL AUTOMATIC CONTROL MODE: While operating a pump in manual, the pump shall be called to stop if a high discharge pressure, low suction pressure, motor TAH or motor/VFD fail condition is encountered. All shutdown alarm states shall be registered at the HMI and a physical reset will be required at the VFD before the pump will be available to start. A lockout stop switch located at the pump shall inhibit pump start and negate a READY status at the VFD.

REMOTE MANUAL
CONTROL MODE: The HMI effluent pump control station shall provide speed indication, start/stop and speed control, pump status (Run, Ready, Auto/Manual, TAH and Fail), runtime and current draw.

With the VFD HOR switch in Remote, and the HMI A/M switch in Manual, the effluent pump may be manually controlled at the HMI by an authorized operator.

REMOTE AUTOMATIC
CONTROL MODE: With the VFD HOR switch in remote and the HMI A/M switch in Auto, the effluent pump will be controlled with a pressure based PLC PID control.

The PLC shall control the effluent pumps to maintain an operator adjustable effluent line.

PROCESS CONTROL DESCRIPTION PCD 01-2

Title: REUSE PUMPS

Drawing: NA

DESCRIPTION: The intent of this project is to keep the existing control for the Effluent pumps the same as it is currently. The control logic will essentially be transferred from PLC-2 to the new Plant PLC-3 since the equipment controlling these pumps will now be in the switchgear building where PLC-3 is located.

In general the Reuse Pump Station control is as described here. The reuse pumps transfer the treated wastewater from the ground storage tank to the hydro tank and then onto the plant water system. The reuse pumps shall operate in lead/lag fashion to maintain a minimum pressure level in the hydro tank.

The system includes 2 constant speed pumps.

Two existing low pressures switches located within the Hydro Tank, control the pumps. The switches are wired directly to the MCC, the PLC only monitors the pump statuses.

LOCAL MANUAL
CONTROL MODE: Manual pump control shall be via the MCC interface only. With the HOR switch in Hand, a pump may be operated manually.

LOCAL AUTOMATIC
CONTROL MODE: While operating a pump in manual, the pump shall be called to stop if a low level, motor TAH or motor fail condition is encountered. All shutdown alarm states shall be registered at the HMI and a physical reset will be required at the MCC before the pump will be available to start.

REMOTE MANUAL
CONTROL MODE: Remote Manual control of the reuse pumps shall not be permitted.

REMOTE AUTOMATIC
CONTROL MODE: With the MCC HOR switch in remote and the HMI A/M switch in Auto, the reuse pumps will be controlled on/off directly by the tank float switch.

PROCESS CONTROL DESCRIPTION PCD 01-3

Title: DIGESTOR SLUDGE TRANSFER PUMPS

Drawing: NA

DESCRIPTION: The intent of this project is to keep the existing control for the sludge transfer pumps the same as it is currently. The control logic will essentially be transferred from PLC-2 to the new Plant PLC-3 since the equipment controlling these pumps will now be in the switchgear building where PLC-3 is located.

In general, the Sludge Transfer Pump Station control is as described here. The sludge transfer pumps allow for the transfer of sludge between the 3 digestor tanks. A separate set of pumps provides the sludge feed to the belt filter presses.

The system includes 2 constant speed transfer pumps with check valves and a local control panel located adjacent to the pump pad.

LOCAL MANUAL
CONTROL MODE: Manual pump control shall be via the local control panel interface only. With the VFD HOR switch in Hand and the speed reference L/R switch in Local, a pump may be operated manually at the VFD interface by means of the integrated S/S controls; pump speed may be controlled by means of the integrated potentiometer.

LOCAL AUTOMATIC
CONTROL MODE: Local Automatic control of the sludge transfer pumps shall not be permitted.

REMOTE MANUAL
CONTROL MODE: Remote Manual control of the sludge transfer pumps shall not be permitted.

REMOTE AUTOMATIC
CONTROL MODE: Remote Automatic control of the sludge transfer pumps shall not be permitted.

PROCESS CONTROL DESCRIPTION PCD 01-4

Title: MISCELLANEOUS CONTROL NARRATIVES

Drawing: NA

UPS UNITS: Provide monitoring of the UPS status and redundant panel power supplies as shown. Alarm conditions shall be annunciated at the HMI as shown on the P&ID drawings.

PANEL SECURITY: Panel intrusion alarms, where indicated, shall be routed to the PLC and alarmed at the HMI.

LEVEL & FLOW MEASUREMENT: Monitor all existing level and flow points as they are integrated currently.

ANALYZER INSTRUMENT FAILURE: Where applicable (reference the specific instrument requirements), if the transmitted analog signal falls to 3.8mA for greater than 2 seconds indicating sensor failure the PLC shall generate an instrument failure alarm.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The work included in this section consists of furnishing, partial installation and placing in operation the instruments and appurtenances, necessary to provide the Owner with a fully operable system properly calibrated and installed.

B. Systems integrator shall implement the use of function blocks within the control logic programming. The function blocks shall prevent negative analog device readings, flag function blocks, provide out of range indication and shut down the process associated with the device.

C. All workmanship utilized in the manufacture and installation of this system shall be of the highest quality and performed in a manner which is consistent with all accepted practices for industrial controls.

END OF SECTION

SECTION 40 63 43

PROCESS CONTROL SYSTEM HARDWARE

PART 1 – GENERAL

1.01 SCOPE

A. Furnish complete with all accessories, a programmable logic control based monitoring and control system with its associated instrumentation as described herein and shown on the contract drawings. The system shall be capable of integration with the existing Fort Myers Beach Water Reclamation Facility (FMB WRF) SCADA system.

B. This Specification has been developed to establish minimum requirements. This system shall be designed, constructed, tested and documented in strict accordance with the guidelines of this document. All system construction and programming will be the responsibility of the control system integrator. All materials and labor shall be provided for a fully functional system including any items which are required for system operation but are not specifically addressed in this document or on the contract drawings.

C. This specification is intended to be used in conjunction with all drawings supplied and is not intended to be complete without reference diagrams on system configurations, etc. All bidders must conform to all areas of the documentation. It is the intent of this specification that the monitoring and control system contractor have single source responsibility for the complete control package for the project.

D. Interconnecting the new control system with existing field devices is required for total system responsibility. The control system integrator shall obtain from the City the required information on those primary elements, valves, valve actuators, and other control equipment or devices (both new and existing) that are required to be interfaced with, but that are not provided under, this section.

E. It shall be understood that some refinement and/or minor modification of the control strategies shall be necessary over the course of the project at no additional cost. Forums for informal discussions and clarifications have been provided in these documents. They include the Pre-submittal Conferences, Graphics/Reports Development meetings, Factory Testing, Field Development Phase and Startup. Note: All timer, level, position, analysis and flow rate values noted within the control strategies are provided for reference only and are subject to change based on final construction.

F. The overall requirements for the Process Instrumentation and Control System are included in other Division 40 sections.

G. Work included consists of:
   1. Modifications to existing PLC-2 including panel components, PLC controller integration work and plant SCADA system integration.
   2. New PLC-3 panel. Complete.

1.02 REFERENCES

A. The PLC shall be listed or recognized by the following registrations:
   1. cULus Listed, Suitable for operation in Class 1 Division 2, Groups A, B, C, and D Hazardous Locations
   2. CE marked, compliant with:
      a. EN 61326-1; Meas./Control/Lab., Industrial Requirements
      b. EN 61000-6-2; Industrial Immunity
      c. EN 61000-6-4; Industrial Emissions
      d. EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
      e. EN EIC 63000; Restriction of Hazardous Substance
   3. C-Tick marked, compliant with AS/NZS CISPR 11; Industrial Emissions
   4. Ex marked, 94/9/EC ATEX Directive, compliant with:
      a. EN 60079-15; Potentially Explosive Atmospheres, Protection “n”
      b. EN 60079-4; General Requirements
      c. II3 G Ex nA IIC T5X
   5. KC marked, compliant with Article 58-2 of Radio Waves Act, Clause 3

B. The PLC shall meet Institute of Electrical and Electronics Engineers, Inc. (IEEE) applicable standards.

1.03 SUBMITTALS

A. As specified in Section 40 61 13 PROCESS CONTROL SYSTEM GENERAL PROVISIONS.

B. The supplier shall provide product data for the PLC and any component equipment, including:
   1. Central Processing Unit (CPU) information
      a. Memory
      b. Input/Output (I/O) capacity
      c. Nonvolatile program and data retention
   2. I/O Modules information
      a. Type and rating
      b. Standard wiring diagram
   3. Bill of materials for supplied equipment
   4. Spare parts list

1.04 QUALITY ASSURANCE

A. The supplier shall provide PLC system components by a single manufacturer:
   1. Only communication modules for communication or network media functions that are not provided by the PLC manufacturer may be produced by third-party sources.

2. Only PLC manufacturer-approved hardware, including cables, mounting hardware, connectors, enclosures, racks, communication cables, splitters, terminators, taps and removable media, may be used.

B. All PLC system components shall be new, free from defects and produced by manufacturers regularly engaged in the manufacture of these products.

1.05 DELIVERY, STORAGE AND HANDLING

A. The supplier shall deliver PLC components in packaging designed to prevent damage from static electricity and physical damage.

B. The supplier shall store the equipment according to manufacturer requirements and in a clean and dry space at an ambient temperature range of -40 °C to 85 °C (-40 °F to 185 °F).

C. The supplier shall protect the units from exposure to dirt, water, fumes, corrosive substances and physical damage.

1.06 WARRANTY

A. As specified in Section 40 61 13 PROCESS CONTROL SYSTEM GENERAL PROVISIONS.

1.07 SPARE PARTS

A. Provisions shall meet the following installed-spare requirements:
1. I/O points – 25 percent spare I/O capacity for each type of I/O signal at every PLC and remote I/O location. All spare I/O shall be wired to field terminal blocks.
2. PLC backplane – the greater of:
    a. 25 percent spare capacity, or
    b. 3 spare backplane slots for the addition of future circuit cards or modules.
    c. A minimum of 10 percent active prewired spares for each I/O type furnished,
3. 1 spare for each type of I/O module supplied.
4. 2 spare 24VDC power supplies
5. 3 spare surge suppressors of each type
6. 10 spare panel fuses for each type
7. 20 percent of spare terminal block relays, ice cube relays, interposing relays, corrosion inhibitor.

PART 2 – PRODUCTS

2.01 PLC ENCLOSURES

A. Each PLC and its corresponding I/O modules, power supplies, communication interface devices, UPS, terminal blocks and all other peripheral equipment shall be mounted inside suitable enclosures.

B. PLC enclosures shall be provided in accordance with Section 26 29 13 - Control Panels

2.02 PROGRAMMABLE LOGIC CONTROLLER - PLC-3

A. The control system integrator shall furnish EthernetIP based PLC as specified herein and as shown on the Drawings. PLC shall be provided complete with rack, power supply, I/O cards, special function cards, instructions, memory, input/output capacity, and appurtenances to provide all features and functions as described herein.

B. The PLC shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0º - 60º Celsius and a relative humidity of 5-95 percent, non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz and be provided with a battery backup system. Integral overcurrent and under-voltage protection shall be provided on the power supply.

C. System configuration shall be as shown on the drawings. PLC's shall be compatible with existing plant EthernetIP architecture and be compatible with existing PLC-1 & 2 Allen Bradley Logix 1756-L1 processor with Ethernet Network module as manufactured by Allen Bradley.

D. The processor and its associated memory shall be enclosed in a modular enclosure. LED-type indicating lights shall be provided to indicate processor, memory, and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm output.

E. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level.

F. Create a master memory map that shall document every tag that is passed from one PLC to another. Tags that pass directly from the SCADA to a PLC do not need to be placed on this memory map. Memory map shall document which devices or PLC’s originate messages, and which devices or PLC’s receive messages, and what tags/address are passed back and forth.

2.03 POWER SUPPLY

A. The PLC shall operate in compliance with electrical service of:
   1. 85 to 265 VAC (120 to 220 VAC nominal), single phase, 47 to 63 Hz
   2. 18 to 32 VDC (24 VDC nominal)
   3. 30 to 60 VDC (48 VDC nominal)
   4. 90 to 143 VDC (125 VDC nominal)

B. A single, main power supply shall be integral to each chassis and have the capability of supplying 1.2V, 3.3V, 5V and 24V power directly to the chassis backplane.

C. The power supply shall monitor the incoming line voltage for proper levels and include an easily viewed indicator to show status of the DC power applied to the backplane.

D. A power disconnect switch to disable power to the PLC shall be easily accessed by the operator.

E. The power supply shall provide electronic protection:
   1. At the time of power-up, the power supply shall inhibit operation of the controller and I/O modules until the DC voltages are within specifications.
   2. The power supply shall automatically shut down the PLC system when its output power exceeds 125% of its rated power.
   3. The power supply shall be fused.

F. The PLC shall be capable of operating with redundant power supplies.

2.04 INPUT/OUTPUT SUBSYSTEMS

A. Input/output hardware shall be Allen Bradley 1756 series and Rockwell/Spectrum 1756 HART series point I/O or (as appropriate for the CPU) plug-in modules in associated I/O rack assemblies.

B. Discrete inputs shall be a 120VDC signal from dry field contacts. Discrete outputs shall be relay type output modules. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices. Interposing relays shall be provided where required to interface with field equipment. Maximum density for discrete I/O modules shall be 16 per input module and 16 per output module.

C. Analog input circuits shall be isolated, 12-bit resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. Analog input modules shall be capable of receiving 4-20 mA HART signals. Analog outputs shall be coordinated with the receivers but shall be isolated 24 VDC 4-20 mA outputs powered from the PLC. Each input/output circuit shall have optical isolation to protect the equipment against high voltage transients. Optical isolation shall be rated at not less than 1500 V RMS. Maximum density for analog I/O modules shall be 8 per module.

D. The modules shall be connected to wiring arms which can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals.

E. External power supplies shall be provided with the PLC as required to meet 50% of the specified installed I/O power requirements plus spares under full load conditions. Power supplies shall be modular units, shall be fully redundant and shall alarm the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein for

the PLC. Power supplies shall be furnished with isolated lightning/surge protection systems.

2.05 FIBER OPTIC BASED COMMUNICATION SYSTEM

A. The Contractor shall furnish, test, install and place in operation an extension of the existing mixed media EthernetIP Protocol network. The network topology will vary by location but basically consists of a combination of unshielded twisted pair (UTP) Cat-6 copper cable within control panels and multi-mode mode fiber optic cable from control panel to control panel or control panel to plant. Each connected device shall be equipped with its own network interface unit, control net repeater module and fiber module. PLC-1 communicates with the existing plant SCADA system via existing multi-mode fiber optic cable using TCP/IP protocols. PLC-2 communicates with the existing plant SCADA system via existing copper cable using TCP/IP protocols. PLC-3 will communicate with the existing SCADA network through the existing Network Rack I/O junctional panel #2 via a new multi-mode fiber optic cable system.

B. Provide for an Ethernet/IP communications with the plant SCADA system through a CAT6 UTP copper connection to the fiber optic backbone as shown on the drawings. Coordinate with the fiber optic contractor for connection to the fiber backbone switch and facilities for the IP addresses required. Provide a combination media converter/ unmanaged 100 base-T Ethernet switch in the Fiber optic conversion cabinet.

C. Multi-Mode Fiber Optic Cable
Provide 62.5/125-micron OM1 Graded-Index Multimode Optical Fiber for use in the backbone and horizontal distribution system.

D. Fiber Characteristics:
1. Reduced Water Peak
2. Maximum Attenuation: 85011300nm: 3.5/1.5dB/km
3. Color coded buffer tube
4. Color coded fiber
5. Loose Tube
6. Maximum Transmission: 1 Gbps Ethernet; 300m at 850nm and 600m at 1300nm
7. Minimum Bend Radius 4.1" long-term, 8.2" during installation.

E. Cable Characteristics:
1. Fiber Count-12 fibers per cable or as otherwise noted on the drawings.
2. Loose Tube Cable with PFM Gel filled buffer tubes
3. Up to 12 fibers per buffer tube
4. UV resistant Outer Jacket
5. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements.
6. Buffer tubes shall be stranded around a dielectric central member using a reverse oscillating lay.
7. Top and bottom ends of cable shall be available for testing.
8. Both ends of cable shall be sealed during shipping to prevent ingress of moisture.

9. The jacket shall be free of holes, splits and blisters. It shall also contain no metal elements and shall be of consistent thickness.
10. Maximum Tensile Loading: 2700N(600lbf) during installation and 890N(200lbf) long term.

F. Manufacturers:
1. Superior Essex Series 11
2. Corning
3. Berk-Tek

PART 3 – EXECUTION

3.01 INSTALLATION

A. The work included in this section consists of furnishing, partial installation and placing in operation the instruments and appurtenances, necessary to provide the Owner with a fully operable system properly calibrated and installed.

B. Systems integrator shall implement the use of function blocks within the control logic programming. The function blocks shall prevent negative analog device readings, flag function blocks, provide out of range indication and shut down the process associated with the device.

C. All workmanship utilized in the manufacture and installation of this system shall be of the highest quality and performed in a manner which is consistent with all accepted practices for industrial controls.

D. Installation shall be in compliance with all manufacturer requirements, instructions and contract drawings, including:
1. Space surrounding the PLC to maintain adequate cooling.
2. Conditioning of space surrounding the PLC enclosure to maintain the manufacturer's ambient temperature and humidity ranges.
3. Accessibility of PLC diagnostic lights, communication ports and memory modules these components shall be free from obstructions at all times.

E. Control Panels
1. As specified in Section 26 29 13 – Process Control Panels.
2. The supplier shall provide all required cables and connectors to interface with other control system equipment.
3. The supplier shall ensure that communication media, analog signals and discrete I/O wiring are properly protected in accordance with manufacturer recommendations.

END OF SECTION

SECTION 40 68 13

PROCESS CONTROL SYSTEM SOFTWARE

PART 1 – GENERAL

1.01 SCOPE

A. Furnish complete with all accessories modifications and extensions to the existing Plant Citect HMI software. Provide Standard and customized software fully installed and configured in the control system as described herein, in specification Section 40 63 43-Process Control System Hardware and shown on the contract drawings. Customized or specially written software shall be furnished if required to meet all of the functional requirements specified herein. Any custom applications software required shall be fully integrated into the basic software and shall not require unique command structures.

B. This Specification has been developed to establish minimum requirements. This system shall be designed, constructed, tested and documented in strict accordance with the guidelines of this document. All system construction and programming will be the responsibility of the control system integrator. All materials and labor shall be provided for a fully functional system including any items which are required for system operation but are not specifically addressed in this document or on the contract drawings.

C. This specification is intended to be used in conjunction with all drawings supplied and is not intended to be complete without reference diagrams on system configurations, etc. All bidders must conform to all areas of the documentation. It is the intent of this specification that the monitoring and control system contractor have single source responsibility for the complete control package for the project.

D. Interconnecting the new control system with existing field devices is required for total system responsibility. The control system integrator shall obtain from the City the required information on those primary elements, valves, valve actuators, and other control equipment or devices (both new and existing) that are required to be interfaced with, but that are not provided under, this section.

E. It shall be understood that some refinement and/or minor modification of the control strategies shall be necessary over the course of the project at no additional cost. Forums for informal discussions and clarifications have been provided in these documents. They include the Pre-submittal Conferences, Graphics/Reports Development meetings, Factory Testing, Field Development Phase and Startup. Note: All timer, level, position, analysis and flow rate values noted within the control strategies are provided for reference only and are subject to change based on final construction.

F. The overall requirements for the Process Instrumentation and Control System are included in other Division 40 sections.

G. Contractor shall provide all software and programming for HMI, PLC and Control System Network furnished under this section.
   1. Reference the Sample Screen Shots Appendix-A which illustrate the quality and general graphic screen development expectations.

1.02 SUBMITTALS

A. As specified in Section 40 61 13 PROCESS CONTROL SYSTEM GENERAL PROVISIONS.

1.03 WARRANTY

A. As specified in Section 40 61 13 PROCESS CONTROL SYSTEM GENERAL PROVISIONS.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The existing Fort Myers Beach WRF HMI software is Citect Version 7.50 SP 1 Patch 36 which includes:
   1. Alarms & Events
   2. Historian
   3. Reporting
   4. The existing license is for “5000 points with 900 in use,” no additional license is required.

B. PLC programming software shall be Studio 5000 Logix Designer, new license not required.

2.02 PLC PROGRAMMING SOFTWARE

A. TAG DATABASE

   1. The database has been established. Follow format for inclusion of all proposed I/O.

B. EVENTS

   1. The HMI shall have the ability to:
      a. Trigger actions based on an event that has an expression applied to it. An expression is an equation that contains tag values, mathematical operations, if-then-else logic, or other functions. An action shall have the ability to produce a variety of functions including, but not limited to, initiating a snapshot of tag values, displaying an error screen, and changing a tag value.
      b. Specify the evaluation period of events.
      c. Edit events during development or run time.
      d. Start and stop event processing while a project is running.
      e. Run 20 event files simultaneously.

C. GRAPHIC DISPLAYS

   1. The graphic display format has been established. Follow existing format referenced in Appendix A.

D. TRENDS

1. Integrate proposed manifold into existing trends. The HMI shall have real-time and historical trending capabilities. It shall also have the ability to display both real-time and historical data at the same time on the same trend.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The work included in this section consists of furnishing, installation, programming and placing in operation the instruments and appurtenances, necessary to provide the Owner with a fully operable system properly calibrated and installed.

B. All workmanship utilized in the manufacture and installation of this system shall be of the highest quality and performed in a manner which is consistent with all accepted practices for industrial controls.

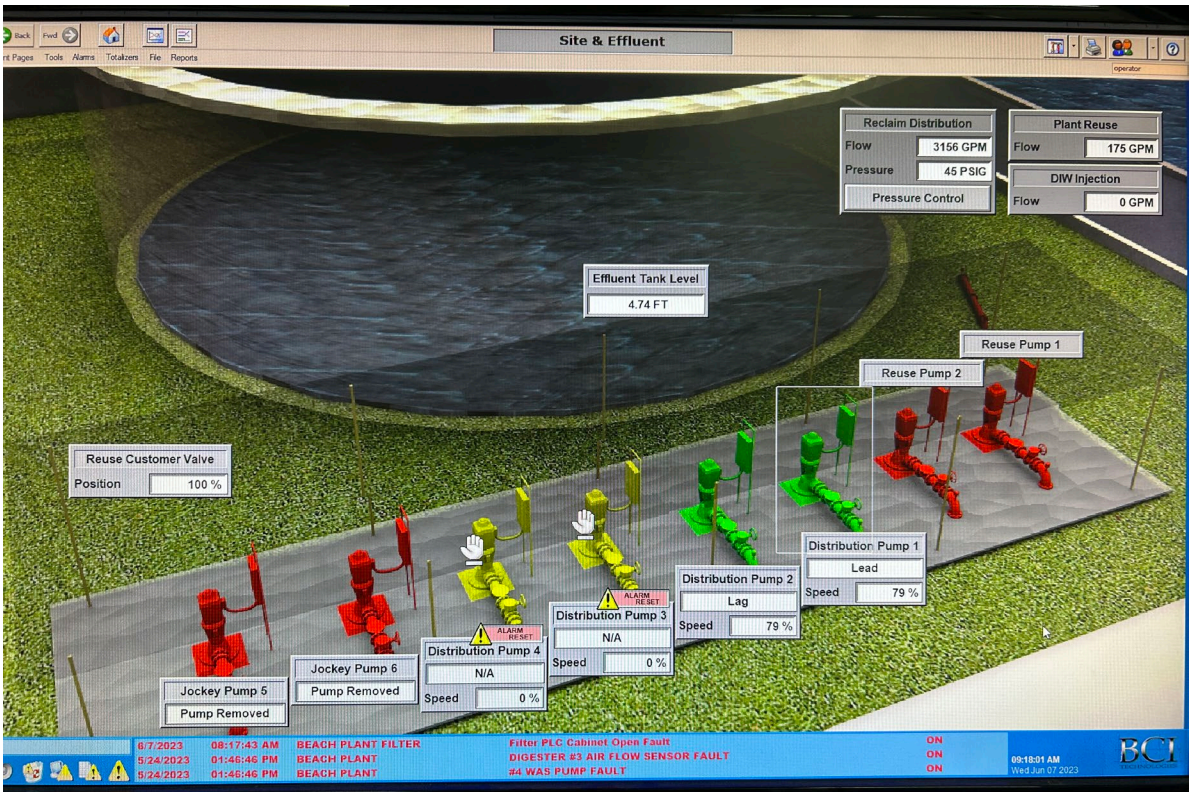
C. Control Panels
1. As specified in Section 26 29 13 – Process Control Panels.
2. The supplier shall provide all required cables and connectors to interface with other control system equipment.
3. The supplier shall ensure that communication media, analog signals and discrete I/O wiring are properly protected in accordance with manufacturer recommendations.

END OF SECTION

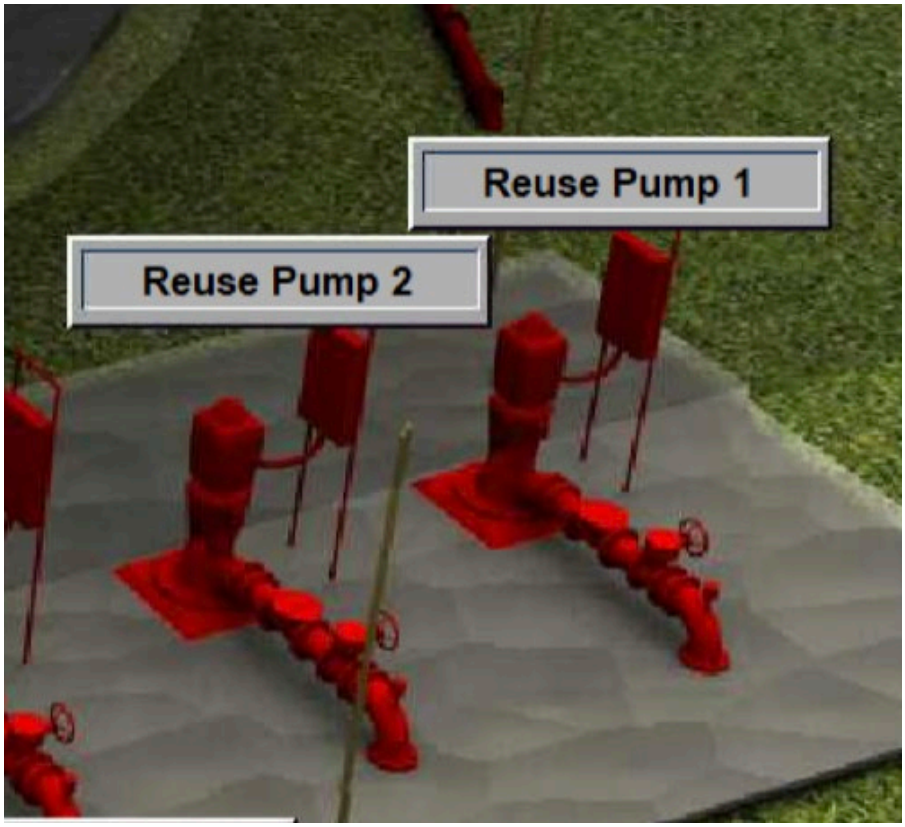
SECTION 40 68 13- APPENDIX A

SAMPLE SCREEN SHOTS

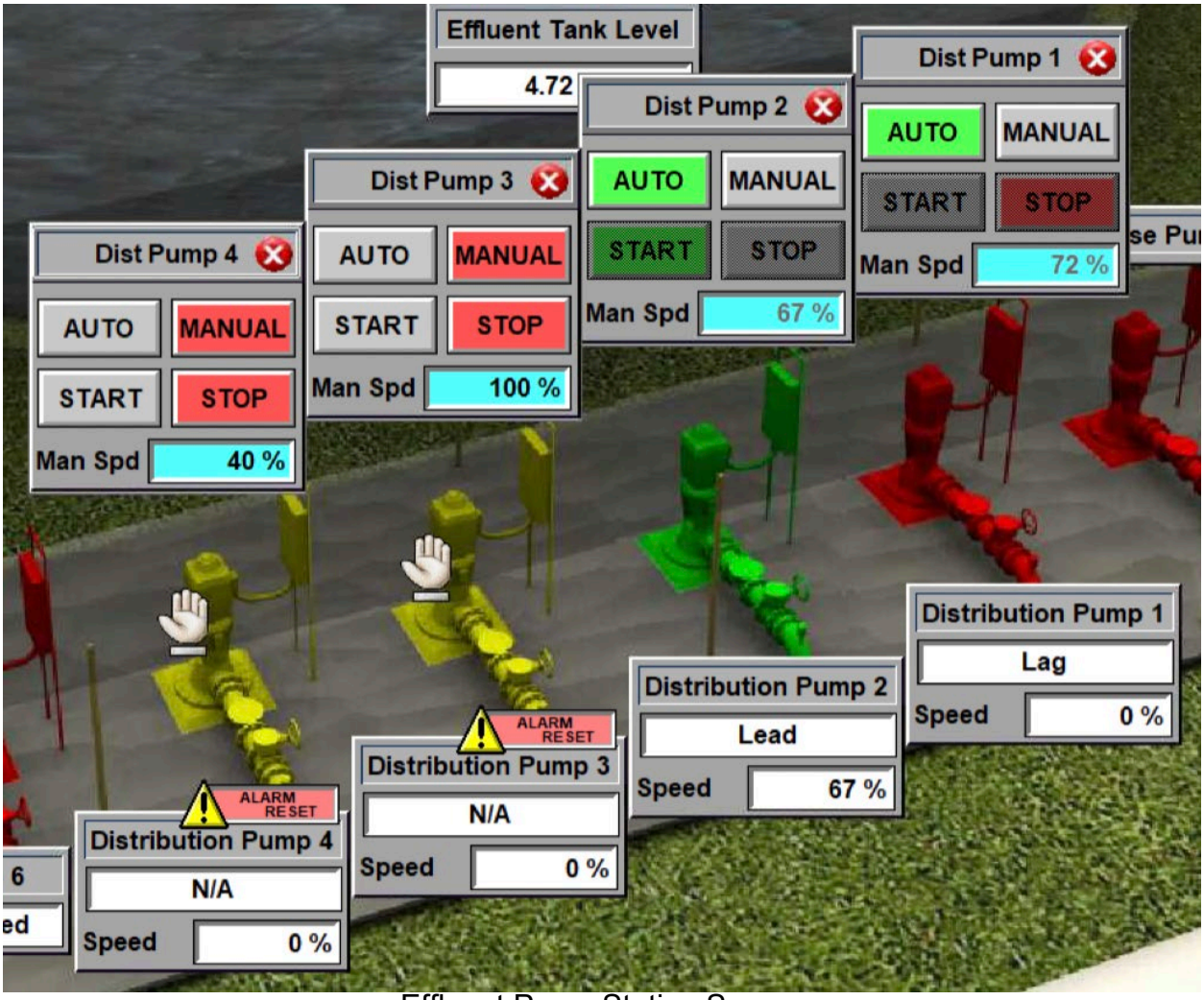
Plant Overview Screen



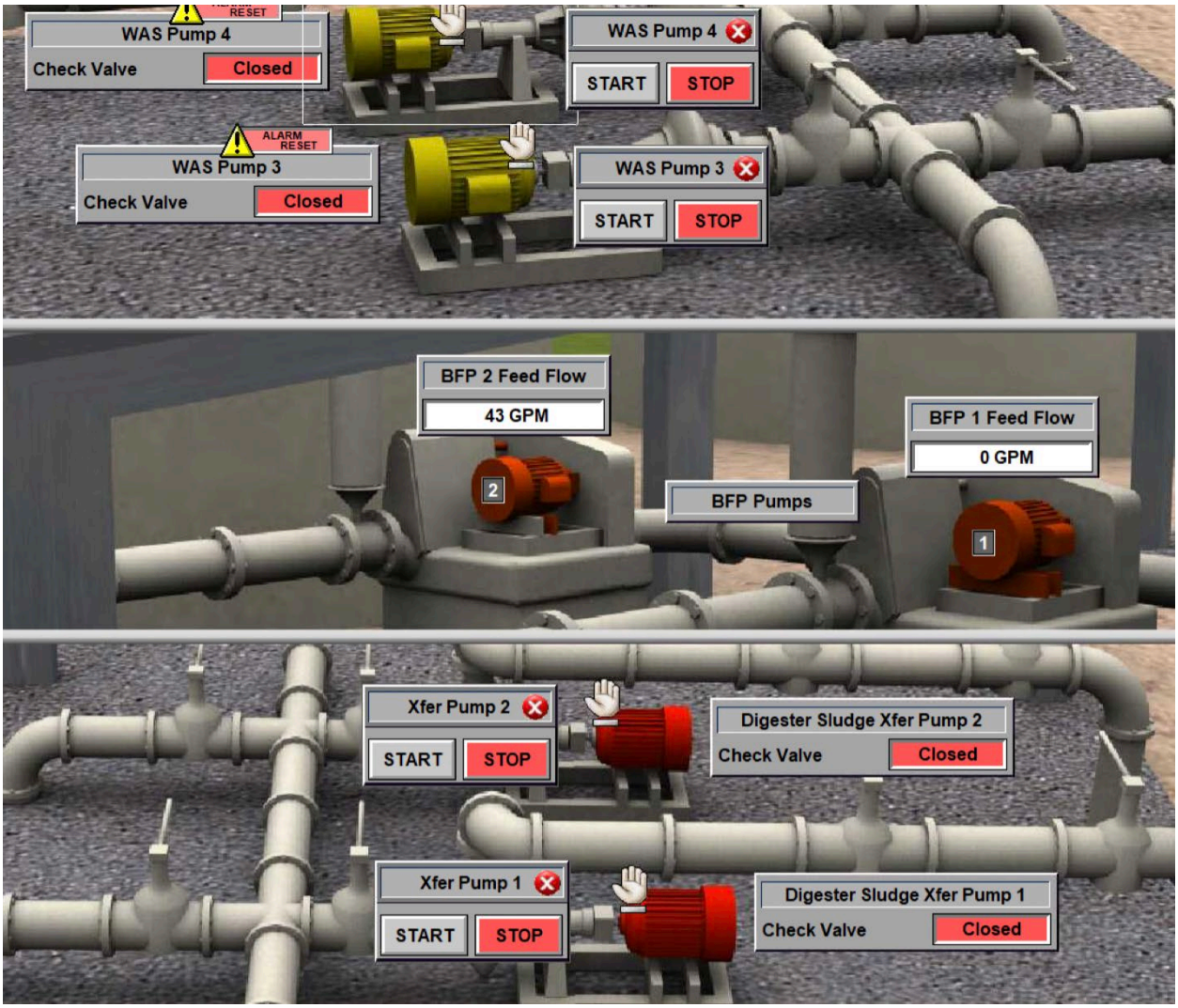
Reuse & Transfer Pump Station Overview Screen



Reuse Pump Station Screen



Effluent Pump Station Screen



Digestor Transfer Pump Station Screen

END OF SECTION

SECTION 40 80 00

COMMISSIONING OF PROCESS SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. This Specification has been developed to establish the minimum testing through commissioning requirements. This system shall be tested and documented in strict accordance with the guidelines of this document. All materials and labor shall be provided for a fully functional system including any items which are required for system operation but are not specifically addressed in this document or on the contract drawings.

B. This specification is intended to be used in conjunction with all drawings supplied and is not intended to be complete without reference diagrams on system configurations, etc. All bidders must conform to all areas of the documentation. It is the intent of this specification that the monitoring and control system contractor have single source responsibility for the complete control package for the project.

C. Interconnecting the new control system with existing field devices is required for total system responsibility. The control system integrator shall obtain from the County the required information on those primary elements, valves, valve actuators, and other control equipment or devices (both new and existing) that are required to be interfaced with, but that are not provided under, this section.

D. The overall requirements for the Process Instrumentation and Control System are included in other Division 40 sections.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 INSTALLATION

A. The work included in this section consists of furnishing, partial installation and placing in operation the instruments and appurtenances, necessary to provide the Owner with a fully operable system properly calibrated and installed.

B. Include the services of a factory trained, qualified service engineer of the equipment manufacturer to inspect the complete equipment installation to assure that it is installed in accordance with the manufacturer's recommendations, make all adjustments necessary to place the system in trouble-free operation and instruct the operating personnel in the proper care and operation of the equipment furnished.

C. All workmanship utilized in the manufacture and installation of this system shall be of the highest quality and performed in a manner that is consistent with all accepted practices for industrial controls.

D. Provide continuous protection of the installed instrumentation equipment from the elements, moisture, construction damage, dust, debris, paint spatter or other conditions which will adversely affect the unit operation until such time as the equipment is scheduled for start-up testing.

3.02 GENERAL TESTING REQUIREMENTS

A. All system start-up and test activities shall follow detailed test procedures, check lists, etc., submitted and previously approved by the Engineer.

B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.

C. The Contractor shall maintain master log books for each phase of installation, startup and testing activities specified herein. Log book shall include signal, loop or control strategy tag number, equipment identification, description and space for sign-off dates, Contractor signature and Engineer signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified here.

D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a copy of all test results shall be furnished to the Engineer together with a statement that allspecified test requirements have been met and that the system is operating in accordance with the Contract Documents.

E. System test procedures shall be developed by the contractor in accordance with the various system test requirements specified herein. Proposed test procedures, shall be submitted to the engineer for review. An approved submittal shall be required prior to the commencement of any system test.

1. Procedures shall be prepared for each process system. The procedures shall be in narrative form and shall describe sequentially the operational steps to be followed in verifying the correct operation of each process system, including all features described in the control strategies contained in Specification Section 40 61 96. All equipment, including the PLC system and its various workstation displays, which function together to form a complete process system shall be tested together, including interlocks between devices performed by the PLCS.

F. Factory Test Procedure: The contractor shall prepare and submit a factory test procedure which incorporates test sequences, test forms, samples of database lists, a PLCs testing block diagram, and an estimated test duration which comply with the requirements of the factory test specified herein.

3.03 FACTORY TESTING

A. The contractor shall arrange for the Manufacturers of the equipment and fabricators of panels and cabinets supplied under this Section to allow the

engineer and County to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the control cabinets, control system network communication systems, special control systems, and other pertinent systems and devices. A minimum of fifteen working days notification shall be provided to the County and engineer prior to testing. No shipments to the Work site shall be made prior to the Factory Test without the engineer's written approval.

B. Prior to the delivery and installation of the PLC at the job site, but after the procurement, assembly, and configuration of all components, the contractor shall conduct a factory test. This test shall be witnessed by representatives of the County and the engineer. The factory test shall demonstrate the functionality and performance of specified features of the PLC. A complete system checklist shall be available during the test for recording results of selected points.

C. Contractor shall schedule the factory test after receiving approval of the factory test procedures submittal. The contractor shall provide the engineer with written notice of the start and expected duration of the factory test at least 30 days prior to the start of the test.

D. The factory test shall be conducted in accordance with the previously submitted and approved test procedures. The test procedures shall include written descriptions of how individual tests shall be performed and shall incorporate testing the following features as a minimum. All testing shall be completed in one continuous factory test which may extend over several continuous days as necessary.

E. Verify all network components are able to communicate over the control system network using the contract required protocols and mediums. Proper functionality of the Domain Server shall also be confirmed.

F. External power to each enclosure and workstation shall be cycled in order to test the operation of the UPS units. Backup power time period shall be verified to be in conformance with the project requirements.

G. All I/O terminal point wiring shall be verified for all PLC’s. The contractor shall provide a means of easily introducing a discrete or variable analog signal to all I/O points. Signals shall be verified at the associated PLC register and the HMI.

H. The ability to enter new setpoints, vary control modes, and adjust control parameters shall be demonstrated. The lack of ability to change these items without the correct security level shall also be demonstrated. Confirmation of changes shall be obtained by checking appropriate PLC registers. Typical PID, VFD, actuator and motor-starter control interfaces shall also be tested. Custom interfaces for specific processes shall also be reviewed.

I. Overall quality and accuracy of the control screens shall be reviewed (based on the Graphics’ Meeting minutes). Verification of all points on each display screen, and the ability to call up displays via point and click targets or function keys. The ability to print out a display screen shall also be tested.

J. Verification of alarm logging, summary display, outputs to horn, lights, and the ability to disable alarms. Silencing and acknowledging of alarms shall also be tested.

K. All components shall be individually inspected to confirm adherence with contract specification documents.

L. The contractor shall record the results of all factory testing on pre-approved test forms which the County's and engineer's representatives shall sign. A copy of the completed test forms and a report certifying the resultsshall be provided to the engineer prior to delivery to the site.

M. If the PLCs do not operate as required, the contractor shall make whatever corrections are necessary, and the failed portion of the test shall be repeated. If, in the opinion of the engineer's representative, the changes made by the contractor to affect such a correction are sufficient in kind or scope to effect parts of system operation already tested, then the effected parts shall be retested also. If a reliable determination of the effect of changes made by the contractor cannot be made, then the engineer's representative may require that all operations be re-tested. The contractor shall bear all of its own costs for the factory test, including any required re-testing.

3.04 START-UP SUPERVISION

A. The system supplier shall provide a qualified service technician to inspect all final connections and check the system prior to start-up of the system. The service technician shall coordinate with the owner's representative for functional check out of the complete system.

B. A system software engineer shall be provided on site during start up of the plant to make adjustments to the Control Computer/ Operator Interface and tune the system as deemed necessary by the engineer.

C. System verification marking end of supplier’s on-site start-up obligations will be issued after system functionality can be demonstrated for a period of 168 continuous hours without interruptions due to error on the part of the supplier.

D. At least two qualified control systems technician shall be provided by the Contractor when loop checkout is being performed and at least one for all other control system startup and test activities.

E. The control system integrator's startup personnel shall be present and coordinate with all other startup and testing activities especially the pump, standby power system and variable frequency drive startups.

3.05 LOOP CHECKS

A. Prior to control system startup and testing, each monitoring and control loop shall be tested by the Contractor on an individual basis from the primary element to the final element, including the PLC I/O module and PLC data table, for continuity and for proper operation and calibration.

B. Individual instrument loop diagrams per ISA Standard S5.4 – Instrument Loop Diagrams, expanded format, shall be submitted for review prior to the loop tests. After the ENGINEER'S review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the County and/or the Engineer.

C. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.

D. The accuracy of all analog inputs shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the PLC or workstation.

E. Final control elements and ancillary equipment shall be tested to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and local automatic (where provided) control circuits.

F. All control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and position settings shall be checked with the valves in place to insure that no changes have occurred since the bench calibration.

G. Interlocks: All hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable speed controllers and packaged equipment controls shall be checked to the maximum extent possible.

H. The Contractor shall prepare loop confirmation sheets for each loop covering each active instrument and control device except simple hand switches and lights. Loop confirmation sheets shall form the basis for operational tests and documentation. Each loop confirmation sheet shall cite the following information:
   1. Project name
   2. Loop number
   3. Tag number, description, manufacturer and model number for each element
   4. Installation bulletin number
   5. Specification sheet number
   6. Loop description number
   7. Adjustment check
   8. Verification of proper surge arrestor installation and grounding as applicable
   9. Space for comments
   10. Space for loop sign-off by Contractor and date

11. Space for Engineer witness signature and date

Each loop tested shall be witnessed, dated and signed off by both the Contractor and the Engineer/County upon satisfactory completion.

3.06 INITIAL START-UP TESTING

A. Perform satisfactory Contractor's initial start-up and functional test PRIOR to demonstration for Owner and Engineer.

B. After the field testing has been successfully demonstrated, a date for system start up involving the Owner's operating personnel will be scheduled as agreed to by the Owner. Notify Engineer fourteen (14) days prior to initial start-up of each item of equipment.

C. Have Contract Documents, shop drawings, product data, and operation and maintenance data at hand during entire start-up process.

D. Provide control diagrams that show actual control components and wiring.

E. Coordinate sequence for initial start-up of various items of equipment

F. Verify control systems are fully operational in automatic and alternate modes of operation.

G. Start up and test the instrumentation equipment with the entire system operational. Conduct start-up and initial functional testing.

3.07 STARTUP AND FUNCTIONAL TESTING

A. Upon successful completion of loop tests and initial start-up testing, the plant control system start up and functional testing shall commence. Perform startup under no-load conditions, if possible. Observe noise, vibration and operation. If all operating characteristics are normal, proceed with startup. Operate equipment and systems under all load conditions and confirm all operating characteristics are normal. If normal operation is observed, proceed with witnessed functional test and performance test as required.

B. All system start-up and test activities shall follow detailed test procedures, test report, check lists, etc., submitted and previously approved by the Engineer.

C. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:
   1. Primary elements such as transmitters and switch devices shall be calibrated and tested as specified.
   2. Each final control element shall be individually tested by Contractor.
   3. Each instrument and control loop shall be tested by Contractor.
   4. Each control strategy shall be tested under automatic control as specified by Contractor.
   5. The entire control system shall be tested for overall monitoring, control, communications, and information management functions,

and demonstrated for system availability as specified by Contractor and Engineer.

D. System start-up and test activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.

E. Verify that the input/output functions of each instrument conform to the requirements of the application.

F. Exercise each system as defined by each loop description through operational tests to demonstrate that it performs as intended on a continuing basis and to demonstrate the integrity of the system.

G. Perform functional and performance tests under supervision of responsible manufacturer's representatives, control system integrator, and Contractor personnel. Representatives of Owner and Engineer shall witness functional test. Perform functional and performance tests on each piece of equipment and operational system as specified in the individual product sections.

H. Demonstrate that equipment operates and complies with specified performance requirements. Demonstrate that control panel functions, including failures and alarms operate and comply with specified performance requirements.

I. Functionally test failures and alarm conditions; or if approved by engineer simulate by jumping failure input terminals. Provide signal generators that simulate control conditions if it is not feasible to create actual conditions. Testing activities shall include the simulation of both normal and abnormal operating conditions.

J. Use Operation and Maintenance manuals, loop descriptions, submittals, graphic screens, etc., to demonstrate operation of equipment. Use actual as-built control diagrams in demonstration of functions.

K. Each control strategy shall be tested by the Engineer to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.

L. Electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed setpoint settings shall be compared to measured final control elementposition/speed values at 0, 25, 50, 75 and 100% of span and the results checked against indicated accuracy tolerances.

M. Functional Testing shall be documented on one of two types of test forms as follows:

1. For functions which can be demonstrated on a loop-by-loop basis, the form shall include:
   a. Project name
   b. Loop number
   c. Loop description
   d. Tag number, description, manufacturer, and data sheet number for each component.
   e. Space for sign-off and date by both the Contractor and Engineer.
2. For functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:
   a. Specification page and paragraph of function demonstrated
   b. Description of function
   c. Space for sign-off and date by both the Contractor and Engineer.

N. The Contractor shall submit an instrumentation and control system functional testing completion report which shall state that all Contract requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the functional testing. Acceptance of the instrumentation and control system functional testing must be provided in writing by the Engineer before the performance testing may begin.

3.08 PERFORMANCE TESTING

A. The entire control system shall operate for 30 days (new and existing control system components) without hardware failure that requires a system reboot of the PLCs, halts operation of the plant or inhibits control system communications. If a system failure occurs, the test shall be considered a failure and not acceptable.

B. The Contractor shall furnish support staff as required to operate the system and to satisfy the repair or replacement requirements.

C. If any software or hardware component fails during the performance test, (with the exception of failures originating in Owner furnished or existing equipment) it shall be repaired or replaced and the performance testing shall be restarted for another 30 day period.

D. Downtime resulting from the following shall be considered system failures:
1. If a component or software failure cannot be repaired/replaced within 2 hours.
2. Downtime of any component (exclusive of I/O) whose failure results in the inability of the Operator to monitor and manipulate control loops from the associated workstation using standard workstation interface procedures.
3. Downtime resulting from concurrent failure of any CRT, keyboard, or mouse which is associated with the workstation.
4. Downtime in excess of 2 hours resulting from any I/O component failure.

5. Downtime resulting from concurrent failure of 2 or more I/O components in a single PLC.
6. Downtime of any component/peripheral associated with the communication network if the failed component (1) results in disabling or significant retardation of control system communications (2) results in a disabling of the historical functions and (3) the failed component is not repaired or replaced within 8 hours.

E. The Contractor shall submit a final performance test completion report which shall state that all contract requirements have been met and which shall include (1) a listing of all PLCs equipment maintenance/repair activities conducted during testing and (2) a listing of all components which were unable to operate successfully. Final acceptance, in writing, of the PLCs system shall be provided by the Engineer if the results of all of the performance tests are acceptable.

F. After acceptance of all required performance tests. The Contractor shall be responsible for furnishing the spare parts/tools on site.

3.09 TRAINING

A. The system supplier shall provide a minimum of three (3) days of training instruction to the owner's personnel to include; one day operator training; and two days PCP and Controls system maintenance training including software maintenance training.

B. Training shall not occur until after completion of successful functional testing and performance testing. Provide training while equipment is fully operational.

C. Training shall not occur until after review and approval of system O&M manuals. Use accepted Operation and Maintenance manuals as the basis of instruction.

D. Submit to OWNER not less than 14 days prior to each training session an outline of the training program and the qualifications of the trainer(s).

E. Coordinate services with the OWNER, with a minimum of two weeks' notice.

F. Training shall be held to accommodate OWNER'S schedule.

G. Training services are exclusive of travel time to and from the facility. The times specified shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to insure equipment is in satisfactory and continuous operation.

H. Trainings should be geared to not only impart knowledge of the control functionality of the new control system but also some background understanding of how and why things work.

I. Onsite Operations Staff Training Sessions shall be held over two full days. A full day training session shall cover all necessary material. Between the

two different days all operations staff should be able to attend at least one training session.

J. Training Manual

1. The operations staff training shall be based on the training manual created by the CONTRACTOR.
2. All training manuals shall be provided with color graphics.
3. The training manual shall provide DETAILED working knowledge of the control of the plant and how to use the SCADA interface.
4. Each SCADA control object, whether it be a display field, push button, or set point field shall be specifically called out and its purpose explained.
5. The underlying theory of why something is controlled shall be explicitly explained.
6. All faults and permissives that affect the operation of equipment shall be explicitly called out.
7. All set points shall be recorded under a separate section titled “Set Points.” An explanation of how the set point value was determined shall also be included next to the set point value.
8. EACH section of the training manual shall include a 10 question quiz. Answer key for each quiz shall also be provided, but not as part of the training manual.
9. The training manual will be used as the basis for the INITIAL Operations Staff Training Sessions. At the end of EACH section covered in the training manual the CONTRACTOR shall administer the 10 question quiz. At the end of the quiz the CONTRACTOR shall review the quiz with the operations staff and discuss what the correct answer was for each quiz question. Operations staff shall be allowed to keep their quizzes for further study.
10. The training manual will be used as the basis for the FINAL Operations
11. Staff Training Sessions. At the end of EACH section covered in the training manual the CONTRACTOR shall administer the 10 question quiz. At the end of the quiz the CONTRACTOR shall collect all quizzes, seal them in an envelope and give them to OWNER Process Control Engineer for grading.
12. The course shall cover the following subjects, as a minimum:
    a. SCADA overview in which the basic systems design, configuration, and purpose is covered.
    b. DCS hardware in which the specific hardware elements and specific configurations provided are covered.
    c. How the actual PLC programs operate.
    d. Programmer equipment orientation in which the student becomes familiar with the operation and operational maintenance procedures.
    e. Specific application program instruction covering the overall design and philosophy of the applications as provided under this contract. The intent shall be to make the student fully knowledgeable in all aspect of the system provided, along with methods for making additions, modifications, and deletions to the SCADA.
    f. Complete systems backup and reload procedures.
    g. Diagnostic software details including capabilities, usage, and interpretation of results.

END OF SECTION