

100765 – EOC & DATA CENTER HVAC IMPROVEMENTS

Corrected Final Design Technical Specifications

Prepared by:
South Florida Water Management District
Operations Maintenance & Construction Division
Engineering and Construction Bureau



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ENGINEERING DESIGN STANDARDS FOR WATER RESOURCE FACILITIES

RFB: 6000000584

EOC & DATA CENTER

HVAC IMPROVEMENTS

PALM BEACH COUNTY, FLORIDA

PROJECT ID: 100765

TECHNICAL SPECIFICATIONS

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END OF DIRECTORY

SECTION 01010 SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY: This SECTION summarizes the WORK of the Project as covered in detail in the complete Contract Documents. This is a general summary and is not intended to be complete and all inclusive of the required WORK items.

1.02 BACKGROUND:

- A. The South Florida Water management District (District's) Emergency Operations Center (EOC) is located at 3301 Gun Club Road, West Palm Beach, Florida 33406. The Emergency Operations Center is staffed and operated 24 hours a day, 365 days a year by the Operation Control Center OCC Staff and the District's Security Department. Additionally, during major weather events, it is operated by additional support Staff of approximately 50 people. The District's current air conditioning system does not have sufficient capacity to support the District's Emergency Operations Center (EOC) and Data Center or have a redundant source for air conditioning needs. The EOC Data Center goal is to become a Tier 4 data center. Therefore, all components need to be fault-tolerant including the chiller. This project addresses providing a new chiller and modifications to the existing chilled water piping which will have sufficient capacity to provide chilled water to the three existing Trane air handlers, three Liebert control room air conditioning units (CRAC-1, 2, &3), two UPS room air conditioning units (UPS CRAC A & B) as well as having additional capacity to accommodate future CRAC units as determined by the District. The new chiller will provide the base capacity to the Trane air handling units and the five Liebert "dual cool" air handlers with the air cooled condensing units providing back-up capacity to the five CRAC units. Two of the three existing CRAC units in the computer room. CRAC-1 and CRAC-2 will be replaced. Two of the existing condensing units CAC-1 and CAC-2 which serve CRAC-1 and CRAC-2 will also be replaced in this project. The existing and proposed replacement condensers will provide the required redundant source for the CRAC unit's air conditioning needs. The existing 70 ton Chiller will be left in place as a partial chilled water back-up.
- B. Since the Emergency Operations Center is staffed and operated 24 hours a day, 365 days a year, all air conditioning units must be in operation at all times, including the five CRAC units in the computer room and UPS rooms and the three Trane building air conditioning units. As a result, cooling must be available from the chilled water system or the air cooled condensing units for the associated units. The Trane air handling units can only use chilled water, however the CRAC units have the ability to use either chilled water (if capacity is available) or the air cooled condensers.

1.03 PROJECT DESCRIPTION:

- A. Description of Total Project: The CONTRACTOR shall provide all labor, material and equipment necessary to install a new chilled water system, replace computer room air conditioning units CRAC-1 and CRAC-2 and replace existing air cooled condensing units CAC-1 and CAC-2, as well as modify the existing chiller/condenser enclosure structure in accordance with the CONTRACT plans and specifications. The Work includes but is not limited to the following major elements.
1. General:
- a. The EOC air conditioning systems must remain in full operation through the construction of this project to support the needs of the facility. When systems are taken out of operation, a back-up system shall be put into operation, at the Contractor's expense to avoid interruption of air conditioning service. When the existing CRAC units CRAC-1 and CRAC-2 are replaced, only one unit shall be replaced at a time and two of three CRAC units shall remain operational at all times. Also, CRAC-1 and CRAC-2 shall be replaced on the weekends to minimize temperature variation in the computer room. When existing condensing units are removed, the existing chilled water system must be in full operation. Taps shall be made into chilled water piping without interrupting operation of the existing Trane air handling units. Any change in air-conditioning service shall be conducted in cooperation with the EOC staff

and the Contractor shall provide the EOC staff two weeks notice of any changes, switchover, or disruption of air conditioning service.

- b. The CONTRACTOR is responsible for relocating/modifying existing piping, ductwork, wiring and conduit, light and miscellaneous components required to install the new piping and equipment required in this project.
- c. The CONTRACTOR shall only use SFWMD electrical power from electrical circuits identified to be used by CONTRACTOR and authorized by the SFWMD representative. If no circuits are identified/authorized, CONTRACTOR shall provide all alternative power for the project.

2. Mechanical:

- a. Remove the existing condensing units CAC-1 and CAC-2 and portion of the associated refrigerant piping and accessories as well as the concrete housekeeping pads.
- b. Remove and replace the existing CRAC units CRAC-1 and CRAC-1. Also remove and replace the connecting chilled water, refrigerant, condensate drain and humidifier make-up piping.
- c. Remove a portion of the water conditioning equipment and relocated to a new location in the chiller enclosure.
- d. Install two new air cooled condensing units and connect to the existing refrigerant piping.
- e. Install new chiller (CH-2), pumps (P-3 and P-4) and associated chilled water piping, housekeeping pads, and accessories in the chiller enclosure.
- f. Install new chilled water piping in the EOC and connect to the existing chilled water system.
- g. Recharge refrigerant systems which have been modified including the new condensers, new and existing piping systems and new CRAC units served to provide a complete working system.
- h. Start-up and test all systems and bring into full operation.
- i. Perform all testing and balancing.

3. Electrical:

- a. Remove existing electrical wiring, conduit and accessories associated with removal of mechanical equipment.
- b. Remove and relocate electrical equipment, conduit and wiring associated with construction of structural modifications to the chiller and condenser enclosures.
- c. Install new electrical equipment and power and control wiring and conduit to support installation of mechanical equipment as well as structural modifications to the chiller and condenser enclosures.
- d. Install new "Siemens – Apogee" building management panel to collect and communicate with the new HVAC equipment to perform control and monitoring functions. The new panel will serve as an additional node on the existing system. Provide necessary coordination and support services to the programming by the District of the existing building management system required to incorporate the HVAC system modifications installed in this project.

4. Structural:

- a. Demolish and modify existing structural features in the EOC building, chiller enclosure and condenser enclosure as shown on the structural drawings.

- b. Construct structural modifications to the EOC building, chiller enclosure and condenser enclosure as shown on the structural drawings.

1.04 RELATED CONTRACT ACTIVITIES:

N/A

1.05 WORK PERFORMED BY OTHERS:

N/A

1.06 CONTRACTOR'S USE OF PREMISES: See General Terms & Conditions Article 6.11.

- A. During construction activities, the CONTRACTOR shall be responsible for maintaining all access roads and parking lots used during the Work in good condition and repair any damage caused by construction use. See Section 00700 - General Terms & Conditions Article 6.13.

1.07 DISTRICT'S USE OF PREMISES:

- A. Full DISTRICT Occupancy: The DISTRICT will occupy and operate the EOC and require continuous operation of the HVAC systems during the construction using chilled water cooling and/or air cooled condensers.
- B. The DISTRICT reserves the right to occupy and to place and install equipment in areas of the Project, prior to Substantial Completion provided that such occupancy does not interfere with completion of the WORK. Such placing of equipment and partial occupancy shall not constitute acceptance of the WORK.

1.08 WORK PLAN, WORK SEQUENCE, COORDINATION ACTIVITIES AND SCHEDULED DATES:

- A. General: Prior to starting work, the CONTRACTOR shall provide a comprehensive work plan and schedule with sufficient details to show work sequence, shut-down requirements, start-up and phase-over to new equipment etc. In developing the work plan, the CONTRACTOR shall use the suggested work sequence as described below. The work and schedule shall be approved by the district prior to starting work
- B. The CONTRACTOR shall coordinate its WORK with other DISTRICT activities, with specific attention to access and staging areas. Construction sequence shall be determined by CONTRACTOR subject to the following needs for continuous access and operation by others.
- C. Suggested Construction Sequence: A suggested sequence of construction has been prepared by the Design Engineers and is presented below. The CONTRACTOR shall determine the final construction sequence of construction in order to satisfy the construction and operational requirements and comply with the overall contract period. Note that the EOC air conditioning systems must be operational at all times with cooling capability provided by chilled water or air cooled condensers. The computer room air conditioning system must be operational at all times with a minimum of two of the three CRAC units in operation. The suggested sequence of construction is as follows.
 - 1. Submit detailed work plan as described in Item A above for District approval. Submit all structural and MEP shop drawings for District approval prior to commencement of work.
 - 2. After shop drawing approvals, order and procure all major structural materials and major equipment required for the project.
 - 3. Prior to November 1, 2013, perform all construction work not related to and/or not impacted by the structural modifications work including but not limited to the installation of air cooled condensers CAC-1 and CAC-2 at the proposed new locations along with associated refrigerant piping, electrical and control work.
 - 4. Complete replacement of the existing CRAC units, CRAC-1 and CRAC-2 as well as installation of the new air cooled condensers CAC-1 and CAC-2 including installation of

refrigerant piping and power and electrical connections. Charge refrigerant systems and bring CRAC- 1 and 2 as well as CAC-1 and CAC-2 into full operation.

5. No construction work specifically relating to the proposed structural modifications shall commence prior to November 1, 2013 and must be substantially completed by June 1, 2014.
 6. Protect existing equipment in accordance with a District-approved protection plan provided by the CONTACTOR.
 7. Demolish existing structural features in the chiller and condenser enclosures required to accommodate the new work as described in the Drawings including Drawing number G002.
 8. Remove existing air cooled condensers CAC-1 and CAC-2 and associated housekeeping pads, refrigerant piping and conduit and wiring. The existing chiller CH-1 and pumps P-1 and P-2 shall be in operation to provide cooling to CRAC units CRAC-1 and 2.
 9. Relocate the water conditioning equipment to the proposed new location including connection of all piping and electrical supply.
 10. Install new chiller CH-2, pumps P-3 and P-4 and housekeeping pads, associated piping, valves and accessories in the chiller and condenser enclosures. Make connections to the existing underground 6" chilled water supply and return piping.
 11. Install chilled water piping in the Map File Room in the EOC. Make connections with the existing operating chilled water system using the hot tap method so the existing chilled water system can remain in operation.
 12. Install power and control wiring, conduit and equipment for the new chiller, pumps and equipment.
 13. Start-up and test the new chilled water system including chiller CH-2, pumps P-3 and P-4 and allocated equipment and prepare the system for full operation.
 14. Complete the system testing and balancing the system.
 15. Place the new chilled water system into full operation with the new chilled water system providing the base cooling capacity to the Trane air handling units and the five Liebert "dual cool" air handlers and with the air cooled condensing units providing back-up capacity to the five CRAC units. The existing chilled water system will be used as a partial back-up to the new chilled water system. Final operation of the chilled water system and air cooled condensers must be done in cooperation with the EOC staff.
- D. Scheduled Events: Schedule the WORK to conform to the following events and dates, and to provide for coordination with the WORK performed by others.
1. The structural modifications to the chiller and condenser enclosures shall commence only after November 1, 2013.
 2. CONTRACTOR shall complete construction of the structural modifications to the chiller and condenser enclosures including steel and reinforced concrete components prior to June 1, 2014,

1.09 COPIES OF DOCUMENTS: See Section 00700 - General Terms & Conditions Article 2.02

1.10 LIST OF DRAWINGS:

A. Contract Drawings:

1. EOC and Data Center HVAC Improvements Work Order No. 4600000867-W004- 37 sheets.

B. Reference Materials:

1. The following reference materials are available for inspection at the offices of the DISTRICT: These materials are for reference only, are provided as-is, are not contractual documents, and do not replace the CONTRACTOR's due diligence in bid preparation.

- a. Construction Drawings; South Florida Water Management District – Headquarters Building B-1 EOC Building Addition Contract NO. 97996.01.

END OF SECTION

SECTION 01015 DEFINITIONS AND STANDARDS

PART 1 - GENERAL

1.01 SCOPE:

- A. Definitions:
1. A substantial amount of specification language constitutes definitions for terms found in other areas of Contract Documents including drawings which must be recognized as diagrammatic in nature and not completely descriptive of requirements indicated.
 2. Certain terms used in the Contract Documents are defined in the General Terms & Conditions. Definitions and explanations are not necessarily either complete or exclusive but are general for the work.
 3. The term "DISTRICT", as defined in the General Terms & Conditions and used in these specifications, is further defined as the District or District's authorized representative, which may include, but is not limited to, the Design Engineer or Construction Manager.
- B. General Requirements: General requirements are the provisions or requirements of Division 1 sections which apply to the entire work of the Contract.

1.02 FORMAT AND SPECIFICATION EXPLANATIONS:

- A. Format Explanation: The format of principal portions of these specifications can be described as follows, although other portions may not fully comply and no particular significance will be attached to such compliance or noncompliance.
1. Sections and Divisions: For convenience, basic unit of specification text is a "section", each unit of which is named and numbered. These are organized into related families of sections, and various families of sections are organized into "divisions", which are recognized as the present industry consensus on uniform organization and sequencing of specifications. The section title is not intended to limit meaning or content of section, nor to be fully descriptive of requirements specified therein, nor to be an integral part of text.
 2. Section Numbering: Used for identification and to facilitate cross-references in contract documents. Sections are placed in numeric sequence; however, numbering sequence is not complete, and listing of sections in Table of Contents at beginning of Contract Documents must be consulted to determine numbers and names of specification sections in these Contract Documents.
 3. Page Numbering: Numbered independently for each section. Section number is shown with page number at bottom of each page to facilitate location of text.
 4. Parts: Each section of these specifications generally has been subdivided into three (3) basic parts for uniformity and convenience (Part 1 "General", Part 2 "Products", and Part 3 "Execution"). These parts do not limit the meaning of text within. Some sections may not contain all three parts when not applicable, or may contain more than three parts to add clarity to organization of section.
 5. Imperative Language: Used generally in specifications. Except as otherwise indicated, requirements expressed imperatively are to be performed by the CONTRACTOR. For clarity of reading, at certain locations contrasting subjective language is used to describe responsibilities which must be fulfilled indirectly by the CONTRACTOR or, when so noted, by others.
 6. Specialists, Assignments: In certain instances, specification text requires that specific work be assigned to specialists or expert entities who must be engaged for performance of those units of work. These must be recognized as special requirements over which the CONTRACTOR has

no choice or option. These assignments must not be confused with, and are not intended to interfere with, normal application of regulations, union jurisdictions and similar conventions. Nevertheless final responsibility for fulfillment of the entire set of requirements remains with the CONTRACTOR.

7. Trades: Except as otherwise specified or indicated, the use of titles such as "carpentry" in specification text, implies neither that the work must be performed by an accredited or unionized tradesperson of corresponding generic name (such as "carpenter"), nor that specified requirements apply exclusively to work by tradespersons of that corresponding generic name.
- B. Specification Content: Because of methods by which this project specification has been produced, certain general characteristics of contents and conventions in use of language are explained as follows:
1. Specifying Methods: The techniques or methods of specifying requirements varies throughout text, and may include "prescriptive", "compliance with standards", "performance", "proprietary", or a combination of these. The method used for specifying one unit of work has no bearing on requirements for another unit of work.
 2. Overlapping and Conflicting Requirements: Where compliance with two (2) or more industry standards or sets of requirements is specified, and overlapping of those different standards or requirements establishes different or conflicting minimums or levels of quality, notify the DISTRICT for a decision as specified in the General Terms & Conditions.
 3. Abbreviations: Throughout the Contract Documents are abbreviations implying words and meanings which will be appropriately interpreted. Specific abbreviations have been established, principally for lengthy technical terminology, and in conjunction with coordination of specification requirements, with notations on drawings and in schedules. These are normally defined at first instance of use. Organizational and association names and titles of general standards are also abbreviated.
- 1.03 DRAWING SYMBOLS: Except as otherwise indicated, graphic symbols used on Drawings are those symbols recognized in the construction industry for purposes indicated. Refer instances of uncertainty to the DISTRICT for clarification.
- 1.04 INDUSTRY STANDARDS - APPLICABILITY: Applicable standards of construction industry have the same force and effect, and are made a part of Contract Documents by reference, as if copied directly into the Contract Documents, or as if published copies were bound herewith. Referenced standards referenced directly in the Contract Documents or by governing regulations have precedence over non-referenced standards which are recognized in industry for applicability to work.

END OF SECTION

SECTION 01020 MEASUREMENT AND PAYMENT

PART 1 - GENERAL

- 1.01 **LUMP SUM CONTRACT:** Unless indicated on the Contract Documents, all work indicated on the Contract Drawings and specified in the Bid Documents and Contract shall be included in the Contract Sum indicated on the Bid Form. The following is a description of the WORK listed in the Bid Form and is not intended to be complete and all-inclusive of the required work items. The WORK shall include all miscellaneous and ancillary items necessary to construct a complete and functional Project.
- A. Bid Item A. EOC AND DATA MANAGEMENT CENTER HVAC IMPROVEMENTS, Total Project Lump Sum.
- 1.02 **BASIS FOR PAYMENTS:** The above descriptions generally outline the scope of work required for those elements of the WORK to be paid for under each lump sum item listed in the Bid Form. Those lump sum amounts shall be further distributed in accordance with subvalues identified in the approved Cost Loaded Schedule specified in SECTION 01310 – Construction Schedules and the GENERAL TERMS & CONDITIONS, Article 2.07.
- A. The CONTRACTOR shall have ninety (90) business days after Contract execution, to produce the required Insurance Declaration Page of Policy for the insurance requirements set forth in the General Terms & Conditions, and the Insurance Requirements Checklist. The DISTRICT may refuse to make whole or part of any payment if the CONTRACTOR fails to submit the required Insurance Policy Declaration Page as stated in the Contract.
- 1.03 **PAYMENTS:** Payments shall be in accordance with the provisions of the GENERAL TERMS & CONDITIONS, Article 14.

END OF SECTION

SECTION 01045 CUTTING AND PATCHING

PART 1 - GENERAL

1.01 WORK INCLUDED:

- A. Definition: "Cutting and patching" includes cutting into existing construction to provide for the installation or performance of other work and subsequent fitting and patching required to restore surfaces to their original condition.
 - 1. Cutting and patching is performed for coordination of the work, to uncover work for access or inspection, to obtain samples for testing, to permit alterations to be performed or for other similar purposes.
 - 2. Cutting and patching performed during the manufacture of products, or during the initial fabrication, erection or installation processes is not considered to be "cutting and patching" under this definition. Drilling of holes to install fasteners and similar operations are also not considered to be "cutting and patching."
- B. Refer to other sections of these specifications and the Drawings for specific cutting and patching requirements and limitations applicable to individual units of work.
 - 1. Unless otherwise specified, requirements of this section apply to mechanical and electrical work.
 - 2. Refer to Division 15 and Division 16 sections for additional requirements and limitations on cutting and patching of mechanical and electrical work.

1.02 SUBMITTALS:

- A. Procedural Proposal for Cutting and Patching: Where prior approval of cutting and patching is required, submit proposed procedures for this work well in advance of the time work will be performed and request approval to proceed. Include the following information, as applicable, in the submittal:
 - 1. Describe nature of the work and how it is to be performed, indicating why cutting and patching cannot be avoided.
 - 2. Describe anticipated results of the work in terms of changes to existing work, including structural, operational and visual changes as well as other significant elements.
 - 3. List products to be used and firms that will perform work.
 - 4. Give dates when work is expected to be performed.
 - 5. List utilities that will be disturbed or otherwise be affected by work, including those that will be relocated and those that will be out-of-service temporarily.
 - a. Indicate how long utility service will be disrupted.
 - 6. Where cutting and patching of structural work involves the addition of reinforcement, submit details and engineering calculations to show how that reinforcement is integrated with original structure to satisfy requirements.
- B. Approval by the DISTRICT to proceed with cutting and patching work does not waive the DISTRICT'S right to later require complete removal and replacement of work found to be cut and patched in an unsatisfactory manner.

1.03 QUALITY ASSURANCE:

- A. Requirements for Structural Work: Do not cut and patch structural work in a manner that would result in a reduction of load-carrying capacity or of load-deflection ratio.

- B. Operational and Safety Limitations: Do not cut and patch operational elements or safety related components in a manner that would result in a reduction of their capacity to perform in the manner intended, including energy performance, or that would result in increased maintenance, or decreased operational life or decreased safety.
- C. Visual Requirements: Do not cut and patch work exposed on the building's exterior or in its occupied spaces, in a manner that would, in the DISTRICT'S opinion, result in lessening the building's aesthetic qualities.
 - 1. Do not cut and patch work in a manner that would result in substantial visual evidence of cut and patch work.
 - 2. Remove and replace work judged by the DISTRICT to be cut and patched in a visually unsatisfactory manner.
 - 3. Retain the original installer or fabricator if possible, or another recognized experienced and specialized firm for cutting and patching.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. General: Except as otherwise indicated, or as directed by the DISTRICT, use materials for cutting and patching that are identical to existing materials.
- B. If identical materials are not available or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect.
- C. Use materials for cutting and patching that will result in equal-or-better performance characteristics.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Before cutting, examine the surfaces to be cut and patched and the conditions under which the work is to be performed. If unsafe or otherwise unsatisfactory conditions are encountered, take corrective action before proceeding with the work.
- B. Coordinate layout of the work and resolve potential conflicts before proceeding with the work.

3.02 PREPARATION:

- A. Temporary Support: To prevent failure, provide temporary support of work to be cut.
- B. Protection: Protect other work during cutting and patching to prevent damage. Provide protection from adverse weather conditions for that part of the project that may be exposed during cutting and patching operations.
 - 1. Avoid interference with use of adjacent facilities or interruption of free passage to adjacent facilities.
 - 2. Take precautions not to cut existing pipes, conduits or ducts serving the building but scheduled to be relocated until provisions have been made to by-pass them. Coordinate with the DISTRICT.

3.03 PERFORMANCE:

- A. General: Employ skilled workmen to perform cutting and patching work. Except as otherwise indicated or as approved by the DISTRICT, proceed with cutting and patching at the earliest feasible time and complete work without delay.
- B. Cutting: Cut the work using methods that are least likely to damage work to be retained or adjoining work. Where possible, review proposed procedures with the original installer; comply with original installer's recommendations.
 - 1. General: Use hand or small power tools designed for sawing or grinding, not hammering and chopping, where cutting is required. Use of gasoline-powered tools will not be permitted in enclosed spaces.
 - 2. Cut through concrete and masonry using a cutting machine such as a carborundum saw or core drill to insure a neat hole.
 - 3. Cut holes and slots neatly to size required with minimum disturbance of adjacent work.
 - 4. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 5. Temporarily cover openings when not in use.
- C. By-pass utility services such as pipe and conduit, before cutting, where such utility services are shown or required to be removed, relocated or abandoned.
- D. Cut off conduit and pipe in walls or partitions to be removed. After by-pass and cutting, cap, valve or plug and seal tight remaining portion of pipe and conduit to prevent entrance of moisture or other foreign matter.
- E. Patching: Patch with seams which are durable and as invisible as possible. Comply with specified tolerances for the work.
 - 1. Inspect and test patched areas to demonstrate integrity of work where feasible.
 - 2. Restore exposed finishes of patched areas and where necessary extend finish restoration into retained adjoining work in a manner which will eliminate evidence of patching and refinishing.
 - 3. Patch and repair floor and wall surfaces in the new space to provide an even surface of uniform color and appearance where removal of walls or partitions extends one finished area into another finished area.
 - 4. If necessary to achieve uniform color and appearance, remove existing floor and wall coverings and replace with new materials.
 - 5. Extend final paint coat over entire unbroken surface containing patch, after patched area has received prime and base coat where patch occurs in a smooth painted surface.
 - 6. Patch, repair or re-hang existing ceilings as necessary to provide an even plane surface of uniform appearance.

3.04 CLEANING:

- A. Thoroughly clean areas and spaces where work is performed or used as access to work. Remove completely paint, mortar, oils, putty and items of similar nature.
- B. Thoroughly clean piping, conduit and similar features before painting or other finishing is applied.
- C. Restore damaged pipe covering to its original condition.

END OF SECTION

SECTION 01050 FIELD ENGINEERING

PART 1 - GENERAL (See General Terms & Conditions Article 4.05 "Reference Points.")

1.01 SCOPE:

A. Summary of Work:

1. The CONTRACTOR shall engage a Professional Engineer of the discipline required, registered in the State of Florida, to perform engineering services for temporary facilities including the design of shoring systems, shores, earth and water retaining systems, forms, temporary erection supports, and similar items provided by the CONTRACTOR as part of its means and methods of construction.
2. The CONTRACTOR shall engage a Professional Surveyor and Mapper registered in the State of Florida to perform the necessary layout, survey control and monumentation.
3. The CONTRACTOR shall provide one set of As-Built Drawings depicting all elevations both NAVD 88 (North American Vertical Datum 88) and NGVD 29 (National Geodetic Vertical Datum 29). The NGVD 29 elevation shall be italicized, bracketed, and underscored. Refer to 2.03.A.5 for datum offset requirements.

B. Related Work Specified Elsewhere:

1. SECTION 01300 - Submittals
2. SECTION 01700 – Contract Closeout
3. SECTION 02200 – Earthwork

1.02 SUBMITTALS:

- A. Submit in accordance with SECTION 01300.

PART 2 - CONTRACTOR CONSTRUCTION STAKING

2.01 DESCRIPTION: In connection with this WORK, CONTRACTOR shall:

- A. Perform all construction layout and reference staking necessary for the proper control and satisfactory completion of the WORK.
- B. Run a level circuit between vertical control points indicated to check plan benchmarks and establish new benchmarks where necessary.

2.02 CONSTRUCTION REQUIREMENTS:

- A. The CONTRACTOR's personnel performing the construction staking shall work under the direct supervision of a Florida registered Professional Engineer or Florida registered Professional Surveyor and Mapper. Submit name and address of individual responsible for surveying to the DISTRICT prior to start of survey activities.
- B. The CONTRACTOR shall be solely and completely responsible for the accuracy of the line and grade of all features of the WORK. Any errors or apparent discrepancies found in previous surveys, plans, or specifications shall be called to the attention of the DISTRICT by the CONTRACTOR for correction or interpretation prior to proceeding with the WORK.
- C. Field notes shall be kept in standard, bound field notebooks in a clear, orderly, and neat manner consistent with standard engineering practices.
- D. The CONTRACTOR shall be responsible for the placement and preservation of adequate ties and reference to all control points, whether established by him or found on the Project, necessary for the accurate reestablishment of all base lines or centerlines shown on the Drawings. All land ties (i.e. section corners, fractional section corners, and similar items) that may be lost or destroyed during construction shall be carefully referenced and replaced.

- E. The supervision of the CONTRACTOR's construction engineering personnel shall be the responsibility of the CONTRACTOR; any deficient engineering layout or construction WORK which may be the result of inaccuracies in his staking operations or of his failure to report inaccuracies found in WORK previously done by the Design Engineer shall be corrected at the expense of the CONTRACTOR.
- F. Station Identification: On linear elements of construction (such as levees, canals, and similar items) the CONTRACTOR shall place temporary identifying signs at intervals no greater than 500 feet using four (4) foot sections of one (1) inch by four (4) inches lumber driven into the ground. The signs shall identify the station at that location.
- G. In order to expedite the commencement of construction operations, the staking operation may commence prior to the issuance of the Notice to Proceed. The CONTRACTOR shall obtain written approval of the DISTRICT prior to commencing staking.

2.03 SURVEYING STANDARDS for stilling wells and water control structures:

- A. A permanent mark shall be established identifying the elevation measuring point on the rim of all stilling wells.
 - 1. All vertical elevations shall commence from a minimum of two (2) National Geodetic Survey (NGS) second order or better published benchmarks.
 - 2. All elevations shall be established to NGS third order standards and certified to those standards by a Professional Surveyor and Mapper registered in the State of Florida.
 - 3. All level runs shall be double run (forward and back) or looped into two (2) NGS second order or better published benchmarks.
 - 4. A Site benchmark shall be set if one does not exist. The benchmark shall consist of a minimum of two (2) 80-pound bags of concrete mix, a ferrous piece of material able to be located with a magnetic locator, and a survey cap (supplied by the DISTRICT) stamped with the Site designation or DISTRICT approved alternative.
 - 5. All elevations shall be established in NAVD 88 with the datum offset for conversion to NGVD 29. Datum offsets shall be made using the CORPSCON 6.0.1 or the most recent version. The datum conversion to NGVD 29 shall be made from the closest bench mark. The NGVD 29 conversions shall be accurate to 0.01 feet.
 - 6. State Plane Coordinates (NAD 83/99) shall be established at all stilling well and benchmark locations with a positional accuracy of +/- three feet.
 - 7. A DISTRICT benchmark description sheet shall be completed for each set benchmark.
 - 8. If there are no second order or better published benchmarks within six miles of the site, contact the DISTRICT Surveying & Mapping Section representative at (561) 682-6688 prior to commencement.
 - 9. Contact the DISTRICT Survey & Mapping Section prior to commencement to check for previously established site benchmarks that may be suitable to use.
- B. All structures shall have a permanent benchmark mounted as shown on the Drawings. The marker for the benchmark can be obtained from the DISTRICT Survey & Mapping Section, (561) 682-6688. The CONTRACTOR shall only stamp or engrave the benchmark identification and not the elevation.
- C. The CONTRACTOR shall install staff gauge in accordance with SECTION 02781.

2.04 RECORDS AND SUBMITTALS:

- A. Submittal:
 - 1. Provide DISTRICT a copy of the designs described in Paragraph 1.01 signed and sealed by the Florida registered Professional Engineer.
 - 2. Provide DISTRICT the data required for the individual responsible for layout and records as required in Paragraph 2.02 A.

3. Provide DISTRICT one (1) copy of the Preliminary Surveyor's Report (MS Word 2007), and two (2) copies of the final signed, sealed and certified Surveyor's Report to the DISTRICT.
 - a. At a minimum, the report shall include: an overall Project description, location sketches, field notes, equipment used, pictures and an NAD 83/99 state plane coordinate (RTK) on each new bench mark (if applicable).
 - b. A CD containing: Surveyor's name and logo, Surveyor's Report, digital pictures, benchmark description sheets and any other associated data.
- B. Records: At the end of the Project, submit to the DISTRICT a certified Site survey showing coordinates and elevations of the completed WORK. These are part of the record documents required in SECTION 01700.
- C. Cross-sections: Canal and Levee cross-sections shall be submitted as specified in SECTION 02200.

END OF SECTION

SECTION 01065 PERMITS AND FEES

PART 1 - GENERAL

- 1.01 Unless otherwise specified, the CONTRACTOR shall obtain and pay for any permits and licenses related to his work as provided for in the General Terms & Conditions, except as otherwise provided herein.
- 1.02 The CONTRACTOR will be issued copies of all permits obtained by the DISTRICT at the pre-construction conference. A copy of the permits shall be posted at the site at all times during construction. The CONTRACTOR shall be responsible for familiarizing himself with the permits and shall abide by the permit conditions at all times.
- 1.03 Work shall be conducted, and shall result in construction of the improvements of this project, in full accordance with the conditions of the permits granted for the project.

END OF SECTION

SECTION 01071 STANDARD REFERENCES

Wherever used in the project manual, the following abbreviations will have the meanings listed:

AA	Aluminum Association Incorporated 818 Connecticut Avenue, N.W. Washington, D.C. 20006
AABC	Associated Air Balance Council 1518 K Street N.W. Washington, D.C. 20005
AAMA	American Architectural Manufacturers Association 2700 River Road, Suite 118 Des Plaines, IL 60018
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 225 Washington, D.C. 20001
ABMA	American Bearing Manufacturers Association 2025 M Street, NW Suite 800 Washington, D.C. 20036
ACI	American Concrete Institute 38800 Country Club Drive Farmington Hills, MI, 48331
AEIC	Association of Edison Illuminating Companies 600 18 th Street N Birmingham, Al 35203
AFBMA	Anti-Friction Bearing Manufacturers Association
AGA	American Gas Association 400 N. Capital Street, NW Suite 450 Washington, D.C. 20001
AGMA	American Gear Manufacturer's Association 500 Montgomery Street, Suite 350 Alexandria, VA 22314
AHA	American Hardboard Association 1210 West Northwest Hwy Palatine, IL 60067
AISC	American Institute of Steel Construction One East Wacker Drive, suite 700 Chicago, IL 60601
AISI	American Iron and Steel Institute 1000 16th Street, N.W. Washington, D.C. 20036

AITC	American Institute of Timber Construction 333 West Hampden Avenue Englewood, CO 80110
ALSC	American Lumber Standards Committee P. O. Box 210 Germantown, MD 20874
AMCA	Air Movement and Control Association, Inc. 30 West University Drive Arlington Heights, IL 60004
ANSI	American National Standards Institute, Inc. 25 West 43 rd Street New York NY 10036
APA	American Plywood Association P.O. Box 11700 Tacoma, WA 98411
API	American Petroleum Institute 1220 L Street, NW Washington, D.C. 20005
AHRI	Air-Conditioning Heating and Refrigeration Institute 1814 North Fort Myer Drive Arlington, VA 22209
ASCE	American Society of Civil Engineers 345 East 47th Street New York, NY 10017
ASCII	American Standard Code for Information Interchange United States of America Standards Institute 10 East 40th Street New York, NY 10016
ASE	American Standard Safety Code for Elevators, Dumbwaiter and Escalators American National Standards Institute/ASME A17.1/CSA B44 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers United Engineering Center 1791 Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers Three Park Avenue New York, NY 10016
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103

AWPA	American Wood Preservers Association P.O. Box 361784 Birmingham, AL 35236
AWPB	American Wood Preservers Bureau 7962 Conell Court P. O. Box 5283 Lorton, VA 22079
AWPI	American Wood Preservers Institute 1945 Old Gallows Rd, Suite 150 Vienna, VA 22182
AWI	Architectural Woodwork Institute 46179 Westlake Drive, Suite 120 Potomac Falls, VA 20165
AWS	American Welding Society 550 NW Lejune Rd Miami, FL 33126
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
BHMA	Builders Hardware Manufacturers Association 355 Lexington Avenue, 17 th Floor New York, NY 10017
BOCA	Building Officials and Code Administrators 17926 Halstead Homewood, IL 60430
CBMA	Certified Ballast Manufacturers Association 2120 Keith Building Cleveland, OH 44115
CMAA	Crane Manufacturers Association of America (Formerly called: Overhead Electrical Crane Institute) (OECI) 8720 Reds Oak blvd, Suite 201 Charlotte, NC 28217
CRSI	Concrete Reinforcing Steel Institute 933 North Plum Grove Rd Schaumburg, IL 60173
CSA	Canadian Standards Association 155 Queen Street, Suite 1300 Ottawa, Ontario, K1P6L1, Canada
DEMA	Diesel Engine Manufacturer's Association 122 East 42nd Street New York, NY 10017

DHI	Door Hardware Institute 14150 Newbrook Drive, Suite 200 Chantilly, VA 20151
DIS	Division of Industrial Safety California Department of Industrial Relations 2422 Arden Way Sacramento, CA 95825
EEI	Edison Electric Institute 701 Pennsylvania Avenue, NW Washington, D.C. 20004
EIA	Electronic Industries Alliance 2001 Eye Street, N.W. Washington, D.C. 20006
EJMA	Expansion Joint Manufacturer's Association 25 North Broadway Tarrytown, NY 10591
EPA	Environmental Protection Agency Region 4 Sam Nunn Atlanta Federal Center 61 Forsyth Street, SW Atlanta, GA 30303-3104
ESO	Electrical Safety Order, California Administrative Code, Title 8, Chap. 4, Subarticle 5 Office of Procurement, Publications Section P. O. Box 20191 8141 Elder Creek Road Sacramento, CA 95820
FAC	Florida Administrative Code
FEDSPEC	Federal Specifications General Services Administration Specification and Consumer Information Distribution Branch Washington Navy Yard, Bldg. 197 Washington, D.C. 20407
FEDSTDS	Federal Standards (see FEDSPECS)
FM	Factory Mutual Research 1151 Boston-Providence Turnpike Norwood, MA 02062
GANNA	Glass Association of North America 800 SW Jackson Street, Suite 1500 Topeka, Kansas 66612
HEI	Heat Exchange Institute 1300 Summer Avenue Cleveland, OH 44115

HI	Hydraulic Institute 1230 Keith Building Cleveland, OH 44115
HPVA	Hardwood Plywood and Veneer Association 1825 Michael Faraday Drive Reston, VA 20190
IAPMO	International Association of Plumbing and Mechanical Officials 5001 E. Philadelphia Street Ontario CA, 91761
ICBO	International Conference of Building Officials 5360 South Workman Mill Road Whittier, CA 90601
ICEA	Insulated Cable Engineers Association P. O. Box P South Yarmouth, MA 02664
ICRI	International Concrete Repair Institute 10600 West Higgins Road, Suite 607 Rosemont, IL 60018
IEEE	Institute of Electrical and Electronics Engineers, Inc. 3 Park Avenue, 17 th Floor New York, NY 10016-5997
IES	Illuminating Engineering Society c/o United Engineering Center 120 Wall Street Floor 17 New York, NY 10005
ISA	Instrument Society of America 67 Alexander Drive Research triangle Park, NC 27709
ISO	International Organization for Standardization 1, ru de Varembé, Case postale 56 CH-1211 Genna 20, Switzerland
JIC	Joint Industrial Council 7901 Westpark Drive McLean, VA 22101
MFMA	Metal Framing Manufacturers Association 401 Michigan Avenue Chicago, IL 60611
MILSPEC	Military Specifications Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120

MSS	Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. 127 Park Avenue, N.E. Vienna, VA 22180
NAAMM	National Association of Architectural Metal Manufacturers 800 Roosevelt rd bldg C, Suite 312 Glen Ellyn, IL 60137
NACE	National Association of Corrosion Engineers P. O. Box 986 Katy, TX 77450
NEC	National Electrical Code National Fire Protection Association 470 Atlantic Avenue Boston, MA 02210
NECA	National Electrical Contractors Association 3 Bethesda Metro Center, Suite 1100 Bethesda, MD 20814
NELMA	Northeastern Lumber Manufacturers Association, Inc. 272 Turtle Road P. O. Box 87A Cumberland Center, ME 04021
NEMA	National Electrical Manufacturer's Association 1300 N. 17 th Street, Suite 1752 Rosslyn, VA 22209
NESC	National Electric Safety Code American National Standards Institute 1430 Broadway New York, NY 10018
NETA	InterNational Electrical Testing Association 3050 Old Centre Avenue, Suite 102 Portage, MI 49024
NFP	National Forest Products Association (Formerly National Lumber Manufacturer's Association) 1619 Massachusetts Avenue Washington, DC 20036
NFPA	National Fire Protection Association Batterymarch Park Quincy, MA 02269
NHLA	National Hardwood Lumber Association P. O. Box 34518 Memphis, TN 38184-0518
NIST	National Institute of Standards and Technology 100 Bureau Drive, Suite 1070 Gaithersburg, MD 20899-1070

NSF	National Sanitation Foundation P.O. Box 130140 789 N. Dixoboro rd. Ann Arbor, MI 48113
OSHA	Occupational Safety and Health Act U.S. Department of Labor Occupational and Health Administration San Francisco Regional Office 200 Constitution Avenue Washington, D.C. 20210
PCI	Prestressed Concrete Institute 200 W. Adams Street, Suite 2100 Chicago, IL 60606
PPIC	The Plumbing & Piping Industry Council, Inc. 135 Calle Catalina Place Houston, TX 77007
RIS	Redwood Inspection Service California Redwood Association 818 Grayson Road, Suite 201 Pleasant Hill, CA 94523
RLM	Reflector and Lamp Manufacturers Standard Institute
RMA	Rubber Manufacturers Association 1400 K Street Washington, D.C. 20005
SAE	Society of Automotive Engineers 400 Commonwealth Drive Warrendale, PA 15096
SBC	Standard Building Code Published by SBCCI
SMC	Standard Mechanical Code Published by SBCCI
SBCCI	Southern Building Code Congress International 1116 Brown-Marx Building Birmingham, AL 35203
SCMA	Southern Cypress Manufacturers Association 805 Sterick Bldg. Memphis, TN 38103

SDI	Steel Door Institute 30200 Detroit road Westlake, OH 44145
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc. 4201 Lafayette Center Drive Chantilly, VA 20151
SPC	Society for Protective Coatings 40 24 th Street, 6 th Floor Pittsburgh, PA 15222
SPI	Society of the Plastics Industry, Inc. 1667 K street, NW Suite 1000 Washington, D.C. 20006
SPIB	Southern Pine Inspection Bureau P.O. Box 10915 Pensacola, FL 32524
SSPC	The Society for Protective Coatings (formerly called: Steel Structures Painting Council) 40 24 th Street, 6 th Floor Pittsburgh, PA 15222-4656
SSPWC	Standard Specifications for Public Works Construction Building News, Inc. 3055 Overland Avenue Los Angeles, CA 90034
TEMA	Tubular Exchanger Manufacturer's Association 3251 Corte Malpaso, Suite 507 Camarillo, CA 93012
UL	Underwriters Laboratories Inc. 2600 N.W. Lake Road Camas, WA 98607
USBR	Bureau of Reclamation U.S. Department of Interior Engineering and Research Center Denver Federal Center, Building 67 Denver, CO 80225
USACE	United States Army Corps of Engineers Jacksonville District P. O. Box 4970 Jacksonville, FL 32232-0019
WCLIB	West Coast Lumber Inspection Bureau 6980 SW Varns Street P. O. Box 23145 Tigard, OR 97223

WWPA

Western Wood Products Association
(Formerly called: West Coast Lumbermen's Association (WCLA))
522 SW 5th Avenue, Suite 500
Portland, OR 97204

END OF SECTION

SECTION 01200 PROJECT MEETINGS AND REPORTS

PART 1 - GENERAL

1.01 SUMMARY: This Section includes the following administrative and procedural requirements:

- A. Project Meetings:
 - 1. Preconstruction conference
 - 2. Progress meetings
- B. Schedules and Reports:
 - 1. Initial coordination submittals
 - 2. Construction progress schedule (See SECTION 01310 Construction Schedules)
 - 3. Special reports

1.02 PROJECT MEETINGS:

- A. Pre-construction Conference
 - 1. The DISTRICT will administer a meeting within 10 days after the Effective Date of the Agreement, to review items stated in the following agenda and to establish a working understanding between the parties as to their relationships during conduct of the Work.
 - 2. Preconstruction conference shall be attended by:
 - a. CONTRACTOR and his superintendent
 - b. Representatives of principal Subcontractors and Suppliers
 - c. Engineer and his Resident Project Representative if any
 - d. DISTRICT or his representative
 - e. Other affected parties determined by the DISTRICT
 - 3. Agenda:
 - a. Projected construction schedules
 - b. Critical Work sequencing
 - c. Designation of responsible personnel
 - d. Project coordination
 - e. Procedures and Processing of:
 - i. Field decisions
 - ii. Substitutions
 - iii. Submittals
 - iv. Change Orders
 - v. Applications for payment
 - f. Procedures for testing
 - g. Procedures for maintaining record documents
 - h. Use of Premises:
 - i. Office, work and storage areas

- ii. DISTRICT'S requirements
 - i. Construction facilities, controls, and construction aids
 - j. Temporary utilities
 - k. Safety and first aid
 - l. Security
 - m. Requirements of any permits obtained by the DISTRICT
4. Location of Meeting: 3301 Gun Club Rd., West Palm Beach, FL 33406

B. Progress Meetings:

1. The DISTRICT will administer a meeting a minimum of twice each month (every two weeks) and at other times requested by the DISTRICT. CONTRACTOR, Engineer and all Subcontractors active on the site shall be represented at each meeting. CONTRACTOR may request attendance by representatives of his Suppliers and other Subcontractors, or other entities concerned with current program or involved with planning, coordination or performance of future activities. All participants in the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.
2. CONTRACTOR and each Subcontractor shall be prepared to discuss the current construction progress report, any anticipated future changes to the schedule, and advise if their current progress or future anticipated schedules are compatible with the Work.
3. If one Subcontractor is delaying another, CONTRACTOR shall direct such changes as are necessary for those involved to mutually agree on schedule changes in the best interest of construction progress.
4. Agenda
 - a. Review of construction progress since previous meeting
 - b. Field observations, interface requirements, conflicts
 - c. Problems which impede construction schedule
 - d. Off-site fabrication
 - e. Delivery schedules
 - f. Submittal schedules and status
 - g. Site utilization
 - h. Temporary facilities and services
 - i. Hours of Work
 - j. Hazards and risks
 - k. Housekeeping
 - l. Quality and Work standards
 - m. Change orders
 - n. Documentation of information for payment request
 - o. Corrective measures and procedures to regain projected schedule if necessary
 - p. Revisions to construction schedule
 - q. Progress and schedule during succeeding Work period
 - r. Review proposed changes for:

- i. Effect on construction schedule and on completion date
 - ii. Effect on other contracts of the Project
 - s. Other business
 - 5. Location of Meetings: 3301 Gun Club Rd., West Palm Beach, FL 33406
 - 6. Reporting: After each meeting, minutes of the meeting will be distributed to each party present and to parties who should have been present.
- C. Special Reports:
- 1. When an event of an unusual and significant nature occurs at the site, a special report shall be prepared and submitted. List the chain of events, persons participating, response by CONTRACTOR'S personnel, an evaluation of the results or effects, and similar pertinent information. Advise the DISTRICT in advance when such events are known or predictable.

END OF SECTION

SECTION 01300 SUBMITTALS

PART 1 - GENERAL

1.01 SCOPE:

- A. This SECTION includes definitions, descriptions, transmittal, and review of "Compliance" and "Miscellaneous" Submittals.
- B. Related Work Specified Elsewhere:
 - 1. SECTION 01300 - Submittals
 - 2. SECTION 01310 – Cost Loaded Construction Schedule

1.02 GENERAL INFORMATION:

- A. Definitions:
 - 1. Compliance Submittals include Shop Drawings, product data, and samples which are prepared by the CONTRACTOR, Subcontractor, MANUFACTURER, or Supplier and submitted by the CONTRACTOR to the DISTRICT as a basis for approval of the use of Equipment and Materials proposed for incorporation in the WORK or needed to describe installation, operation, maintenance, or technical properties.
 - a. Shop Drawings include custom-prepared data of all types including drawings, diagrams, performance curves, material schedules, templates, instructions, and similar information not in standard printed form applicable to other projects.
 - b. Product data includes standard printed information on materials, products and systems not custom-prepared for this Project, other than the designation of selections from available choices.
 - c. Samples include both fabricated and unfabricated physical examples of materials, products, and WORK; both as complete units and as smaller portions of units of WORK; either for limited visual inspection or (where indicated) for more detailed testing and analysis. Mock-ups are a special form of samples which are too large to be handled in the specified manner for transmittal of sample Submittals.
 - 2. Miscellaneous Submittals are those technical reports, administrative Submittals, certificates, and guarantees not defined as Shop Drawings, product data, or samples.
 - a. Technical reports include laboratory reports, tests, technical procedures, technical records, CONTRACTOR's design analysis and CONTRACTOR's survey field notes for construction staking, before cross-sections and after cross-sections.
 - b. Administrative Submittals are those nontechnical Submittals required by the Contract Documents or deemed necessary for administrative records. These Submittals include maintenance agreements, workmanship bonds, Project photographs, physical work records, statements of applicability, copies of industry standards, as-constructed data, security/protection/safety data, and similar type Submittals.
 - c. Certificates and guarantees are those Submittals on Equipment and Materials where a written certificate or guarantee from the MANUFACTURER or Supplier is called for in the Specifications.
 - d. Reports as required by Contract describing CONTRACTOR's means and methods for items such as dewatering, earth and water retaining, erosion/turbidity control, and safety plans.
 - 3. Refer to ARTICLE 1.03 and 1.04 of this Part for detailed lists of documents and specific requirements.

B. Quality Requirements:

1. The CONTRACTOR shall utilize the DISTRICT's Internet based Primavera Contract Management software – EXPEDITION (EXPEDITION software) to submit all Project related correspondences including, but not limited to Request for Information (RFI), Submittals, miscellaneous correspondences, etc.
2. The DISTRICT's EXPEDITION software can be accessed at: <https://expedition.sfwmd.gov/exponline>.
3. The CONTRACTOR shall provide the DISTRICT with a list of personnel that require access to the DISTRICT's EXPEDITION software prior to the issuance of the Notice to Proceed.
4. Identified CONTRACTOR's personnel will be provided with an EXPEDITION software user ID and Password by the DISTRICT for use in transmitting Compliance Submittals and Project related correspondences.
5. Access to the DISTRICT's EXPEDITION software will be provided by the DISTRICT and restricted to CONTRACTOR's use on only the contracted WORK/Project for the Contract duration. CONTRACTOR's access and use of the DISTRICT's EXPEDITION software shall cease upon completion and closeout of the Contract WORK.
6. Submittals such as Shop Drawings and product data shall be of the quality for legibility and reproduction purposes. Every line, character, and letter shall be clearly legible. Drawings such as reproductions shall be useable for further reproduction to yield legible hard copy.
7. Documents submitted to the DISTRICT that do not conform to these requirements shall be subject to rejection by the DISTRICT, and upon request by DISTRICT, CONTRACTOR shall resubmit conforming documents. If conforming Submittals cannot be obtained, such documents shall be retraced, redrawn, or photographically restored as may be necessary to meet such requirements. CONTRACTOR's (or his Subcontractor's) failure to initially satisfy the legibility quality requirements will not relieve CONTRACTOR (or his Subcontractors) from meeting the required schedule for Submittal of Shop Drawings and product data.

C. Language and Dimensions:

1. All words and dimensional units shall be in the English language.
2. Metric dimensional unit equivalents may be stated in addition to the English units.

D. Submittal Completeness:

1. Submittals shall be complete with respect to dimensions, design criteria, materials of construction, and other information specified to enable the DISTRICT to review the information effectively.
2. Where standard drawings are furnished which cover a number of variations of the general class of equipment, each such drawing shall be individually annotated to describe exactly which parts of the drawing apply to the equipment being furnished. Use hatch marks to indicate variations that do not apply to the Submittal. The use of "highlighting markers" is not an acceptable means of annotating Submittals. Such annotation shall also include proper identification of the Submittal permanently attached to the drawing.
3. Reproduction or copies of Drawings or portions thereof will not be accepted as complete fabrication or erection drawings. The CONTRACTOR may use a reproduction of the DISTRICT-prepared Contract Drawings for erection drawings such as to indicate information on erection or to identify detail drawing references. Where the Drawings are revised to show this additional CONTRACTOR information, the DISTRICT's title block shall be replaced with a CONTRACTOR's title block and the DISTRICT's professional seal shall be removed from the Drawing. The CONTRACTOR shall revise these erection drawings for subsequent DISTRICT revisions to the Contract Drawings.

1.03 COMPLIANCE SUBMITTALS:

- A. Items shall include, but not be limited to, the following:
1. MANUFACTURER's specifications
 2. Catalogs, or parts thereof, of manufactured equipment
 3. Shop fabrication and erection drawings
 4. General outline drawings of equipment showing overall dimensions, location of major components, weights, and location of required building openings and floor plates
 5. Detailed equipment installation drawings, showing foundation details, anchor bolt sizes and locations, baseplate sizes, location of DISTRICT's connections, and all clearances required for erection, operation, and disassembly for maintenance.
 6. Schematic diagrams for electrical items, showing external connections, terminal block numbers, internal wiring diagrams, and one-line diagrams
 7. Bills of material and spare parts list
 8. Instruction books and operating manuals
 9. Material lists or schedules
 10. Performance tests on equipment by MANUFACTURERS
 11. Concrete mix design information
 12. Samples and color charts
 13. All drawings, calculations, catalogs or parts thereof, MANUFACTURER's specifications and data, samples, instructions, and other information specified or necessary:
 - a. For DISTRICT to determine that the Equipment and Materials conform with the design concept and comply with the intent of the Contract Documents.
 - b. For the proper erection, installation, operation and maintenance of the Equipment and Materials which the DISTRICT will review for general content but not for substance.
 - c. For the DISTRICT to determine what supports, anchorages, structural details, connections, and services are required for the Equipment and Materials, and the effects on contiguous or related structures and Equipment and Materials.
- B. Schedule and Log of Compliance Submittals:
1. Prepare for the DISTRICT, a schedule and log for submission of all Compliance Submittals specified or necessary for DISTRICT's review of the use of Equipment and Materials proposed for incorporation in the WORK or needed for proper installation, operation or maintenance. Submit the schedule and log with the procurement schedule and WORK progress schedule. Schedule submission of all Compliance Submittals to permit review, fabrication, and delivery in time so as to not cause a delay in the WORK of CONTRACTOR or his Subcontractors or any other contractors as described herein.
 2. In establishing schedule for Compliance Submittals, allow fifteen (15) working days in DISTRICT's office for reviewing original Submittals and ten (10) working days for reviewing resubmittals.
 3. The schedule shall indicate the anticipated dates of original submission, and shall be prepared in accordance with SECTION 01310.
 4. Schedule all Compliance Submittals required prior to fabrication or manufacture for submission within 60 days of the Notice to Proceed Schedule Compliance Submittals pertaining to storage, installation and operation at the Site for DISTRICT's acceptance prior to delivery of the Equipment and Materials.

5. Resubmit Compliance Submittals the number of times required for DISTRICT's "Submittal Accepted." However, any need for resubmittals in excess of the number set forth in the accepted schedule, or any other delay in obtaining acceptance of Submittals, will not be grounds for extension of the Contract Time, provided the DISTRICT completes its reviews within the times stated above.

C. Transmittal of Compliance Submittals:

1. All Compliance Submittals and related correspondences shall be submitted to the DISTRICT by CONTRACTOR using the DISTRICT's EXPEDITION software.
2. All Compliance Submittals of Equipment and Materials furnished by Subcontractors, MANUFACTURERS, and Suppliers shall be submitted to the DISTRICT by CONTRACTOR electronically utilizing the DISTRICT's EXPEDITION software.
3. After checking and verifying all field measurements, transmit all Compliance Submittals to the DISTRICT for acceptance as follows:
 - a. Identify each Compliance Submittal by Submittal Number, Project name and number, Contract title and number, and the Specification SECTION and article number marked thereon or in the letter of transmittal. Unidentifiable Submittals will be returned for proper identification.
 - b. Check and stamp Compliance Submittals of Subcontractors, Suppliers, and MANUFACTURERS with CONTRACTOR's approval prior to transmitting them to the DISTRICT. CONTRACTOR's stamp of approval shall constitute a representation to the DISTRICT that CONTRACTOR has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, or he assumes full responsibility for doing so, and that he has coordinated each Compliance Submittal with the requirements of the WORK and the Contract Documents.
 - c. At the time of each submission, call to the attention of DISTRICT in the letter of transmittal any deviations from the requirements of the Contract Documents.
 - d. Make all modifications noted or indicated by DISTRICT and return revised prints, copies, or samples until accepted. Direct specific attention in writing, or on revised Submittals, to changes other than the modifications called for by the DISTRICT on previous Submittals. After Submittals have been accepted, submit copies thereof for final distribution. Prints of accepted drawings transmitted for final distribution will not be further reviewed and are not to be revised. If errors are discovered during manufacture or fabrication, correct the Submittal and resubmit for review.
 - e. Following completion of the WORK and prior to final payment, furnish those drawings necessary to indicate "as constructed" conditions, including field modifications, in the number of copies specified. Furnish additional copies for insertion in equipment instruction books as required. All such copies shall be clearly marked "AS BUILT DRAWING."
 - f. WORK requiring a Compliance Submittal shall not be commenced or shipped until the Submittal has been stamped "Submittal Accepted" or "Submittal Accepted as Noted" by the DISTRICT.
 - g. Keep a copy or sample of each Compliance Submittal in good order at the Site.
4. Copies of the equipment CONTRACTOR's erection drawings and other Compliance Submittals required for the installation of equipment furnished by others under separate Contract for installation under this Contract will be transmitted to CONTRACTOR by the DISTRICT in the final distribution of such Submittals.
5. Information to MANUFACTURER's District Office: MANUFACTURERS and Suppliers of Equipment and Materials shall furnish copies of all agreements, drawings, specifications, operating instructions, correspondence, and other matters associated with this Contract to the MANUFACTURER's district office servicing the DISTRICT. Insofar as practicable, all business

matters relative to Equipment and Materials included in this Contract shall be conducted through such local district offices.

D. DISTRICT's Review:

1. The DISTRICT will review and return Compliance Submittals to CONTRACTOR with appropriate notations via the DISTRICT's EXPEDITION software. Instruction books and similar Submittals will be reviewed by the DISTRICT for general content but not for substance.
2. The DISTRICT's acceptance of Compliance Submittals will not relieve CONTRACTOR from his responsibility as stated in the Section 00700 – General Terms and Conditions.

E. Compliance Submittal Action Stamp:

1. The DISTRICT's review action stamp or designation, appropriately completed, will appear on all Compliance Submittals of CONTRACTOR when returned by the DISTRICT. Review status designations listed on DISTRICT's action stamp are defined as follows:
 - a. "ACCEPTED AS SUBMITTED": Signifies Equipment or Material represented by the Submittal conforms with the design concept and complies with the intent of the Contract Documents and is acceptable for incorporation in the WORK. CONTRACTOR is to proceed with fabrication or procurement of the items and with related WORK.
 - b. "ACCEPTED AS NOTED": Signifies Equipment and Material represented by the Submittal conforms with the design concept and complies with the intent of the Contract Documents and is acceptable for incorporation in the WORK subject to the condition that as constructed it shall be in accordance with all notations and/or corrections indicated. CONTRACTOR is to proceed with fabrication or procurement of the items and with related WORK in accordance with DISTRICT's notations.
 - c. "RETURNED FOR REVISION": Means that deviations from the requirements of the Contract Documents exist in the submittal. CONTRACTOR is to resubmit revised information responsive to DISTRICT's annotations on the returned Submittal or written in the letter of transmittal. Fabrication or procurement of items represented by the Submittal and related WORK is not to proceed until the Submittal is approved.
 - d. "NOT ACCEPTABLE (SUBMIT ANEW)": Signifies Equipment and Material represented by the Submittal does not conform with the design concept or comply with the intent of the Contract Documents and is disapproved for use in the WORK. CONTRACTOR is to resubmit Compliance Submittals responsive to the Contract Documents.
 - e. "PRELIMINARY SUBMITTAL": Signifies Submittals of such preliminary nature that a determination of conformance with the design concept or compliance with the intent of the Contract Documents must be deferred until additional information is furnished. CONTRACTOR is to submit such additional information to permit layout and related activities to proceed.
 - f. "FOR REFERENCE ONLY": Signifies Submittals which are for supplementary information only; pamphlets, general information sheets, catalog cuts, standard sheets, bulletins and similar data, all of which are useful to the DISTRICT in design, operation, or maintenance, but which by their nature do not constitute a basis for determining that items represented thereby conform with the design concept or comply with the intent of the Contract Documents. The DISTRICT reviews such Submittals for general content but not for substance.
 - g. "DISTRIBUTION COPY (PREVIOUSLY ACCEPTED)": Signifies Submittals which have been previously accepted and are being distributed to CONTRACTOR, DISTRICT, Resident Project Representative, and others for coordination and construction purposes.

F. Instruction Books / Operation & Maintenance Manuals:

1. Equipment instruction books and manuals shall be prepared by the MANUFACTURER and shall include the following:
 - a. Index and tabs
 - b. Instructions for installation, start-up, operation, inspection, maintenance, parts lists and recommended spare parts, and data sheets showing model numbers
 - c. Applicable drawings
 - d. Name of contact person, phone number, and address of the nearest authorized service facility
 - e. Attached to the above shall be a notice of the exact warranty effective dates, beginning and ending.
 - f. All additional data specified
2. Information listed above shall be submitted electronically in a PDF file format and also be bound into hard-back binders of three-ring type. Sheet size shall be 8-1/2 inches x 11 inches. Binder color shall be yellow for Electrical and Electronics and brown for Miscellaneous Equipment. Capacity shall be a minimum of 1-1/2 inches, but sufficient to contain and utilize sheets with ease.
 - a. Instruction Books/Operation & Maintenance Manuals shall contain the following:
 - i. Equipment name
 - ii. MANUFACTURER's name
 - iii. Project name
 - iv. Contract number
 - v. Reference to applicable Drawing No. & Technical Specifications Section
 - b. Format: The overall manual should be constructed around certain types of structures or equipment in the Project, and not merely assembled by technical specification section, so that all pertinent data needed by personnel to operate or maintain the equipment or structure is in one (1) manual (as far as is practical). The CONTRACTOR shall coordinate with the DISTRICT as to how the manuals are to be assembled.

G. Samples:

1. Office samples shall be of sufficient size and quantity to clearly illustrate the following:
 - a. Functional characteristics of the product, with integrally related parts and attachment devices
 - b. Full range of color, texture, and pattern

1.04 MISCELLANEOUS SUBMITTALS:

- A. Miscellaneous Submittals are comprised of technical reports, administrative Submittals, and guarantees which relate to the WORK, but do not require DISTRICT's approval prior to proceeding with the WORK. Miscellaneous Submittals may include but are not limited to (at DISTRICT's discretion):
 1. Welder qualification tests
 2. Welding procedure qualification tests
 3. X-ray and radiographic reports
 4. Field test reports
 5. Concrete cylinder test reports
 6. Certification on Materials:
 - a. Steel mill tests

- b. Paint lab tests
 - c. Cement tests
 - 7. Soil test reports
 - 8. Temperature records
 - 9. Shipping or packing lists
 - 10. Job progress schedules
 - 11. Equipment and Material delivery schedules
 - 12. Progress photographs
 - 13. Warranties and guarantees
 - 14. Fire protection and hydraulic calculations
 - 15. Surveying field notes, preliminary and final Surveyor's Reports
 - 16. Pump tests
 - 17. Traffic control plan
- B. Transmittal of Miscellaneous Submittals:
- 1. All Miscellaneous Submittals furnished by Subcontractors, MANUFACTURERS, and Suppliers shall be submitted to DISTRICT by CONTRACTOR electronically utilizing the DISTRICT's EXPEDITION software, unless otherwise specified.
 - a. Identify each miscellaneous Submittal by Project name and number, Contract title and number, and the specification section and article number marked thereon or in the letter of transmittal. Unidentifiable Submittals will be returned for proper identification.
 - b. Check and stamp Miscellaneous Submittals of Subcontractors, Suppliers, and MANUFACTURERS with CONTRACTOR's approval prior to transmitting them to the DISTRICT. CONTRACTOR's stamp of approval shall constitute a representation to the DISTRICT that CONTRACTOR has either determined and verified all information, or he assumes full responsibility for doing so, and that he has coordinated Miscellaneous Submittal with the requirements of the WORK and the Contract Documents.
 - c. At the time of each submission, call to the attention of the DISTRICT in the letter of transmittal any deviations from the requirements of the Contract Documents.
 - d. Make all modifications noted or indicated by DISTRICT and return revised prints, or copies until accepted. Direct specific attention in writing, or on revised Submittals, to changes other than the modifications called for by the DISTRICT on previous Submittals. After Submittals have been accepted, submit copies thereof for final distribution.
 - 2. Quantity Requirements:
 - a. CONTRACTOR shall provide the following documentation to the DISTRICT in addition to submitting all Miscellaneous Submittals electronically utilizing the DISTRICT's EXPEDITION software,
 - i. Technical reports except as otherwise specified: One (1) hard copy with an electronic PDF file format to DISTRICT
 - ii. Written Certificates and Guarantees: One (1) hard copy with an electronic PDF file format to DISTRICT
 - 3. Test Reports:

- a. Responsibilities of CONTRACTOR and DISTRICT regarding tests and inspections of Equipment and Materials and completed WORK are set forth elsewhere in these Contract Documents.
 - b. The party specified responsible for testing or inspection shall in each case, unless otherwise specified, arrange for the testing laboratory or reporting agency to distribute test reports in an electronic PDF file format to the following in addition to submitting test reports electronically utilizing the DISTRICT's EXPEDITION software to the DISTRICT :
 - i. DISTRICT
 - ii. Resident Project Representative
 - iii. CONTRACTOR
 - iv. MANUFACTURER or supplier
- C. DISTRICT'S Review:
1. DISTRICT will review Miscellaneous Submittals for indications of WORK or material deficiencies within fifteen (15) working days in DISTRICT's office for original Submittals and ten (10) working days for reviewing resubmittals.
 2. DISTRICT will respond to CONTRACTOR on those Miscellaneous Submittals which indicate WORK or material deficiency.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.01 SUBMITTAL LOG:

- A. CONTRACTOR shall maintain an accurate Submittal Log and a Distribution List for the duration of the WORK, showing current status of all Submittals and Distributees at all times in a form acceptable to the DISTRICT. CONTRACTOR shall make the Submittal Log available to the DISTRICT for its review on request, and shall bring a copy of the Submittal Log to all Progress Meetings.

END OF SECTION

SECTION 01310 COST LOADED CONSTRUCTION SCHEDULES

PART 1 - GENERAL

1.01 SCOPE:

- A. COST LOADED CONSTRUCTION SCHEDULE (Construction Schedule): The WORK under this Contract shall be planned, scheduled, executed, and reported by the CONTRACTOR. The CONTRACTOR shall adhere to established technical standards for CPM (Critical Path Method) scheduling using the computerized PDM (Precedence Diagram Method), unless otherwise directed by the DISTRICT. The CONTRACTOR is required to provide all Construction Schedules in electronic format.
- B. The CONTRACTOR shall submit a detailed Cost Loaded Construction Baseline Schedule (Baseline Schedule) showing all WORK required under the Contract and scheduled within the time constraints set forth under the Contract. The DISTRICT will review and comment on the Baseline Schedule submittal as per 2.03. Upon acceptance, the CONTRACTOR shall not change the accepted Baseline Schedule without prior concurrence of the DISTRICT. The Baseline Schedule shall be updated to show actual progress. Any proposed changes in the schedule activities, original duration, logic, activity constraints, other than progress, shall be incorporated into a request for a revision to the accepted Baseline Schedule and submitted for review and acceptance.
- C. The CONTRACTOR shall be responsible for coordinating its own schedules (including subcontractors) as well as the construction activities of others as required to fully execute the WORK.

1.02 SOFTWARE/INTERFACE REQUIREMENTS:

- A. The CONTRACTOR shall use the latest version of Oracle/Primavera P6 Professional Project Management (P6) for creating and updating all Construction Schedules and reports. No other scheduling software programs will be accepted.
- B. To ensure compatibility for DISTRICT asset accounting, the DISTRICT will provide Activity Codes (for all Asset and Non-asset Activities), and assist the CONTRACTOR in developing a Work Breakdown Structure (WBS) to be entered into the scheduling software as referenced in Section 2.02. The Construction Schedule (i.e. the accepted Baseline Schedule and all Schedule Updates) shall be used as the basis for payment.

1.03 QUALITY ASSURANCE:

- A. The CONTRACTOR shall perform the WORK covered by this SECTION with personnel having substantial experience in the use of the latest version of P6 scheduling software on construction projects which required the development and maintenance of the schedule throughout the Project duration.
- B. It is the responsibility of the CONTRACTOR to work with each subcontractor and supplier to obtain information pertinent to the planning and updating of their respective activities in the schedules.

1.04 DEALING WITH SUBSTITUTES:

- A. All versions of the CONTRACTOR's Construction Schedule shall be based solely on the WORK as awarded, and shall exclude any substitute proposals, even if the CONTRACTOR pursues a substitution in accordance with the provisions of the Contract.
- B. The DISTRICT's final determination on any proposed substitutions may not be made until after the CONTRACTOR's Construction Schedule is prepared and accepted. Accepted proposed substitutions shall be identified in the schedule as Change Orders.

1.05 USE OF FLOAT:

- A. Total Float is the amount of time a scheduled activity can be delayed without delaying the completion of the WORK beyond the contractually required end date. Contract Float is the number of days

between the CONTRACTOR's anticipated date for early completion of the WORK, or specified part, and the corresponding Contract Time. Total Float and Contract Float belong to the Project and are not for the exclusive benefit of any party. Contract Float and Total Float shall be available to the DISTRICT, consultants, or the CONTRACTOR to accommodate changes in the WORK or to mitigate the effect of events which may delay performance or completion. The DISTRICT will monitor and optimize the use of float for the benefit of the Project.

- B. The CONTRACTOR shall adjust or remove any float suppression techniques (e.g., preferential sequencing, out-of-sequence activity relationships, crew movements, equipment use, form reuse, extended durations, imposed dates, etc.) as a prerequisite to a request for an increase in Contract Price and/or Contract Time. Use of constraints should be minimized and require approval by the DISTRICT.

1.06 EARLY COMPLETION:

- A. An early completion schedule is one which anticipates completion of all or a specified part of the WORK ahead of the corresponding Contract Time. Since Contract and Total Floats belong to the Project, the CONTRACTOR shall not be entitled to any extension in Contract Time or recovery for any delay incurred because of extensions in an early completion date until all Contract Float is used or consumed and performance or completion of the WORK extends beyond the Contract Time. The accepted Baseline Schedule must have a single longest path with zero Total Float. Multiple longest paths are not acceptable.

1.07 NON-COMPLIANCE:

- A. The DISTRICT may refuse to recommend/authorize a progress payment in the event of the CONTRACTOR's failure, refusal or neglect to provide the required schedule information, since this will preclude the proper evaluation of the CONTRACTOR's progress. Remedies for the CONTRACTOR's failure, neglect or refusal to comply with the requirements of this SECTION are in addition, and not limited to, those provided under other sections of the Contract.

PART 2 - PRODUCTS

2.01 GENERAL CRITERIA:

- A. All Construction Schedules shall be prepared by the CONTRACTOR and reflect the CONTRACTOR's plans, means and methods, techniques and sequences for performing of the WORK.
- B. The Construction Schedules shall break down the WORK into distinct activities with interdependencies to the extent required to clearly depict the planned approach for completion of the WORK and to effectively manage the execution of the WORK.
 - 1. The Construction Schedules shall divide the WORK into manageable and logical segments and specify the progression from the Notice to Proceed (NTP) to Substantial Completion (SC) to Final Completion (FC) within Contract Time.
 - 2. The Construction Schedule is to include, at minimum, appropriate time allowances for submittals, procurement, coordination with others, construction, start-up/check-out (if applicable), operational and performance testing (if applicable), commissioning (if applicable), and Contract Close-Out.
 - 3. Site-related activities shall not reflect a combination of work located in separate structures, work corresponding to different divisions of the specifications, work performed by first and second tier subcontractors or rough-in and finish work of the same trade.
 - 4. The NTP activity shall be the first activity in the schedule and shall be a Start Milestone, with an assigned 7-day, no holiday calendar. The SC and FC activities shall be Finish Milestones, with assigned "Finish on or Before" constraints, with the Contract SC and FC dates assigned to the constraints, with a 7-day, no holiday calendar.
 - 5. Primavera Settings:
 - a. Constraints – Mandatory Starts or Finishes, Start on or Finish on and Late as Possible constraints cannot be used in the Construction Schedules.

- b. Calculation Settings – Default settings must be used, except that Critical activities must be defined as Longest Path activities.
 - c. Activity Types – Resource Dependent & WBS Summary activity types cannot be used except as directed by the DISTRICT. Most activity types will be set to Task Dependent.
 - d. Percent (%) Complete Type must be set to Duration.
 - e. Duration Type must be set to Fixed Duration & Units.
 - f. There must not be any Curve applied to an activity if the Status % Complete method is going to be used to calculate the actual cost.
6. The CONTRACTOR’s Construction Schedule shall include preparation, review and acceptance of Shop Drawings, material fabrication and material deliveries. The first submittal review and acceptance activity durations shall be fifteen (15) working days. Resubmittal review and acceptance cycles shall have activity durations of ten (10) working days. The CONTRACTOR shall include only the first submittal review and acceptance cycle for each submittal in the Construction schedule. If more than one cycle for a submittal occurs, the CONTRACTOR shall add that cycle to the schedule at the time it occurs. Additional submittal, review and acceptance cycles will require a revision to the Baseline Schedule.
- C. The CONTRACTOR shall schedule any requirements (such as submittal reviews) of the DISTRICT, the DESIGN CONSULTANT and others (performing WORK for the DISTRICT) indicated in, or required by the Contract Documents. The Construction Schedule shall incorporate appropriate activities and WORK sequences based upon the Contract Documents.

2.02 RESOURCE AND COST LOADING:

- A. Each activity in the Contract Schedule shall be assigned a dollar value in accordance with the physical value of that work in relationship to the Activity Codes/WBS. The total budget value of all activities shall equal the Contract Price. The CONTRACTOR shall also indicate the estimated duration for each construction activity.
- B. The Major Categories for the WORK being performed shall be broken down by the following Asset Templates and entered as a separate Activity Code:
- 1. **District Facilities:**
 - a. **HVAC Improvements**
 - i. **Chiller**
 - a) Pumps
 - b) Piping
 - ii. **Condensers**
 - a) Piping
 - iii. **Control Room Air Conditioning (CRAC) Units**
 - a) piping
 - iv. **Building Improvements**
- C. The WBS for the logical construction sequencing, at a minimum shall consist of the following:
- 1. General (e.g., NTP, SC, FC, General Conditions, Bonds & Insurance, Punchlist)
 - 2. Submittal Preparation
 - 3. Submittal Review and Acceptance – If there are engineering costs associated with a submittal, those costs must be approved by the DISTRICT before they can be cost loaded in the Construction Schedule. Once approved, a separate activity named “Submittal Accepted” with zero (0) days duration can be added with the cost loading applied. No payment will be made for submittals until the review and acceptance process has been completed for that submittal.
 - 4. Fabrication & Delivery - If there are costs associated with the Fabrication and Delivery, then a separate cost loaded Delivery Activity must be added with one (1) day duration, and assigned

to its appropriate Activity Code/WBS. The DISTRICT will only pay for materials once delivered and stored in a manner that complies with all the Contract Documents.

5. The WBS for the remaining construction related work shall be broken down in sufficient detail for conveying the sequence at which the CONTRACTOR intends to construct the Project.
- D. Schedules where activities are not assigned both an Activity Code and WBS will not be accepted.
- E. Cost Resource Loading:
1. A single unique resource for the cost loading of all activities shall be created in the resource dictionary.
 2. The resource type for costs shall be "Nonlabor".
 3. Cost loading of activities shall be lump sum loading of the Budgeted Cost field or Budgeted Units.
 4. Activity Costs shall be updated using the Actual Nonlabor Cost field or, if "Calculating Costs from Units", change the Duration % Complete or Remaining Duration for each activity. The Duration % Complete must match the Cost % Complete or a specific reason must be given in the narrative for this discrepancy and the DISTRICT will determine if the discrepancy is acceptable.
 5. All costs must be displayed to two (2) decimal places.
 6. The Costs for Mobilization and Demobilization activities must be equal.
- F. Financial Periods and Stored Period Performance:
1. The Financial Periods must be set for the duration of the Project and start on the first day of the month and finish on the last day of the month.
 2. "Stored Period Performance" must be used on a monthly basis in order for the "Actual This Period Nonlabor Cost" to be displayed correctly in the reports.
- G. Stored Material - For those Construction Schedule activities of WORK that will use Stored Materials, the material or equipment delivery activities related to the WORK will be cost loaded with enough money to cover the stored material. The cost loading of activities related to the work-in-place will be reduced by the amount of the stored material costs loaded into the delivery activities. The CONTRACTOR must provide a list of materials and/or equipment that will be paid for under Stored Materials prior to acceptance of the Baseline Schedule so that the DISTRICT can check for proper cost loading.
- H. If the WORK includes items covered by allowances, the CONTRACTOR shall ensure that WORK is completed within the limits of the Contract Time. The Construction Schedule shall incorporate the CONTRACTOR's best estimate of the activities and logic associated with the allowances.

2.03 COST LOADED CONSTRUCTION SCHEDULE SUBMITTAL:

- A. The Construction Schedule submittal, which refers to both the Baseline Schedule and all Schedule Updates, are to consist of the following items:
1. An electronic file containing PDF formats of all required reports and graphics, including a written narrative.
 2. An electronic backup of the Construction Schedule in Primavera P6 XER format.
 3. For Schedule Updates, a copy of the payment application is required. The Period Ending date in the DISTRICT Application for Payment must match the Data Date of the corresponding Schedule Update.
- B. The Schedule Narrative Report for the Construction Schedule shall consist of a written description of how the WORK will be accomplished in accordance with the planned Construction Schedule. The Schedule Narrative accompanying each Schedule Update shall, at a minimum, compare current progress and cost performance to the accepted baseline schedule for all milestones and activities, including longest path activities. If there are potential or actual delays, the narrative shall state the

cause of the delay and impact to the Construction Schedule and define steps that have been taken or intend to be taken to mitigate delay impacts. The CONTRACTOR shall list any proposed changes in network activities and logic that will need to be incorporated into a revision to the Baseline Schedule. The narrative shall provide sufficient detail to allow the DISTRICT to verify the progress of the WORK, compare actual versus planned activities, and identify assumptions made in scheduling work, including Change Order work. The CONTRACTOR shall direct specific attention, in writing, to adjustments or corrections made, either in response to the DISTRICT's comments on the previous submittal or otherwise. A Schedule Narrative Report must be provided for all Baseline Schedules and Schedule Updates even if there are no detailed comments for each sub-heading.

1. Schedule Narrative Report
 - a. The Schedule Narrative Report shall show the following sub-headings with detailed comments:
 - i. Progress, issues, delays, and claims
 - ii. Schedule changes, including out-of-sequence work
 - iii. Milestones
 - iv. Critical submittals and Procurement items
 - v. Response to DISTRICT Review comments from previous submittal on an item by item basis.
 - b. It shall be an electronic color PDF – 8 ½ x 11 portrait format file.
- C. Required Schedule Reports and Graphics - Bar Chart reports/P6 (plf) layouts will be provided by the DISTRICT and imported for use by the CONTRACTOR.
 1. Schedule/Leveling Report (Schedlog)
 - a. The report shall indicate software settings and calculations generated by Primavera software.
 - b. Shall be an electronic color PDF - 8 ½ x 11 portrait format file.
 2. WBS with Cash Flow Diagram (Grouped by WBS)
 - a. Bar Chart shall indicate all activities grouped by WBS and sorted by Early Start, Early Finish and Total Float.
 - b. Cash Flow Diagram shall be shown at the end of the Bar Chart, which shows budget and actual monthly bars, and cumulative curves.
 - c. Shall be an electronic color PDF - 11 x 17 landscape format file.
 3. Longest Path Bar Chart (No Grouping)
 - a. Bar Chart shall indicate all longest path activities without grouping and sorted by Early Start, Early Finish and Total Float.
 - b. Bar Chart shall be an electronic color PDF - 11 x 17 landscape format file.
 4. Pay App - Expanded (Grouped by Activity Codes)
 - a. Bar Chart shall indicate all activities grouped by Activity Codes and sorted by Activity ID.
 - b. Bar Chart shall be an electronic color PDF - 11 x 17 landscape format file.
 5. Pay App - Rollup (Grouped by Activity Codes)
 - a. Bar Chart shall indicate all activities grouped by Activity Codes rolled up per each major Activity Code. The application for payment line items must match this layout.
 - b. Bar Chart shall be an electronic color PDF - 11 x 17 landscape format file.
 6. Earned Value Report
 - a. The report shall show Earned Value information comparison between the accepted Baseline and the Current Schedule Update.
 - b. The report shall be an electronic color PDF - 11 x 17 landscape format file.

- D. Draft Schedule Reports – The following reports are to be provided prior to the formal submission of the Schedule Update and application for payment for the purpose of agreeing upon the Duration % Complete and Cost % Complete of each activity.
 - 1. WBS with Cash Flow Diagram
 - 2. Pay App - Expanded
 - 3. Longest Path
- E. Prior to each Schedule Update submittal, the DISTRICT and the CONTRACTOR will agree upon the physical progress of the WORK (Duration % Complete of each activity), and the value (Cost % Complete) of the scheduled work in place. The Duration % Complete must match the Cost % Complete, or a specific reason must be given in the Schedule Narrative Report.
- F. All documents shall show the Project ID and Name. The DISTRICT’s review shall not extend to the CONTRACTOR’s means, methods, or techniques, the correctness of which shall remain the sole responsibility of the CONTRACTOR.
- G. All schedules shall be in accordance with the Contract Time requirements of the Contract. Neither the DISTRICT’s review of the Construction Schedule, nor the DISTRICT’s statement of “Accepted As Submitted”, will relieve the CONTRACTOR from responsibility for complying with Contract Time requirements, adhering to those sequences of work indicated in or required by the Contract Documents, or from completing any omitted WORK within the Contract Time.
- H. Acceptance by the DISTRICT of the Baseline Schedule and Schedule Updates shall be a CONDITION PRECEDENT to the processing of Applications for Payment.

2.04 INITIAL AND REVISED COST LOADED CONSTRUCTION BASELINE SCHEDULE:

- A. The CONTRACTOR shall submit their Initial Cost Loaded Construction Baseline Schedule to the DISTRICT for review and acceptance within 30 calendar days after Contract Execution and prior to NTP. It will be reviewed for conformance to the requirements of the Contract Documents. If the schedule is not accepted and requires revisions, the CONTRACTOR will revise this Initial Construction Baseline Schedule and resubmit it for review and acceptance within ten (10) calendar days.
- B. Schedule Naming Structure: Once the Initial Construction Baseline Schedule is accepted, it becomes the CONTRACTOR’s Baseline Schedule Revision 0 and is the basis for monitoring the CONTRACTOR’s progress against milestones, Contract Time, and the evaluation and reconciliation of extensions in Contract Time. From then on, all activities, original durations, and their relationships may not be changed, added, or deleted without the prior approval of the DISTRICT. The CONTRACTOR’s Baseline Schedule Revision 0 must be revised when it is no longer useful as a status and control mechanism as determined by the DISTRICT. All changes must be coordinated with and approved by the DISTRICT. Contract Time (including all contracted milestones) cannot be changed without a formal Change Order approved by the DISTRICT. When a revision to the Baseline Schedule is required, a new revised Baseline Schedule shall be submitted in accordance with change procedures, for review and acceptance by the DISTRICT. Revisions to the Baseline Schedule shall follow the naming sequence listed below: (commas (“,”) or ampersands (“&”) cannot be used in the naming structure because they are recognized as commands by Primavera).

Project Name – R0A-U0	1 st Submission of Baseline Schedule.
Project Name – R0B-U0	2 nd Submission of Baseline Schedule, which is accepted.
Project Name – R1A-U0	1 st Submission of Revision to the Accepted Baseline Schedule R0B-U0, which is accepted.
Project Name – R2A-U0	1 st Submission of revised Baseline Schedule R1A-U0, which is accepted.
Project Name – R3A-U0	1 st Submission of revised Baseline Schedule R2A-U0, which is accepted.

- C. Baseline Schedule revisions shall accurately reflect all approved Change Orders including the exact duration and cost. They will be reviewed for conformance to the requirements of the Contract Documents as amended by Change Orders.
- D. Upon execution of a Change Order, a new Activity Code for that Change Order must be created. All activities associated with that Change Order will be assigned to both the new Activity Code and their corresponding WBS. Both the Application for Payment and the layout report, Pay App - Rollup, will have a line item indicating the new Change Order.
- E. The cost loading must not be changed from any Baseline Schedule Activities as a result of an executed Change Order. Original duration and logic may be changed on the Baseline Schedule Activities but the dollars amounts can only be changed by adding a new Change Order activity. This is applicable for both additive and deductive Change Orders.
- F. If a particular Scope of Work (SOW) has been deleted in a Change Order, the activity associated with that SOW must have the proper logic that causes both the new deductive Change Order Activity and the Baseline Schedule Activity to progress equally so the costs calculate correctly for that SOW.
- G. If a Baseline Schedule Activity becomes associated with a Change Order that affects its original duration or logic, then the Activity Name must include the Change Order. (e.g. ***CO#01***).
- H. If a new activity is added because of an executed Change Order both the Activity ID and the Activity Name must reflect the associated Change Order. (e.g. CO#01-A2500, Additional Silt Fence ***CO#01***).
- I. Baseline Schedule Activity ID's must not be changed or deleted.
- J. An executed Change Order may require multiple activities broken down in sufficient detail to convey the new SOW.

2.05 COST LOADED CONSTRUCTION SCHEDULE UPDATES:

- A. A Schedule Update is a copy of the accepted Baseline Schedule with progress added. Progress is Duration % Complete.
- B. The Schedule Update must be submitted by the CONTRACTOR each month with each pay application or as directed by the DISTRICT. The Schedule Update will indicate actual performed WORK and WORK forecast through Project completion. The actual schedule data shall record when WORK was performed. Forecast data will be calculated by the schedule.
- C. All out of sequence activities that originally had a finish to start relationship, but became a Start to Start or Finish to Finish relationship must be corrected in the Schedule Update. For other out of sequence relationships, a revision to the baseline is required.
- D. Each Schedule Update shall be named beginning with the Accepted Baseline Number followed by the Update number beginning with "1A" as follows:

Project Name – R0B-U1A	1 st submitted Update of the accepted Baseline R0B, which was rejected.
Project Name – R0B-U1B	Resubmittal of 1 st Update, which was accepted.
Project Name – R0B-U2A	2 nd submitted Update of the accepted Baseline R0B, which was rejected.
Project Name – R0B-U2B	Resubmittal of 2 nd Update, which was accepted.

PART 3 - EXECUTION

3.01 MONTHLY UPDATE CYCLE:

- A. Schedule Update Submittals are due every 30 days and are to be attached to each Application for Payment. The Schedule Update Total Actual Cost to Date must match the Application for Payment

WORK Completed and Stored to Date amount. The DISTRICT will advise the CONTRACTOR of any change to the due dates.

- B. See Paragraph 2.03.D for the Draft Schedule Reports that are to be provided prior to the formal submission of the Schedule Update and application for payment.

3.02 CHANGES:

- A. Within ten (10) days after a schedule problem is identified by either CONTRACTOR or DISTRICT, or at any time the percentage of the dollar value for completed work is 10 % less than the value of the scheduled WORK, the CONTRACTOR shall submit a Construction Recovery Schedule that identifies the cause of the Change and any actions required by the CONTRACTOR to recover the schedule and complete the WORK within Contract Time. The CONTRACTOR shall promptly undertake appropriate action, at no additional cost to the DISTRICT, to recover the schedule whenever the current schedule shows that the CONTRACTOR did not or cannot achieve a milestone established in the Contract.
- B. Appropriate recovery actions include, but are not limited to, assignment of additional labor, subcontractors, equipment, shift or overtime work, expediting of submittal or deliveries, or any combination of thereof. Overlapping of activities or sequencing changes shall be deemed appropriate only if properly substantiated in the submittal. Recovery plans that are accepted by the DISTRICT that add, delete, or change activities, activity relationships, durations or constraints and cost or resource loading must be submitted as a Revision to the Baseline Schedule with zero Total Float in accordance with this specification. Once the revised baseline is accepted by the DISTRICT, the CONTRACTOR must prepare a Schedule Update of the Baseline Schedule with all actuals to date and submit it for acceptance.
- C. The CONTRACTOR's refusal, failure or neglect to take appropriate recovery action or to submit a written recovery statement shall constitute reasonable evidence that the CONTRACTOR is not prosecuting the WORK, or separable part, with the diligence that will ensure its completion within the Contract Time. Such lack of action shall constitute sufficient basis for the DISTRICT to recommend the withholding of some or all of any payment due and/or shall be considered grounds for termination of the Contract by the DISTRICT in accordance with Article 15 of the General Terms & Conditions.

END OF SECTION

SECTION 01320 CONSTRUCTION VIDEO AND PHOTOGRAPHS

PART 1 - GENERAL

1.01 SCOPE:

- A. Summary of Work: This SECTION specifies administrative and procedural requirements for construction photographs.
- B. Related Work Specified Elsewhere:
 - 1. SECTION 01300 - Submittals

1.02 SUBMITTALS:

- A. Submit photographs electronically as specified in SECTION 01300 and in PART 3, this SECTION.

1.03 QUALITY ASSURANCE:

- A. Photographs and video shall be clear and sufficient to show significant detail, not blurred, or taken in shadow, nor too distant. The DISTRICT may require that the photographs or video be retaken should the quality be insufficient. Costs for such re-takes are the CONTRACTOR's responsibility at no extra cost to the DISTRICT.

PART 2 - PRODUCTS

2.01 PHOTOGRAPHIC REQUIREMENTS:

- A. Specified in PART 3, this SECTION.

PART 3 - EXECUTION

3.01 COLOR AUDIO VIDEO TAPING OF CONSTRUCTION AREA:

- A. Prior to beginning any construction, the CONTRACTOR shall prepare a color audio digital video recording of all the areas to be affected by construction
- B. The audio digital video recording shall be done within the two-week period prior to placement of materials or equipment on the construction area and furnished one week prior to the start of construction. The audio video recording shall be done with a DISTRICT Representative present.
- C. To preclude the possibility of tampering or editing in any manner, all video recordings shall, by electronic means, generate and display continuously and simultaneously on the screen digital information to include the date and time of recording. The time information shall consist of hours, minutes and seconds, separated by colons (i.e., 10:35:18).
- D. The audio video recording shall consist of one video and one audio track which shall be recorded simultaneously. All tracks shall consist of original live recordings and thus shall not be copies of other audio and video recordings. The audio track shall contain the narrative commentary.
- E. The rate of speed in the general direction of travel of the conveyance used during recording shall be controlled to provide a usable image. Panning rates and zoom-in, zoom-out rates shall be controlled sufficiently such that playback will produce clarity of the object viewed.
- F. All recording shall be done during times of good visibility. No recording shall be done during periods of visible precipitation, unless otherwise authorized by the DISTRICT.
- G. The DISTRICT shall have the authority to designate what areas may be omitted or added for audio video coverage.

- H. When conventional wheeled vehicles are used, the distance from the camera lens to the ground shall not be less than eight feet to insure perspective.
- I. In some instances, audio video coverage will be required in areas not accessible by conventional wheeled vehicles. Such coverage shall be obtained by walking or special conveyance by the DISTRICT.
- J. Areas covered shall include offsite roadways that will be subjected to heavy usage such as for haul routes or delivery of heavy components or equipment.

3.02 PROGRESS SITE PHOTOGRAPHS:

- A. The CONTRACTOR shall be responsible for photographs of the Site to show the existing and general progress of the WORK. The DISTRICT will advise as to which views are of interest. Photographs shall be taken of the following areas and at the following times.
 - 1. Existing Site conditions before Site WORK is started. Number of views shall be adequate to cover the Site.
 - 2. Progress of the WORK from beginning and throughout construction. Progress photos must be provided with each pay request. Pay requests will not be considered acceptable until photographs are provided. Number of views shall be adequate to cover the Site.
 - 3. Finished Project after completion of WORK. Number of views shall be adequate to show the finished WORK.
 - 4. If Project is not completed during the Contract Time, or authorized extensions, photographs shall continue to be taken at no increase in Contract Price.
- B. Photographs shall be taken with three (3) megapixel minimum resolution.
- C. Provide a CD containing all photographic images in JPG format. Label CD with the name and Contract number of Project, name of CONTRACTOR, description of view, and date photograph was taken.
- D. Deliver CD to DISTRICT with pay applications.

3.03 ADDITIONAL PHOTOGRAPHS:

- A. From time to time the DISTRICT may issue requests for additional photographs, in addition to periodic photographs specified. Additional photographs will be paid for by Change Order, and are not included in the Contract Price or an Allowance.
 - 1. The DISTRICT will give the photographer three (3) days' advance notice, where feasible.
 - 2. In emergency situations, the photographer shall take additional photographs within 24 hours of the DISTRICT's request.
 - 3. Circumstances that could require additional photographs include, but are not limited to:
 - a. Substantial Completion of a major phase or component of WORK.
 - b. DISTRICT's request for special publicity photographs.
 - c. Special events planned at Project Site.
 - d. Immediate follow-up when on-site events result in construction damage or losses.
 - e. Photographs to be taken at fabrication locations away from Project Site.
 - f. Extra record photographs at time of final acceptance.

END OF SECTION

SECTION 01410 TESTING AND QUALITY CONTROL

PART 1 - GENERAL

1.01 CONTRACTOR QUALITY CONTROL: The CONTRACTOR shall provide and maintain an effective quality control program that fulfills the requirements of Article 13 "*Warranty and Guarantee, Tests and Inspections, Correction, Removal or Acceptance of Defective Work*" of the GENERAL TERMS & CONDITIONS.

- A. Establish a quality control system to perform sufficient inspection of all items of Work, including that of Subcontractors, to insure conformance to the Specifications and Drawings with respect to the materials, workmanship, construction, equipment performance, and identification.
- B. The CONTRACTOR's job supervisory staff may be used for quality control, supplemented as necessary by additional personnel for surveillance or special technicians to provide capability for the controls required by the Technical Specifications. The CONTRACTOR's quality control plan must clearly identify the quality control leader and personnel organizational system. The leader must have the authority to direct the removal and replacement of work.
- C. After the Contract is awarded and before construction begins, the CONTRACTOR shall meet with the DISTRICT or its representative to discuss quality control requirements. The meeting shall develop mutual understanding relative to details of the system, including the CONTRACTOR's forms to be used for recording the quality control operations, inspections, administration of the system, and the interrelationship of CONTRACTOR and DISTRICT inspection.
- D. All compliance inspections shall be recorded on appropriate forms, including but not limited to the specific items required in each section of the Technical Specifications. Those forms, including record of corrective actions taken, shall be furnished to the DISTRICT. The DISTRICT's quality control representative shall maintain a check off list of all deficiencies which are not corrected the same day as they are discovered.
- E. Should recurring deficiencies in an item or items indicate that the quality control system is not adequate, the CONTRACTOR shall take such corrective actions as may be directed by the DISTRICT.
- F. CONTRACTOR shall submit his written quality control plan for review, describing the activities and listing those inspection and testing activities that the CONTRACTOR will perform prior to beginning the Work. The CONTRACTOR's Quality Control Plan shall describe how he will communicate timely notification to allow for test and inspection activities performed by the DISTRICT, or its representatives, for on and off-site construction activities.

1.02 TESTING LABORATORY SERVICES: All tests which require the services of a laboratory to determine compliance with the Contract Documents shall be performed by an independent commercial testing laboratory acceptable to DISTRICT. The laboratory shall be staffed with experienced technicians, properly equipped, ACI certified, and fully qualified to perform the tests in accordance with the specified standards.

1.03 TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR: Testing that the DISTRICT will coordinate and pay for is described in Section 1.04 below. All other testing laboratory services in connection with tests (which are identified as the CONTRACTOR's responsibility in the Contract Documents) shall be performed and paid for by the CONTRACTOR, and a certified copy of the results will be furnished to the DISTRICT within 5 days of the test.

The CONTRACTOR is also responsible for testing and inspection services required to achieve an effective quality control program, to assure that the work strictly complies with the contract requirements. CONTRACTOR shall pay all costs for such services. CONTRACTOR shall also pay for any tests performed by DISTRICT which do not meet Specifications, as described below.

1.04 TESTING LABORATORY SERVICES FURNISHED BY DISTRICT:

- A. The DISTRICT will secure the services of a materials testing company, for field and laboratory tests, for certain items of work. The DISTRICT shall pay all charges for services on: cast-in-place concrete, moisture density (Proctor) and relative density tests on embankment, fill and backfill materials, in-place field density tests on embankments and fills, and tests required for Grouting Beneath Structures. Field sampling and testing will be performed in the general manner indicated in the Specifications, with minimum interference with construction operations.

While the CONTRACTOR may request testing in order to proceed to a following construction stage, the DISTRICT will determine the exact time and location of field sampling and testing, and may require additional sampling and/or testing as necessary to determine that materials and equipment conform with CONTRACTOR-submitted data and with the Contract Documents.

1. DISTRICT shall be reimbursed by CONTRACTOR for the cost of any CONTRACTOR requested tests or inspections, or tests on an item purported to be ready, which fail to meet Specification requirements. DISTRICT may withhold such amounts from payments otherwise due CONTRACTOR.
- B. Arrangements for delivery of samples and test specimens to the testing laboratory under this paragraph will be made by the DISTRICT. The testing laboratory shall perform all laboratory tests within a reasonable time consistent with the specified standards and shall furnish a written report of each test.
- C. CONTRACTOR shall furnish all sample materials and cooperate in the sampling and field testing activities, interrupting the Work when necessary.
- D. When sampling or testing activities are performed in the field by testing laboratory personnel, CONTRACTOR shall furnish personnel and facilities to assist in the activities.
- E. Testing Laboratory employed by the DISTRICT will not be authorized to:
1. Release, revoke, alter or enlarge on requirements of the Contract Documents.
 2. Approve or accept any portion of the Work.
 3. Perform any duties of the CONTRACTOR.
 4. The CONTRACTOR shall provide 24 hours notice of any work for which he may desire required testing for compliance by the DISTRICT.

1.05 TRANSMITTAL OF TEST REPORTS:

- A. Written reports of test and engineering data furnished by CONTRACTOR shall be submitted as specified in SECTION 01300.

END OF SECTION

SECTION 01510 TEMPORARY UTILITIES AND FACILITIES

PART 1 - GENERAL

1.01 SUMMARY:

- A. This SECTION includes requirements of a temporary nature not normally incorporated into final WORK. It includes the following:
 - 1. Utility services
 - 2. Construction and support facilities
 - 3. Construction aids
 - 4. Fire protection
- B. Related Work Specified Elsewhere:
 - 1. SECTION 01300 – Submittals
 - 2. SECTION 01530 - Barriers and Temporary Controls
 - 3. SECTION 01590 - Field Offices and Sheds
 - 4. DIVISIONS 2 through 16

1.02 APPLICABLE STANDARDS AND PUBLICATIONS:

- A. Standards or Codes: The edition of the publications of the organizations listed below in effect at the time of the advertisement for bids form a part of this specification to the extent referenced. See the various paragraphs for the specified standard. In the case of a conflict between the requirements of this SECTION and those of the listed document, the requirements of this SECTION shall prevail.
 - 1. American National Standards Association (ANSI):
 - a. A10 Series - Safety Requirements for Construction and Demolition
 - b. ANSI/ASME PTC 19.1-1998 Test Uncertainty, Instrument and Apparatus
 - 2. National Electrical Contractors Association (NECA):
 - a. Electrical Design Library - Temporary Electrical Facilities
 - 3. National Fire Protection Association (NFPA):
 - a. NFPA 10 - Portable Fire Extinguishers
 - b. NFPA 70 - National Electrical Code
 - c. NFPA 241 - Safeguarding Construction, Alterations, and Demolition Operations
 - 4. National Electrical Manufacturers Association (NEMA)
 - 5. Underwriters Laboratories (UL)
 - 6. Florida Department of Transportation Standard Specifications for Road and Bridge Construction
 - 7. Florida Trench Safety Act (90-96, Laws of Florida)

1.03 SUBMITTALS:

- A. Submit in accordance with SECTION 01300.
- B. Site Plan: Submit to the DISTRICT a Site Plan indicating CONTRACTOR's facilities including:
 - 1. Trailers
 - 2. Equipment Yard
 - 3. Parking
 - 4. Traffic Control

1.04 QUALITY ASSURANCE:

- A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:
 - 1. Building Code requirements
 - 2. Utility company regulations
 - 3. Police, Fire Department, and rescue squad rules
 - 4. Environmental protection regulations
- B. Standards:
 - 1. Comply with NFPA 10 and 241, and ANSI A10 Series standards "Temporary Electrical Facilities."
 - 2. Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70.
- C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT:

- A. Provide new materials and equipment. If acceptable to the DISTRICT, undamaged previously used materials and equipment in serviceable condition may be used. Provide materials and equipment suitable for the use intended, of capacity for required usage, and meeting applicable codes and standards. Comply with requirements of DIVISIONS 2 through 16.
- B. Water: Provide potable water approved by local health authorities.
- C. Water Hoses: Provide 3/4-inch (19-mm), heavy-duty, abrasion-resistant, flexible rubber hoses 100 feet (30 m) long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.
- D. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120V plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.
- E. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
- F. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.
- G. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for the exposures. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.01 TEMPORARY UTILITIES:

- A. General:
 - 1. Engage the appropriate local utility company to extend temporary electric and phone service to the Project area from nearby existing utilities. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company recommendations.

2. Provide adequate utility capacity at each stage of construction. Prior to availability of temporary utilities at the Site, or in remote areas without services, provide trucked-in services as required for start-up and construction operations.
3. Furnish, install and maintain temporary utilities required for adequate construction, safety and security. Modify, relocate and extend systems as WORK progresses. Repair damage caused by installation or use of temporary facilities. Grade the areas of Site affected by temporary installations to required elevations and grades, and clean the area. Remove on completion of WORK or until service or facilities are no longer needed or are replaced by authorized use of completed permanent facilities.
4. The types of temporary construction utilities and facilities required include, but are not limited to, potable drinking water, wastewater, drainage, dewatering equipment, enclosure of WORK, ventilation, electrical power, lighting, hoisting facilities, stairs, ladders, and roads.
5. Inspect and test each service before placing temporary utilities in use. Arrange for required inspections and tests by governing authorities, and obtain required certifications and permits for use.
6. Materials used for temporary service shall not be used in the permanent system unless so specified or acceptable to the DISTRICT.

3.02 TEMPORARY ELECTRICITY AND LIGHTING:

A. New Service:

1. Arrange with utility company to extend existing electric service to temporary office trailers.
2. Connect temporary service in a manner directed by utility company officials. Provide separate meter for metering of power used by all entities authorized to be at or perform WORK at the Project Site.
3. The electric service shall be of sufficient capacity and characteristics for the various construction tools, machinery, lights, heating and air conditioning, pumps, and other tools required by CONTRACTOR and his Subcontractors. In areas of the Project where permanent or temporary power service from the local utility is not available, the CONTRACTOR shall supply and maintain engine-driven, power-generator sets.
4. Provide weatherproof, grounded, power distribution system sufficient to accommodate construction operations requiring power, use of power tools, electrical heating and lighting. Provide overload protection. Supply power for electric welding, if any, from engine-driven, power-generator sets.
5. Provide adequate artificial lighting for all areas of WORK when natural light is not adequate for WORK.
6. Sufficient light shall be provided for general construction areas, with additional sufficient lighting for specific tasks and to meet safety requirements.

B. Use of Permanent System:

1. Prior to use of permanent system to be installed by the power company for construction purposes, obtain written permission of the DISTRICT.
2. Maintain permanent system as specified for temporary facilities.

C. Costs of Installation and Operation:

1. Pay fees and charges for permits and applications.
2. Pay costs of installation, maintenance, removal of temporary services, and restoration of any permanent facilities used.
3. Pay costs of electrical power used (if applicable).
4. Pay costs of furnishing, operating, and maintaining engine-driven power-generator sets, where applicable.

3.03 TEMPORARY HEAT AND VENTILATION:

A. General:

1. Provide temporary heat, ventilation and cooling as required to maintain adequate environmental conditions in temporary office trailers and storage sheds and to facilitate progress of the WORK, to meet specified minimum conditions for the installation of materials, and to protect materials and finishes from damage. Protect from adverse affects of low temperatures or high humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
2. Methods of heating and fuel shall be suitable for particular purposes. Portable heaters shall be standard approved units with controls.

B. Costs of Installation and Operation:

1. Pay fees and charges for applications, permits, and inspections.
2. Pay costs of installation, operation, maintenance, removal of equipment, and restoration of existing or permanent facilities if used.
3. Pay cost of power and fuel used.

3.04 TEMPORARY TELEPHONE SERVICE:

A. General:

1. Arrange with local telephone service company to extend existing direct line telephone service to the CONTRACTOR's field office site for the use of construction personnel and employees.
2. Telephone Service: Local Provider.
3. Minimum Service Required:
 - a. One direct line instrument in superintendent's field office.
 - b. Adequate number of service lines and instruments for needs of trades.
 - c. Other instruments and pay telephone station(s) at the option of the CONTRACTOR, or as required by regulations.
 - d. Provide a dedicated telephone line for a fax machine in the Superintendent's field office.
4. CONTRACTOR shall arrange with local cellular/mobile telephone service company to provide mobile telephone service for use by CONTRACTOR and so CONTRACTOR can be reached throughout the entire Project area during normal working hours.

B. Costs of Installation and Operation:

1. Pay all costs for installation, maintenance and removal, and service charges for local calls. Toll charges shall be paid by the party who places the call.

3.05 TEMPORARY SANITARY FACILITIES:

A. CONTRACTOR-Furnished Facilities:

1. Furnish, install and maintain temporary sanitary facilities for use through construction period. Remove on completion of WORK.
2. Provide for all construction workers under this Contract and representatives at the Site.
3. Toilet facilities shall be of the chemical-aerated recirculation or combustion type, properly vented and fully enclosed with a glass- fiber-reinforced polyester shell or similar nonabsorbent material.

3.06 TEMPORARY CONSTRUCTION AIDS:

A. General:

1. Provide construction aids and equipment required by personnel, available for DISTRICT observers' use, and to facilitate the execution of the WORK; scaffolds, staging, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes, and other such facilities and equipment.
2. Materials may be new or used, must be suitable for the intended purpose and meet the requirements of applicable codes, regulations and standards.

3. When platform stair framing is in place, provide temporary treads, platforms, and railings for use by construction personnel.

3.07 INSTALLATION AND REMOVAL:

- A. Relocation: Relocate construction aids as required by progress of construction, by storage or WORK requirements, and to accommodate requirements of DISTRICT and other CONTRACTORS at the Site.
- B. Removal: Remove temporary materials, equipment and services when construction needs can be met and allowed by use of permanent construction, or at completion of the Project.
- C. Repair: Clean and repair damage caused by installation or by use of temporary facilities.
 1. Remove foundations and underground installations for construction aids.
 2. Grade the areas of the Site affected by temporary installations to required elevations and clean the area.

END OF SECTION

SECTION 01530 TEMPORARY BARRIERS AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes General Requirements for:
 - 1. Protection of Work
 - 2. Protection of existing property
 - 3. Barriers
 - 4. Security
 - 5. Environmental controls
 - 6. Access roads and parking areas
 - 7. Traffic control and use of roadways
- B. Related Work Specified Elsewhere:
 - 1. SECTION 02435 Turbidity Control and Monitoring

1.02 REFERENCES:

- A. Florida Department of Transportation Standard Specifications for Road and Bridge Construction (FDOT)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 SAFETY AND PROTECTION OF WORK AND PROPERTY:

- A. General:
 - 1. Provide for the protection of the Work as set forth in GENERAL TERMS & CONDITIONS. Provide protection at all times against rain, wind, storms, frost, freezing, condensation, or heat so as to maintain all Work and Equipment and Materials free from injury or damage. At the end of each day all new Work likely to be damaged shall be appropriately protected.
 - 2. Notify DISTRICT immediately at any time operations are stopped due to conditions which make it impossible to continue operations or to obtain proper results.
 - 3. Construct and maintain all necessary temporary drainage and do all pumping necessary to keep excavations, pits, and trenches dewatered sufficiently to permit continuous construction.
 - 4. Protect floors from damage by proper covering and care when handling heavy equipment, painting, or handling mortar or other such materials. Use proper cribbing and shoring to prevent overloading of floors while moving heavy equipment. Provide metal pans under pipe-threading machines and other machines that may leak oil and clean such pans daily, keeping oil off floors. Restore floors to former condition where damaged or stained.
 - 5. Concrete floors less than 28-days old shall not be loaded without written permission from DISTRICT.
 - 6. Restrict access to roofs except as required by the Work. Where access is required, provide protection with plywood, boards, or other suitable materials.

B. Property Other than DISTRICT's:

1. Provide for the protection of property as set forth in the GENERAL TERMS & CONDITIONS. Report immediately to the owners thereof and promptly repair damage to existing facilities resulting from construction operations.
2. Names and telephone numbers of representatives of the power company having jurisdiction over power lines in the Work area can be obtained from the DISTRICT. CONTRACTOR shall contact the power company a minimum of 7 calendar days prior to performing Work within 500' of power transmission line property, right-of-way or easement lines.
3. The applicable requirements specified for protection of the Work shall also apply to the protection of existing property of others.
4. Restore all property affected by CONTRACTOR's operations to the original or better condition.

3.02 BARRIERS:

A. General:

1. Furnish, install, and maintain suitable barriers as required to prevent public entry, protect the public, and to protect the Work, existing facilities, trees, and plants from construction operations. Remove when no longer needed or at completion of Work.
2. Materials may be new or used, suitable for the intended purpose, but must not violate requirements of applicable codes and standards or regulatory agencies.
3. Barriers shall be of a neat and reasonable uniform appearance, structurally adequate for the required purposes.
4. Maintain barriers in good repair and clean condition for adequate visibility.
5. Relocate barriers as required by progress of Work.
6. Repair damage caused by installation and restore area to original or better condition. Clean the area.

3.03 ENVIRONMENTAL CONTROLS:

A. Dust Control:

1. If appropriate to the site location, and at the discretion of the DISTRICT, provide positive methods and apply dust control materials to minimize raising dust from construction operations.
2. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.
3. Schedule operations so that dust and other contaminants will not fall on wet or newly-coated surfaces.
4. Cover materials transported to and from site as necessary to prevent depositing material on offsite roadways or creating dust.

B. Water and Erosion Control:

1. Provide methods to control surface water to prevent damage to the Project, the site, or adjoining properties as specified in SECTION 02435. Coordinate with on-site farming operations.
2. Plan and execute construction and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
 - a. Hold the areas of bare soil exposed at one time to a minimum.
 - b. Provide temporary control measures such as berms, dikes, and drains.

3. Control fill, grading, and ditching to direct surface drainage away from excavations and other construction areas, and to direct drainage to proper runoff.
 4. Provide, operate, and maintain hydraulic equipment of adequate capacity to control surface and ground water.
 5. Dispose of drainage water in a manner to prevent flooding, erosion, or other damage to any portion of the site or to adjoining areas.
- C. Debris Control and Clean-Up:
1. Keep the premises free at all times from accumulations of debris, waste materials, and rubbish caused by construction operations and employees. Responsibilities shall include:
 - a. Adequate trash receptacles about the site, emptied promptly when filled.
 - b. Periodic cleanup to avoid hazards or interference with operations at the site and to maintain the site in a reasonably neat condition.
 - c. The keeping of construction materials such as forms and scaffolding neatly stacked.
 - d. Immediate cleanup to protect the Work by removing splattered concrete, oil, paint, corrosive liquids, and cleaning solutions from walls, floors, and metal surfaces before surfaces are marred.
 2. Prohibit overloading of trucks to prevent spillages on access and haul routes. Provide periodic inspection of traffic areas to enforce requirements.
 3. Final cleanup is specified in SECTION 01700 Contract Closeout.
- D. Pollution Control:
1. Provide methods, means, and facilities required to prevent contamination of soil, water, or atmosphere by the discharge of hazardous or toxic substances from construction operations.
 2. Provide equipment and personnel and perform emergency measures required to contain any spillages, and to remove contaminated soils or liquids. Excavate and dispose of any contaminated earth off-site in approved locations, and replace with suitable compacted fill and topsoil.
 3. Take special measures to prevent harmful substances from entering public waters, sanitary, or storm sewers.
 4. If hazardous materials are discharged, report to authorities as required by Law or Regulations and notify DISTRICT.

3.04 TRAFFIC CONTROL AND USE OF ROADWAYS:

- A. Traffic Control:
1. Provide, operate, and maintain equipment, services, and personnel, with traffic control and protective devices, as required to expedite vehicular traffic flow on haul routes, at site entrances, on-site access roads, and parking areas. This includes barricades and other devices or personnel as necessary to adequately protect the public. Prepare and submit Traffic Control Plan to DISTRICT for acceptance.
 2. Remove temporary equipment and facilities when no longer required. Restore grounds to original, better, or specified conditions.
 3. Provide and maintain suitable detours or other temporary expedients if necessary.
 4. Bridge over open trenches where necessary to maintain traffic.
 5. Consult with governing authorities to establish public thoroughfares which will be used for site access. All operations shall meet the approval of owners or agencies having jurisdiction.

B. Maintenance of Roadways:

1. Repair off-site roads, water control and DISTRICT levees damaged by operations. Keep traffic areas as free as possible of excavated materials and maintain in a manner to eliminate dust, mud, and hazardous conditions.
2. All operations and repairs shall meet the approval of owners or agencies having jurisdiction.

3.05 SECURITY:

- A. The CONTRACTOR is solely responsible for initiating and maintaining security at the construction site. CONTRACTOR shall take all necessary precautions for the security of, and shall provide the necessary protection to:
1. Materials and equipment incorporated into the work, or stored on-site prior to incorporation into the work.
 2. Temporary field offices and sheds, and their contents including those listed in SECTION 01590.
 3. Plant and equipment including any equipment furnished for use by the DISTRICT.
- B. The CONTRACTOR shall replace, in kind, any materials or equipment lost, damaged or destroyed at its own expense.

END OF SECTION

SECTION 01580 PROJECT IDENTIFICATION AND SIGNS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes basic requirements for temporary Project identification and informational signs required during construction.
- B. Related Work Specified Elsewhere:
 - 1. SECTION 1300 Submittals.

1.02 QUALITY ASSURANCE:

- A. Design sign and structure to withstand wind and environmental conditions of locality. Provide with finish adequate to withstand weathering, fading, chipping, and peeling for duration of construction.

1.03 SUBMITTALS:

- A. Submit as specified in SECTION 01300.
- B. Includes, but not limited to, the following:
 - 1. Shop Drawings and product data as applicable.
 - 2. Show content, layout, lettering, colors, structure, and foundation.

PART 2 - PRODUCTS

2.01 IDENTIFICATION SIGNS:

- A. Project Identification:
 - 1. Construct structure and framing of wood or metal, structurally adequate to resist design requirements of locality.
 - 2. Construct sign surface of minimum 3/4-inch thickness exterior grade plywood with medium density overlay. Panels shall be of size to minimize joints. Overall size shall be 48 inches by 96 inches.
 - 3. Rough hardware shall be galvanized or aluminum.
 - 4. Coating: Paint shall suitable for outdoor applications and shall be resistant to weathering, peeling, chipping and fading. Sign colors shall be approved by the DISTRICT.
 - 5. Information Content:
 - a. Project title, logo, and name of DISTRICT as shown on Contract Documents
 - b. Names and titles of authorities
 - c. Name and title of Design Engineer
 - d. Name of prime CONTRACTOR and major Subcontractors
- B. CONTRACTOR Identification: If not part of Project identification sign, provide and install CONTRACTOR's standard sign.
- C. Design Engineer Identification: Design Engineer will provide, install and maintain his own signs.

2.02 INFORMATIONAL SIGNS:

- A. Construction:
 - 1. This includes signs for traffic, construction workers, and general public in regards to directions, warnings, hazards, locations of areas, facilities, equipment, and others of a similar nature.
 - 2. Provide signs of design, size, color, and lettering as required by regulatory agencies. Signs shall be painted metal, wood, plastic, or fiberglass and of materials suitable for the conditions in which it is placed, such as weathering and fading.
 - 3. Construct structure and framing of wood or metal, structurally adequate to resist design requirements of area of Project.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Project and Contractor Identification Sign:
 - 1. Install in a location acceptable to the DISTRICT. Install so as not to obstruct traffic or construction operations.
 - 2. Erect on framing or foundation, and rigidly brace.
 - 3. Maintain sign in good repair, in a clean and neat condition.
 - 4. Remove upon completion of Project.
- B. Informational Signs:
 - 1. Install at appropriate locations and in sufficient quantities to assure visibility. Relocate as required by progress of Work.
 - 2. Maintain signs in good repair, in a neat, clean, readable condition.
 - 3. Remove all signs, framing, supports, and foundations upon completion of Project.

END OF SECTION

SECTION 01590 FIELD OFFICES AND SHEDS

PART 1 - GENERAL

1.01 SCOPE:

- A. Summary: This SECTION includes requirements for temporary field offices and other structures for office and storage space required by CONTRACTOR and the DISTRICT.
- B. Related Work Specified Elsewhere:
SECTION 01510 - Temporary Utilities and Facilities
SECTION 01600 - Equipment and Materials
- C. Use of Existing Facilities: Existing facilities at the Site shall not be used for field offices.
- D. Use of Permanent Facilities: Permanent facilities, when substantially completed, shall not be used for field offices or for storage.

PART 2 - PRODUCTS

2.01 FIELD OFFICES:

- A. General:
 - 1. If needed, provide trailers, mobile buildings, or buildings constructed with floors raised aboveground, with steps and landings at entrance doors.
 - 2. Buildings shall be structurally sound, secure, and weathertight.
 - 3. Provide four (4) appropriate portable type fire extinguishers at each office and storage area.
 - 4. Maintain offices for duration of Contract.
 - 5. Install office spaces ready for occupancy within 30 days of the Notice to Proceed.
 - 6. Obtain any required building permits for installation of temporary field offices and sheds.
- B. CONTRACTOR's Office:
 - 1. If needed, provide a field office for CONTRACTOR's superintendent on the Site.
 - 2. Field office shall be of size required for general use, with lights, heat, furnishings, telephone service, and other necessary facilities and utilities required by CONTRACTOR's operations.

2.02 STORAGE SHEDS AND TRAILERS:

- A. On-Site:
 - 1. The CONTRACTOR shall provide temporary buildings or trailers needed for storage of Equipment and Materials installed under this Contract (and those furnished by DISTRICT or others under separate Contract).
 - 2. Provide ventilation and heating as required by Equipment and Material stored or as per MANUFACTURER's requirements.
 - 3. The CONTRACTOR shall be solely responsible for temporary buildings and trailers located on site.
- B. Off-Site:
 - 1. The CONTRACTOR shall advise the DISTRICT of any arrangements made for storage of Equipment and Materials in a place other than DISTRICT's Site. The CONTRACTOR shall furnish evidence of insurance coverage with Application for Payment in conformance with the Section 00700 - General Terms & Conditions.

PART 3 - EXECUTION

3.01 LOCATION, INSTALLATION AND MAINTENANCE:

A. General:

1. Place temporary buildings, trailers, and stored materials in locations acceptable to DISTRICT.
2. Installed field offices and sheds to resist winds and elements of the locality where installed.
3. Remove when no longer needed at the Site or when WORK is completed.
4. Keep approach walks free of leaves, mud, water, or ice.
5. At completion of WORK, remove temporary buildings and trailers, foundations (if any), utility services, and debris.
6. Prepare ground or paved areas as specified in applicable SECTIONS.

END OF SECTION

SECTION 01600 EQUIPMENT AND MATERIALS

PART 1 - GENERAL

1.01 **SUMMARY:** This section includes general requirements for Equipment and Material transportation and handling, delivery, storage, and protection of CONTRACTOR and DISTRICT - furnished Equipment and Materials.

A. Related Work:

1. SECTION 01630 Product Options and Substitutions
2. SECTION 01641 Start Up/Check Out Manufacture's Field Services for Owner Furnished Equipment
3. SECTION 01640 Start Up/Check Out/Manufacturer's Field Services for Contractor Furnished Equipment
4. SECTION 01660 Equipment and System Performance and Operational Testing
5. SECTION 01300 Submittals

1.02 **DEFINITIONS:** Definitions used in this paragraph are not intended to negate the meaning of other terms used in the Contract Documents, including such terms as "systems," "structure," "finishes," "accessories," "furnishings," "special construction," and similar terms. Such terms are self-explanatory and have recognized meanings in the construction industry.

- A. Products: Items purchased for incorporation in the Work, regardless of whether they were specifically purchased for the Project or taken from the previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and other terms of similar intent.
- B. Equipment: A product with operational or non-operational parts, regardless of whether motorized, manually operated, or fixed. Equipment may require service connections such as wiring or piping.
- C. Materials: Products that must be substantially cut, shaped, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form parts of Work.

1.03 **QUALITY ASSURANCE:**

- A. Equipment and Material Incorporated into the Work: Provide products that comply with the requirements of the Contract Documents, are undamaged, and unless otherwise indicated, are unused at the time of installation. Provide products that are complete with all accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and for the intended use and effect.
- B. Standard Products: Where they are available and comply with Specifications, provide standard products of types that have been produced and used successfully in similar situations on other projects.
- C. Continued Availability: Where, because of the nature of its application, the DISTRICT is likely to need replacement parts or additional amounts of a product at a later date, either for maintenance and repair or replacement, provide standard products for which the manufacturer has published assurances that the products and its parts are likely to be available to the DISTRICT at a later date.
1. Conform to applicable Specifications, codes, standards, and regulatory agencies.
 2. Comply with size, make, type, and quality specified, or as specifically approved in writing by the DISTRICT.
 3. Manufactured and Fabricated Products:

- a. Design, fabricate, and assemble in accordance with the best engineering and shop practices.
 - b. Manufacture like parts of duplicate units to standard sizes and gauges, to be interchangeable.
 - c. Equipment and Materials shall be suitable for service conditions intended.
 - d. Equipment capacities, sizes, and dimensions indicated or specified shall be adhered to unless variations are specifically approved in writing.
 - e. Provide labels and nameplates where required by regulatory agencies or to state identification and essential operating data.
 - f. Two or more items of the same kind shall be identical, supplied by the same manufacturer.
4. Do not use equipment and material for any purpose other than that for which it is designed or is specified.
- D. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.
- E. Identification: Each item of equipment shall have permanently affixed to it a label or tag with its equipment number designated in this contract. Marker shall be stainless steel and shall be located so as to be easily visible.

1.04 TRANSPORTATION AND SHIPMENT:

- A. Shipment Preparation: CONTRACTOR shall require manufacturers and suppliers to prepare Equipment and Materials for shipment in a manner to facilitate unloading and handling, and to protect against damage or unnecessary exposure in transit and storage, for CONTRACTOR supplied equipment. Provisions for protection shall include the following:
1. Crates or other suitable packaging materials
 2. Covers and other means to prevent corrosion, moisture damage, mechanical injury, and accumulation of dirt in motors, electrical equipment, and machinery
 3. Suitable rust-preventive compound on exposed machined surfaces and unpainted iron and steel
 4. Grease packing or oil lubrication in all bearings and similar items
 5. Precast concrete components shall be transported, lifted and stored as specified by the precast supplier. Precast supplier shall provide written instructions to the CONTRACTOR as to the above. CONTRACTOR shall provide a copy to DISTRICT.
- B. Marking: Each item of Equipment and Material shall be tagged or marked as identified in the delivery schedule or on Submittals. Complete packing lists and bills of material shall be included with each shipment. Each piece of every item need not be marked separately, provided that all pieces of each item are packed or bundled together and the packages or bundles are properly tagged or marked.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Delivery:
1. Arrange deliveries of Equipment and Materials in accordance with construction schedules, in ample time to facilitate inspection prior to installation, and to avoid delay of the Work.
 2. Deliver, store and handle Equipment and Materials in accordance with manufacturer's recommendations using means and methods that will prevent damage, deterioration, and loss, including theft.

3. Control delivery schedules to minimize long term storage at the site and to prevent overcrowding of construction spaces. In particular, coordinate delivery and installation to ensure minimum holding or storage times for items known or recognized to be flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other sources of loss.
 4. Avoid conflict with Work of DISTRICT or other contractors.
 5. Deliver Equipment and Materials to the site in manufacturer's sealed containers or other packaging system with identifying labels and instructions for handling, storing, unpacking, protecting, and installing.
 6. Mark deliveries of component parts of equipment to identify the equipment, to permit easy accumulation of parts, and to facilitate inspection and measurement of quantity or counting of units.
 7. Immediately on delivery, inspect shipment to assure:
 - a. Product complies with requirements of Contract Documents and reviewed Submittals.
 - b. Quantities are correct.
 - c. Containers and packages are intact, labels are legible.
 - d. Equipment and Materials are properly protected and undamaged.
- B. Storage:
1. Store Equipment and Materials immediately on delivery, and protect until completion of the Work. Store in accordance with manufacturer's instructions with seals and labels intact and legible.
 2. Store Equipment and Materials in a manner that will not endanger the supporting construction.
 3. Store Equipment and Materials that are subject to damage by elements in weathertight enclosures.
 4. Maintain temperature and humidity within ranges required by manufacturer.
 5. Protect motors, electrical equipment, plumbing fixtures, and machinery of all kinds against corrosion, moisture deteriorations, mechanical injury, and accumulation of dirt or other foreign matter.
 6. Protect exposed-machined surfaces and unpainted iron and steel as necessary with suitable rust-preventive compounds.
 7. Protect bearings and similar items with grease packing or oil lubrication.
 8. Handle and store steel plate, sheet metal, and similar items in a manner to prevent deformation.
 9. Exterior Storage:
 - a. Provide substantial platforms, blocking, or skids to support fabricated products aboveground; and to prevent soiling or staining. Cover products subject to discoloration or deterioration from exposure to the elements, with impervious sheet coverings. Provide adequate ventilation to avoid condensation.
 - b. Store loose granular materials on solid surface areas to prevent mixing with foreign matter.
 - c. Provide surface drainage to prevent flow or ponding of rainwater.
 10. Equipment and Materials shall not show any pitting, rust, decay, or other deleterious effects of storage prior to final acceptance of Work.
 11. 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.

- C. Handling:
 - 1. Provide equipment and personnel necessary, to unload and handle Equipment and Materials, by methods to prevent damage or soiling to Equipment and Materials, or packaging.
 - 2. Handle by methods to prevent bending or overstressing. Where lifting points are designated, lift components only at those points.
 - 3. Provide additional protection to surrounding surfaces as necessary to prevent damage.
- D. Maintenance of Storage:
 - 1. Inspect stored Equipment and Materials on a scheduled basis.
 - 2. Verify that storage facilities comply with manufacturer's product storage requirements, including environmental conditions continually maintained.
 - 3. Verify that surfaces of products exposed to elements are not adversely affected; that any weathering of finishes is acceptable under requirements of Contract Documents.
 - 4. For mechanical and electrical equipment in long-term storage, provide manufacturer's service instructions to accompany each item, with notice of enclosed instructions on exterior of package. Service Equipment on a regularly scheduled basis.
- E. Protection after installation: Provide substantial coverings as necessary to protect installed Equipment and Materials from damage from subsequent construction operations. Remove when no longer needed or as specified.

1.06 EXISTING EQUIPMENT AND MATERIALS:

- A. Equipment and Materials to be reused: For Equipment and Materials specifically indicated or specified to be reused in the Work, use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work. Arrange for transportation, storage and handling of products which require off-site storage, restoration, or renovation and pay all costs for such Work. CONTRACTOR may at his option, furnish and install new items in lieu of those specified to be reused.
- B. Equipment and Materials designated to be removed but not reused or delivered to DISTRICT, shall become the property of the CONTRACTOR and shall be removed from the site.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MANUFACTURERS:

- A. Specified in each applicable Section of Specifications

2.02 PRODUCT SELECTION AND SUBSTITUTIONS:

- A. Specified in Instructions to Bidders and General Terms & Conditions

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS:

- A. Installation:
 - 1. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions if not a part of Submittals, containers, or packaging to parties involved in the installation, including a copy to the DISTRICT.

2. Maintain one complete set of instructions at the job site during installation and until completion.
3. Handle, install, connect, clean, condition, and adjust products in accordance with such instructions and in conformance with specified requirements. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with DISTRICT for further instructions.
4. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by Contract Documents, or approved in writing by manufacturer and the DISTRICT.
5. Accurately locate and align with other Work, and anchor Equipment and Materials securely in place except as required for proper movement and performance.
6. Clean and protect exposed surfaces as necessary to ensure freedom from damage and deterioration at time of acceptance.

END OF SECTION

SECTION 01630 PRODUCT OPTIONS AND SUBSTITUTIONS

PART 1 - GENERAL

1.01 SUMMARY: This SECTION covers the DISTRICT's review procedures for CONTRACTOR's requests of acceptable substitute items of material and equipment. All requests for substitution shall be made no earlier than the Effective Date of the Contract. See Article 24 of the Instructions to the Bidders of this Contract Document. A determination of acceptability or rejection of the substitution request will be made in accordance with paragraph 6.05 of Section 00700 - General Terms and Conditions.

Requests received prior to the date established above will not be considered. Substitutions may be approved at the DISTRICT's sole discretion where one or more of the following conditions apply:

- A. The substitution must be required for compliance with final interpretation of code requirements or regulations.
- B. The substitution must be due to the unavailability of the specified products, through no fault of the CONTRACTOR.
- C. The substitution may be requested when subsequent information discloses the inability of the specified products to perform properly or to fit in the designated space.
- D. The substitution may be requested when in the judgment of the DISTRICT a substitution would be substantially to the DISTRICT's best interests in terms of cost, time or other considerations.

1.02 SUBSTITUTION REQUEST:

- A. Submit as required in SECTION 01300 - Submittals:
 - 1. Complete data substantiating compliance of the proposed substitution with the Contract Document
 - a. Product identification including MANUFACTURER's name and address
 - b. MANUFACTURER's literature including product description, performance and test data, and reference standards
 - c. Name and address of similar projects on which product was used and dates of installation
 - 2. Itemized comparison of proposed substitution with product or method specified
 - 3. Data relating to changes in the construction schedule
 - 4. Accurate cost data on proposed substitution in comparison with product or method specified
- B. In submitting the request for substitution, the CONTRACTOR makes the following representations:
 - 1. The CONTRACTOR has investigated the proposed product and has determined that it is equal or superior in all respects to that specified.
 - 2. The CONTRACTOR will provide the same warranty or guarantee for the substitution as for the product specified.
 - 3. The CONTRACTOR will coordinate installation of the accepted substitution into the WORK, making such changes as may be required for the WORK to be completed in all respects.
 - 4. The CONTRACTOR waives all claims for additional costs related to substitution that subsequently becomes apparent.
 - 5. Cost data is complete and includes all related costs under the Contract.

1.03 DISTRICT ENGINEER'S REVIEW: The DISTRICT, in evaluating the request for substitution, will consider all variations of the proposed substitute from that specified to determine the acceptability of the proposal. The DISTRICT may require the CONTRACTOR to furnish additional data about the proposed substitute necessary to make such a determination. The DISTRICT will be the sole judge of acceptability, and no substitute will be ordered or installed without the DISTRICT's prior written acceptance. The DISTRICT may require the CONTRACTOR to furnish, at the CONTRACTOR's expense, a special performance guarantee or other surety with respect to any substitute. Substitutions will not be considered if:

- A. Substitutions are indicated or implied on Shop Drawings or product data submittals without a request submitted in accordance with this SECTION.
- B. Acceptance will require substantial revision to the Contract Documents.

END OF SECTION

SECTION 01640 START UP/CHECK OUT/MANUFACTURER'S FIELD SERVICES FOR CONTRACTOR
FURNISHED EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY: This Section includes requirements of manufacturers for services to be performed at the Project site in regards to erection, start-up, and testing of equipment.

A. Related work specified elsewhere:

1. SECTION 01660 Equipment and System Performance and Operational Testing
2. SECTION 01662 Commissioning

1.02 SERVICES REQUIRED:

A. Services with Equipment and Materials Furnished Under this Contract:

1. Furnish the services of qualified field personnel from the manufacturers or suppliers of Equipment and Materials furnished and installed under this Contract, as required to perform all Manufacturer's Field Services called for in the Specifications. Field personnel shall be certified by the manufacturer of the specific product or system as having the necessary knowledge and experience to perform the required functions.
2. Where such service is specified, CONTRACTOR shall not perform any Work related to the installation or operation of Equipment and Materials furnished and installed under this Contract without direct observation and guidance of the manufacturer's or Supplier's field personnel unless DISTRICT concurs otherwise.
3. Where required, the Manufacturer's or Supplier's field personnel shall perform the following:
 - a. Observe the erection, installation, start-up and testing of equipment.
 - b. Instruct and guide CONTRACTOR in proper procedures.
 - c. Supervise the initial start-up, operational check, and any required adjustments of equipment.
 - d. Instruct DISTRICT's designated personnel in proper operation and maintenance of all equipment.
 - e. Furnish a written report to DISTRICT covering all Work done at least once each week and when Work on each item of equipment or system is completed.
4. CONTRACTOR shall provide five (5) day's notice prior to the arrival of any manufacturer's and supplier's field personnel at the site.

B. CONTRACTOR shall submit a start up/check out plan to the DISTRICT for review. Plan as a minimum will include components to be started/checked out, duration, personnel required, and details of procedures to be used.

PART 2 - PRODUCTS (Specified in applicable Sections)

PART 3 - EXECUTION

3.01 OPERATION AND TESTING:

A. Placing Equipment in Operation:

1. Place all Equipment and Materials installed under this Contract into successful operation according to instructions of the Supplier, manufacturer, or field representative, including making all required adjustments, tests, operation checks, and the following:
 - a. Cleaning, sounding, blowing-out, and flushing of lubricating oil and water systems, and other pipelines
 - b. Lubrication, fuels, supplies, power, consumables, water, and labor to be supplied by the Contractor for the duration of start up and testing, and until substantial completion of the work
 - c. Tests of lubrication system safety interlocks and system performance
 - d. Final alignment checks and measurements made under observation of the DISTRICT. Alignment checks shall include opening connections, if required, to ensure there are no abnormal stresses on equipment from pipes, ducts, or other attachments. Alignment shall be within tolerances specified by the manufacturer, and measurements shall be recorded and furnished to the DISTRICT.
 - e. Motor rotation checks before connecting couplings
 - f. Inspection of sleeve bearings for adequate contact
 - g. Checking of anchor-bolt tensions, grout and shims. Tighten anchor bolts with calibrated torque wrenches using care not to over stress bolts.
 2. After "run-in" and acceptance of alignment, and where specified, affix major equipment in place using standard tapered dowels with jack-out nuts at head end to facilitate removal.
 3. Record all above operations on forms acceptable to the DISTRICT.
 4. Furnish all necessary attendants and personnel as part of the Work to accomplish the above operations until such time as individual items, systems, equipment, or sections of the plant are acceptable for operation by DISTRICT.
 5. Provide attendants on a continuous basis as required to complete events without interruption once they have been started.
 6. CONTRACTOR shall provide lubricants for placing equipment in operation.
- B. Performance Tests:
1. Equipment and Materials Furnished Under this Contract:
 - a. DISTRICT may conduct acceptance tests after installation to determine if the Equipment and Materials installed as part of the Work perform in accordance with Contract Documents. Final acceptance of Equipment and Materials will be based on acceptable results of such tests.
 - b. No tests will be conducted on Equipment and Materials for which Manufacturer's Field Service is specified unless manufacturer's Field Representative is present and declares in writing that the Equipment and Materials are ready for such test.
 - c. The tests will be made as set forth in the Contract Documents unless the interested parties mutually agree upon some other manner of testing.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section contains requirements for the CONTRACTOR in documenting testing work required under this contract. In addition, this section contains requirements for the CONTRACTOR during installed performance testing of all mechanical, electrical, instrumentation, and HVAC equipment and systems, including structures for watertight construction, provided under this contract and all equipment furnished by the DISTRICT. This section supplements but does not supersede specific testing requirements found elsewhere in this project manual.

1.02 QUALITY ASSURANCE:

- A. CONTRACTOR's Quality Assurance Manager: The CONTRACTOR shall appoint an operations engineer or equally qualified operations specialist as Quality Assurance Manager to manage, coordinate, and supervise the CONTRACTOR's quality assurance program. The Quality Assurance Manager shall have at least 5 years of total experience, or experience on at least 5 separate projects, in managing the start-up commissioning of mechanical, electrical, instrumentation, HVAC, and piping systems. Operations Engineers shall be a graduate from a 4-year course in mechanical or civil engineering. Operations specialists shall have equivalent experience in the operation and maintenance of diesel engines, right-angle gear reducers, large drainage pumps, and standby engine generators. The quality assurance program shall include:

1. A testing plan setting forth the sequence in which all testing work required under this project manual will be implemented
2. A documentation program to record the results of all equipment and system tests
3. An installed performance testing program for all mechanical, electrical, instrumentation, and HVAC equipment and systems installed under this contract
4. A calibration program for all instruments, meters, monitors, gages, and thermometers installed under this contract
5. A calibration program for all instruments, gages, meters, and thermometers used for determining the performance of equipment and systems installed under this contract
6. A testing schedule conforming to the requirements specified in paragraph 01660-2.02 C

For the purposes of this Section, a system shall include all items of equipment, devices and appurtenances connected in such a fashion as their operation or function complements, protects or controls the operation or function of the others. The CONTRACTOR's Quality Assurance Manager shall coordinate the activities of all subcontractors and suppliers for equipment and materials supplied by both the CONTRACTOR and the DISTRICT to implement the requirements of this section.

1.03 CALIBRATION:

1. All test equipment (gages, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this contract shall be calibrated to within plus or minus 2 percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.

2. Liquid flow meters, including all open channel flow meters and all meters installed in pipelines with diameters greater than 2 inches shall be calibrated in situ using either the total count or dye dilution methods. Gas flow meters installed in piping systems with diameters greater than 6 inches shall be calibrated in situ using the pitot tube velocity averaging method. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than 10 percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus 2 percent.
- B. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ANSI/ASME B40.1-85	Gauges Pressure Indicating Dial Type--Elastic Element
ASTM E77-84	Method for Verification and Calibration of Liquid-in-Glass Thermometers
ASHRAE 41.8	Standard Methods of Measurement of Flow of Gas
Dye Dilution Calibration Method	<u>Flow Measurement in Open Channels and Closed Conduits</u> Vol. 1, U.S. Department of Commerce, National Bureau of Standards, pg. 36; <u>Techniques of Water-Resources Investigations of the United States Geological Survey</u> , Chapter 16, Measurement of Discharge Using Tracers

1.04 SUBMITTALS:

- A. Submittal material, to be submitted in accordance with SECTION 01300, shall consist of the following:
1. The CONTRACTOR's plan for documenting the results from the test program in conformance with the requirements of paragraph 01660-2.02 A, provided 8 weeks before testing is to begin, including:
 - a. Proposed plan for documenting the calibration of all test instruments
 - b. Proposed plan for calibration of all instrument systems, including flow meters and all temperature, pressure, weight, and analysis systems
 - c. Sample forms for documenting the results of field pressure and performance tests
 2. The credentials and certification of the testing laboratory proposed by the CONTRACTOR for calibration of all test equipment
 3. Preoperational check-out procedures, reviewed and approved by the respective equipment manufacturers
 4. Detailed testing plans, setting forth step-by-step descriptions of the procedures proposed by the CONTRACTOR for the systematic testing of all equipment and systems installed under this contract
 5. A schedule and subsequent updates, whenever schedule changes occur, presenting the CONTRACTOR's plan for testing the equipment and systems installed under this contract
 6. A schedule establishing the expected time period (calendar dates) when the CONTRACTOR plans to commence operational testing of the completed systems, along with a description of the temporary systems and installations planned to allow operational testing to take place

7. A summary of the Quality Assurance Manager's qualifications, showing conformance to paragraph 01660-1.02 A requirements

PART 2 - PRODUCTS

2.01 GENERAL:

- A. The CONTRACTOR shall prepare test plans and documentation plans as specified in the following paragraphs. The DISTRICT will not witness any test work for the purpose of acceptance until all test documentation and calibration plans and the specified system or equipment test plans have been submitted and accepted.

2.02 DOCUMENTATION:

- A. Documentation Plans: The CONTRACTOR shall develop a records keeping system to document compliance with the requirements of this Section. Calibration documentation shall include identification (by make, manufacturer, model, and serial number) of all test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory.

Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test and signature spaces for the DISTRICT's witness and the CONTRACTOR's Quality Assurance Manager. A separate file shall be established for each system and item of equipment. These files shall include the following information as a minimum:

1. Field calibration tests
2. Field pressure tests
3. Field performance tests
4. Field operational tests

The CONTRACTOR shall develop test documentation forms specific to each item of equipment and system installed under this contract. Acceptable documentation forms for all systems and items of equipment shall be produced for review by the DISTRICT.

- B. Test Plans: The CONTRACTOR shall develop test plans detailing the coordinated, sequential testing of each item of equipment and system installed under this contract. Each test plan shall be specific to the item of equipment or system to be tested. Test plans shall identify by specific equipment or tag number each device or control station to be manipulated or observed during the test procedure and the specific results to be observed or obtained. Test plans shall also be specific as to support systems required to complete the test work, temporary systems required during the test work, subcontractors' and manufacturers' representatives to be present and expected test duration.

As a minimum, the test plans shall include the following features:

1. Step-by-step proving procedure for all control and electrical circuits by imposing low voltage currents and using appropriate indicators to affirm that the circuit is properly identified and connected to the proper device
2. Calibration of all analysis instruments and control sensors
3. Performance testing of each individual item of mechanical, electrical, and instrumentation equipment. Performance tests shall be selected to duplicate the operating conditions described in the project manual.
4. System tests designed to duplicate, as closely as possible, operating conditions described in the project manual

Test plans shall contain a complete description of the procedures to be employed to achieve the desired test environment.

The importance of the test plan submittals is represented by the requirement to provide it as a milestone on the construction progress schedule, and as a line item in the Schedule of Values. Delivery of all test plans required for the systematic field performance and operational tests for all equipment and systems installed under this contract shall be made eight weeks in advance of the date the CONTRACTOR wishes to begin such testing. Once the DISTRICT has reviewed and taken no exception to the CONTRACTOR's test plans, the CONTRACTOR shall reproduce the plans in sufficient number for the CONTRACTOR's purposes and an additional ten copies for delivery to the DISTRICT. No test work shall begin until the CONTRACTOR has delivered the specified number of final test plans to the DISTRICT.

- C. Testing Schedule: The CONTRACTOR shall produce a testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the CONTRACTOR's construction schedule specified in SECTION 01310. The schedule shall show the contemplated start date, duration of the test and completion of each test. The test schedule shall be submitted no later than four weeks in advance of the date testing is to begin. The DISTRICT will not witness any testing work for the purpose of acceptance until the CONTRACTOR has submitted a schedule to which the DISTRICT takes no exception. The test schedule shall be updated weekly, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of this project manual.

2.03 SYSTEM AND EQUIPMENT PERFORMANCE TESTS:

- A. Each item of mechanical, electrical, instrumentation, and HVAC equipment installed under this contract shall be tested to demonstrate compliance with the performance requirements of this project manual.
- B. Each electrical, instrumentation, mechanical, piping, and HVAC system installed or modified under this contract shall be tested in accordance with the requirements of this project manual.

2.04 OPERATIONAL TESTS:

- A. Once all equipment and systems have been tested individually, the CONTRACTOR shall fill all systems with the intended process fluids sufficient to satisfy all individual component and system tests. The CONTRACTOR shall then operate all systems for a continuous period of not less than 5 days, simulating actual operating conditions to the greatest extent possible. During the operational testing period, the CONTRACTOR's Quality Assurance Manager and testing team shall monitor the characteristics of each machine and system and report any unusual conditions to the DISTRICT.

2.05 PRODUCT DATA:

- A. Records produced during the testing program shall be considered as Product Data, to be provided in accordance with SECTION 01300.

PART 3 - EXECUTION

3.01 GENERAL:

- A. The CONTRACTOR's Quality Assurance Manager shall organize teams made up of qualified representatives of equipment suppliers (for both CONTRACTOR and DISTRICT supplied equipment and materials), subcontractors, the CONTRACTOR's independent testing laboratory, and others, as appropriate, to efficiently and expeditiously calibrate and test the equipment and systems installed and constructed under this contract. The objective of the testing program shall be to demonstrate, to the DISTRICT's complete satisfaction, that the structures, systems, and equipment constructed and

installed under this contract meet all performance requirements and the facility is ready for the commissioning process to commence. In addition, the testing program shall produce baseline operating conditions for the DISTRICT to use in a preventive maintenance program.

3.02 CALIBRATION OF FIXED INSTRUMENTS:

- A. Calibration of analysis instruments, sensors, gages, and meters installed under this contract shall proceed on a system-by-system basis. No equipment or system performance acceptance tests shall be performed until instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the DISTRICT.
- B. All analysis instruments, sensors, gages, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test. All analysis instruments, sensors, gages, and meters installed under this contract shall be subject to recalibration as a condition precedent to commissioning under the provisions of SECTION 01662.

3.03 PERFORMANCE TESTS:

- A. General: Performance tests shall consist of the following:
 - 1. Pressure and/or leakage tests
 - 2. Electrical testing as specified in DIVISION 16
 - 3. Wiring and piping, individual component, loop, loop commissioning and tuning testing as described in DIVISION 15 and 16
 - 4. Preoperational checkout for all mechanical and HVAC equipment. Preoperational check-out procedures shall be reviewed and approved by the respective equipment manufacturers.
 - 5. Initial operation tests of all mechanical, electrical, HVAC, and instrumentation equipment and systems to demonstrate compliance with the performance requirements of this project manual

In general, performance tests for any individual system shall be performed in the order listed above. The order may be altered only on the specific written authorization of the DISTRICT after receipt of a written request, complete with justification of the need for the change in sequence.

- B. Pressure and Leakage Tests: Pressure and leakage tests shall be conducted in accordance with applicable portions of the Specifications. All acceptance tests shall be witnessed by the DISTRICT. Evidence of successful completion of the pressure and leakage tests shall be the DISTRICT representative's signature on the test forms prepared by the CONTRACTOR.
- C. Functional Checkout: Prior to energization (in the case of electrical systems and equipment), all circuits shall be run out and tested for continuity and shielding in accordance with the procedures required in DIVISION 16.
- D. Component Calibration and Loop Testing: Prior to energization (in the case of instrumentation system and equipment), all loops and associated instruments shall be calibrated and tested in accordance with the procedures required in DIVISIONS 13 and 16.
- E. Electrical Resistance: Electrical resistance testing shall be in accordance with DIVISION 16.
- F. Pre-Operational Tests: Preoperational tests shall include the following:
 - 1. Alignment of equipment using reverse dial indicator method
 - 2. Pre-operation lubrication
 - 3. Tests per the manufacturers' recommendations for prestart preparation and pre-operational check-out procedures
- G. Functional Tests:

1. General: Once all affected equipment has been subjected to the required preoperational check-out procedures and the DISTRICT has witnessed and has not found deficiencies in that portion of the work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the requirements of these specifications. If available, canal water may be employed for the testing of all liquid systems except gaseous, oil, or chemical systems. If not available, potable water shall be employed as the test medium. Test media for these systems shall either be the intended fluid or a compatible substitute. The equipment shall be operated a sufficient period of time to determine machine operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, the CONTRACTOR shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system at no additional cost to the DISTRICT. Disposal methods for test media shall be subject to review by the DISTRICT. During the functional test period, the CONTRACTOR shall obtain baseline operating data on all equipment with motors greater than 1 horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for the DISTRICT to enter in a preventive maintenance system.

Test results shall be within the tolerances set forth in the detailed specification sections of this project manual. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory functional test, any doubt, dispute, or difference should arise between the DISTRICT and the CONTRACTOR regarding the test results or the methods or equipment used in the performance of such test, the DISTRICT may order the test to be repeated.

If the repeat test, using such modified methods or equipment as the DISTRICT may require, confirms the previous test, then all costs in connection with the repeat test will be paid by the DISTRICT. Otherwise, the costs shall be borne by the CONTRACTOR. Where the results of any functional test fail to comply with the contract requirements for such test, then such repeat tests as may be necessary to achieve the contract requirements shall be made by the CONTRACTOR at his expense. The CONTRACTOR shall provide, at no expense to the DISTRICT, all power, fuel, compressed air supplies, water, chemicals, and any other necessary consumable item, all labor, temporary piping, heating, ventilating, and air conditioning for any areas where permanent facilities are not complete and operable at the time of functional tests, and all other items and work, required to complete the functional tests. Temporary facilities shall be maintained until permanent systems are in service.

2. Retesting: If under test, any portion of the work should fail to fulfill the contract requirements and is adjusted, altered, renewed, or replaced, tests on that portion when so adjusted, altered, removed, or replaced, together with all other portions of the work as are affected thereby, shall, unless otherwise directed by the DISTRICT, be repeated within reasonable time and in accordance with the specified conditions. The CONTRACTOR shall pay to the DISTRICT all reasonable expenses incurred by the DISTRICT, including the costs of the Engineer if applicable, as a result of repeating such tests.
3. Post-Test Inspection: Once functional testing has been completed, all machines shall be rechecked for proper alignment and realigned, as required. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the DISTRICT. All machines or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled and inspected. Any defects found during the course of the inspection shall be repaired or the specific part or entire equipment item shall be replaced to the complete satisfaction of the DISTRICT at no cost to the DISTRICT.

END OF SECTION

SECTION 01662 COMMISSIONING

PART 1 - GENERAL

1.01 SCOPE:

- A. Summary of Work: This SECTION contains requirements for the CONTRACTOR's performance prior to (i.e. operational testing period) and during the commissioning of the structures, equipment and systems constructed and installed during the course of this Contract. All WORK during the operational testing period and prior to commissioning shall be done by the CONTRACTOR.
- B. Related Work Specified Elsewhere:
 - 1. SECTION 01300 - Submittals

1.02 QUALITY ASSURANCE:

- A. Cleanup: Following completion of the operational testing period, the CONTRACTOR shall remove, clean, and replace all permanent and temporary filters and strainers in all pipeline systems; replace all HVAC (heating, ventilation and air conditioning) filters; dewater and clean all sumps; and dewater all process units for final inspection as a condition precedent to commissioning.
- B. Commissioning team: The CONTRACTOR shall assemble a commissioning team under the direction of an individual duly authorized to commit the CONTRACTOR's personnel and resources to respond to requests from the DISTRICT. The commissioning team shall consist of representatives of the CONTRACTOR's mechanical, electrical, and instrumentation subcontractors, and others as appropriate. The commissioning team shall be available at the Site of the WORK when needed. The commissioning team shall at all times be equipped and ready to provide for emergency repairs, adjustments, and corrections to the equipment and systems installed and modified as a part of this Contract.

1.03 SUBMITTALS: The following information shall be submitted to the DISTRICT in accordance with the provisions of SECTION 01300:

- A. Detailed plans for commissioning each process unit and each system constructed or modified as a part of the WORK performed under this Contract.
- B. The CONTRACTOR's commissioning team shall include a staffing plan with names, qualifications, and telephone numbers of those assigned with both daytime and off-hour standby duty.

PART 2 - PRODUCTS

- A. Working with representatives of the DISTRICT, the Engineer, and the MANUFACTURERS and suppliers of DISTRICT or CONTRACTOR Furnished Equipment and Materials, the CONTRACTOR shall develop and produce a detailed, written plan for the start-up and initial operation, under actual operating conditions, of the equipment and systems installed and constructed under this Contract. The document, after acceptance by the DISTRICT, shall serve as the guidance manual for the commissioning process.

PART 3 - EXECUTION

- A. After completion of the equipment and system performance and operational testing, where required, and agreement on the part of the DISTRICT that the systems did meet all test requirements, commissioning will begin.
- B. The CONTRACTOR shall remove all temporary piping, bulkheads, controls and other alterations to the permanent systems that may have been needed during the performance and operational testing and

shall perform the tasks necessary to make the improvements constructed under this Contract fully operational. The DISTRICT shall confirm in writing the date(s) that the system is ready for commissioning and on which actual commissioning activities commence. Activities conducted prior to such written confirmation shall not constitute commissioning.

- C. The DISTRICT's operation and maintenance personnel will be responsible for operation of the systems to be commissioned, with guidance and support by the Commissioning Team. The portion of the WORK to be commissioned shall be fully operational, performing all functions for which it was designed.
- D. The CONTRACTOR shall be available at all times during commissioning periods to provide immediate assistance in case of failure of any portion of the system being constructed.
- E. During the commissioning period, the DISTRICT shall be responsible for all normal operational costs and the CONTRACTOR shall bear the costs of all necessary repairs or replacements, including labor and materials, required to keep the portion of the plant being commissioned, operational.

END OF SECTION

SECTION 01664 TRAINING

PART 1 - GENERAL

- 1.01 DESCRIPTION: This section contains requirements for training the DISTRICT's personnel, by persons retained by the CONTRACTOR specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this contract. In addition, the CONTRACTOR shall coordinate, plan and schedule training for owner furnished equipment, as specified in Contract Documents.
- 1.02 QUALITY ASSURANCE: Where required by the detailed specifications, the CONTRACTOR shall provide on-the-job training of the DISTRICT's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers, and the CONTRACTOR will be responsible to coordinate services for Owner Furnished Equipment as well as CONTRACTOR supplied equipment. Training shall include instruction in both operation and maintenance of the subject equipment.
- 1.03 SUBMITTALS: The following information shall be submitted to the DISTRICT in accordance with the provisions of SECTION 01300. The material shall be provided as a line item on the Schedule of Values. This information shall be provided not less than 3 weeks prior to the provision of training (see also paragraph 2.03):
- A. Lessons plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
 - B. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 - PRODUCTS

- 2.01 GENERAL: Where specified, the CONTRACTOR shall conduct training sessions for the DISTRICT's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 30 days prior to the date scheduled for the individual training session. See SECTIONS 01300, 01662, and 01730.
- 2.02 LOCATION: Training sessions shall take place at the site of the work in Palm Beach County, Florida.
- 2.03 LESSON PLANS: Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.
- One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the DISTRICT and shall be suitably bound for proper organization and easy reproduction. The CONTRACTOR shall furnish ten copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.
- 2.04 FORMAT AND CONTENT: Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:
- A. Familiarization
 - 1. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.

2. Check out the installation of the specific equipment items.
 3. Demonstrate the unit and indicate how all parts of the specifications are met.
 4. Answer questions.
- B. Safety
1. Using material previously provided, review safety references.
 2. Discuss proper precautions around equipment.
- C. Operation
1. Using material previously provided, review reference literature.
 2. Explain all modes of operation (including emergency).
 3. Check out DISTRICT's personnel on proper use of the equipment.
- D. Preventive Maintenance
1. Using material previously provided, review preventive maintenance (PM) lists including:
 - a. Reference material
 - b. Daily, weekly, monthly, quarterly, semiannual, and annual jobs
 2. Show how to perform PM jobs.
 3. Show DISTRICT's personnel what to look for as indicators of equipment problems.
- E. Corrective Maintenance
1. List possible problems.
 2. Discuss repairs--point out special problems.
 3. Open up equipment and demonstrate procedures, where practical.
- F. Parts
1. Show how to use previously provided parts list and order parts.
 2. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.
- G. Local Representatives
1. Where to order parts: Name, address, telephone
 2. Service problems
 3. Who to call
 4. How to get emergency help
- H. Operation and Maintenance Manuals
1. Review any other material submitted.
 2. Update material, as required.

2.05 **VIDEO RECORDING:** The DISTRICT will record each training session. The CONTRACTOR shall advise all manufacturers providing training sessions that the material will be video taped and shall make available to the DISTRICT such utility services and accommodation as may be required to facilitate the production of the video tape recording.

PART 3 - EXECUTION

- 3.01 Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The CONTRACTOR shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Concurrent classes shall not be allowed.
- 3.02 Acceptable operation and maintenance manuals for the specific equipment shall be provided to the DISTRICT prior to the start of any training. Video taping shall take place concurrently with all training sessions.
- 3.03 The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.
- A. As a minimum, classroom equipment training for operations personnel will include:
1. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
 2. Purpose and plant function of the equipment.
 3. A working knowledge of the operating theory of the equipment.
 4. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
 5. Identify and discuss safety items and procedures.
 6. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
 7. Operator detection, without test instruments, of specific equipment trouble symptoms.
 8. Required equipment exercise procedures and intervals.
 9. Routine disassembly and assembly of equipment if applicable (as judged by the DISTRICT on a case-by-case basis) for purposes such as operator inspection of equipment.
- B. As a minimum, hands-on equipment training for operations personnel will include:
1. Identify location of equipment and review the purpose.
 2. Identify piping and flow options.
 3. Identify valves and their purpose.
 4. Identify instrumentation:
 - a. Location of primary element.
 - b. Location of instrument readout.
 - c. Discuss purpose, basic operation, and information interpretation.
 5. Discuss, demonstrate, and perform standard operating procedures and round checks.
 6. Discuss and perform the preventative maintenance activities.
 7. Discuss and perform start-up and shutdown procedures.
 8. Perform the required equipment exercise procedures.
 9. Perform routine disassembly and assembly of equipment if applicable.
 10. Identify and review safety items and perform safety procedures, if feasible.

- C. Classroom equipment training for the maintenance and repair personnel will include:
1. Theory of operation
 2. Description and function of equipment
 3. Start-up and shutdown procedures
 4. Normal and major repair procedures
 5. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings
 6. Routine and long-term calibration procedures
 7. Safety procedures
 8. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.
- D. Hands-on equipment training for maintenance and repair personnel shall include:
1. Locate and identify equipment components.
 2. Review the equipment function and theory of operation.
 3. Review normal repair procedures.
 4. Perform start-up and shutdown procedures.
 5. Review and perform the safety procedures.
 6. Perform DISTRICT approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

SECTION 01700 CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SCOPE:

- A. Summary of Work: This SECTION includes administrative and procedural requirements for Contract Closeout including, but not limited to, the following:
 - a. Inspection procedures
 - b. Project record document submittal
 - c. Operation and maintenance manual submittal
 - d. Submittal of warranties
 - e. Final cleaning
 - f. CONTRACTOR's Certification
- B. Closeout requirements for specific construction activities are included in the appropriate SECTIONS in DIVISIONS 2 through 16.
- C. Related Work Specified Elsewhere:
 - 1. SECTION 01300 - Submittals
 - 2. SECTION 01050 - Field Engineering
 - 3. SECTION 01530 – Temporary Barriers and Controls

1.02 SUBSTANTIAL COMPLETION:

- A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, the CONTRACTOR shall satisfy the following:
 - 1. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents. Submit in accordance with SECTION 01300.
 - 2. Obtain and submit releases enabling the DISTRICT unrestricted use of the WORK and access to services and utilities. Include Certificates of Occupancy (C.O.), operating certificates, and similar releases, as required.
 - 3. Submit Record Documents, maintenance manuals, Project photographs, damage or settlement surveys, property surveys, and similar record information as specified in Paragraph 1.04. All drawings shall be scanned and submitted in accordance with SECTION 01300, and in hard copy form, 24 inch by 36 inch plan size. All other documents shall also be scanned and submitted in accordance with SECTION 01300.
 - 4. The CONTRACTOR shall provide one (1) set of As-Built Drawings depicting all elevations both NAVD 88 and NGVD 29. The NGVD 29 elevation shall be italicized, bracketed and underscored. To prevent clutter, each plan sheet shall have a common note depicting the datum conversion from NAVD 88 to NGVD 29 obtained using CORPSCON 6.0.1 or most recent version.
 - 5. Provide as-built surveys of canal cross-section certified by a Professional Land Surveyor registered in the State of Florida. This includes verifying proper embankment slopes and removal of excess material.
 - 6. Complete final cleanup requirements, including touch up painting.
 - 7. Touch up and otherwise repair and restore marred, exposed finishes.
- B. Inspection Procedures: On receipt of a request for inspection, the DISTRICT will either proceed with inspection or advise the CONTRACTOR of unfilled requirements. The DISTRICT will prepare the Certificate of Substantial Completion following inspection or advise the CONTRACTOR of WORK that must be completed or corrected before the certificate will be issued.
 - 1. The DISTRICT will reschedule the inspection when in its opinion, the WORK is substantially complete.

1.03 FINAL ACCEPTANCE:

- A. Preliminary Procedures: Submit certification by CONTRACTOR that WORK has been completed in accordance with the Contract Documents to the knowledge of the CONTRACTOR. Before requesting final inspection, complete the following:
 - 1. Submit the final payment request with releases and supporting documentation. Include insurance certificates for products and completed operations where required.
 - 2. Submit a certified copy of the DISTRICT's final inspection list of items to be completed or corrected. The certified copy of the list shall state that each item has been completed.
 - 3. Submit consent of surety to final payment.
 - 4. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 - 5. Submit Release of Liens (from the Prime, and all Subcontractors, Vendors and Suppliers).
 - 6. Submit Maintenance Bond (if applicable).
 - 7. The above shall be submitted in accordance with SECTION 01300.
- B. Reinspection Procedure: The DISTRICT will reinspect the WORK upon receipt of notice that the WORK, including inspection list items from earlier inspections, has been completed.
 - 1. Upon completion of reinspection, the DISTRICT will advise the CONTRACTOR of WORK that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
 - 2. If necessary, reinspection will be repeated.
- C. Return all keys furnished by the DISTRICT. The CONTRACTOR shall forfeit his key deposit for keys that are not returned.

1.04 RECORD DOCUMENT SUBMITTALS:

- A. General: Do not use record documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for the DISTRICT's reference during normal working hours.
- B. As-Built Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Drawings and Shop Drawings. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set. Mark the set to show the actual installation where the installation varies substantially from the WORK as originally shown. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Call attention to each entry by drawing a "cloud" around the areas affected.
- C. The DISTRICT will make electronic copies of whatever electronic versions of the Drawings exist, available to the CONTRACTOR for As-Built purposes. The CONTRACTOR must obtain concurrence of the DISTRICT as to form and content of record information provided in electronic format prior to proceeding, but in general, information similar to that shown below needs to be similarly provided.
 - 1. Record information concurrently with construction progress.
 - 2. Mark record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the WORK. Mark each document "AS-BUILT DRAWINGS" in neat, large, printed letters.
 - 3. Mark as-built invert elevations for all water control structures, culverts, etc. Refer to SECTION 01050 for structures which require a permanent benchmark.
 - 4. Mark new information that is important to the DISTRICT that is not shown on Drawings or Shop Drawings.
 - 5. Note related change-order numbers where applicable.
 - 6. Include the following:

- a. Where Submittals (like Shop Drawings) are used for mark-up, record a cross-reference at corresponding location on Drawings.
 - b. Field changes of dimension and detail.
 - c. Changes made by Change Order or other Modifications.
 - d. Details not on original Contract Drawings.
 - e. As-Built shall include a plot of the actual excavation cross-sections plotted at the same station as and on top of the design cross-sections.
 - f. As-Built shall include a plot of the actual levee and embankment cross-sections plotted at the same station as and on top of the design cross-sections.
 - g. Give particular attention to concealed elements that would be difficult or expensive to locate at a later date.
 - h. GPS (global positioning system) coordinates of major structures using the format lat/long DD (decimal/degree) NAD83 (North American Datum).
7. Record Specifications: Maintain one (1) complete copy of the Contract Documents including addenda. Include with the Contract Documents one (1) copy of other written construction documents, such as Change Orders and modifications issued in printed form during construction.
8. Mark these documents to show substantial variations in actual WORK performed in comparison with the text of the Specifications and modifications.
9. Give particular attention to substitutions and selection of options and information on concealed construction that cannot otherwise be readily discerned later by direct observation.
10. Note related As-Built information and Product Data.
11. Upon completion of the WORK, submit record Specifications to the DISTRICT for the DISTRICT's records on CD in PDF format.
12. Include the following:
- a. MANUFACTURER, trade name, catalog number, and Supplier of each product and item of equipment actually installed, including optional and substitute items
 - b. Changes made by Addendum, Change Order, or other Modifications
 - c. Related Submittals
13. Affix the CONTRACTOR's corporate seal on the cover sheet indicating the documents within are representative of the as-built condition of the Project. The seal shall be signed by an officer of the company.
- D. Record Product Data: Provide one (1) copy of each Product Data submittal. Note related Change Orders and markup of Record Documents.
- 1. Mark these documents to show significant variations in actual WORK performed in comparison with information submitted. Include variations in products delivered to the Site and from the MANUFACTURER's installation instructions and recommendations.
 - 2. Give particular attention to concealed products and portions of the WORK that cannot otherwise be readily discerned later by direct observation.
- E. Record Sample Submitted: Immediately prior to Substantial Completion, the CONTRACTOR shall meet with the DISTRICT's personnel at the Project Site to determine which Samples are to be transmitted to the DISTRICT for record purposes. Comply with the DISTRICT's instructions regarding packaging, identification, and delivery to the DISTRICT.
- F. Miscellaneous Record Submittals: Refer to other Specification SECTIONS for requirements of miscellaneous record keeping and submittals in connection with actual performance of the WORK. Immediately prior to the date or dates of Substantial Completion (unless otherwise specified), complete miscellaneous records and place in good order. Identify miscellaneous records properly, bind or file, and submit to the DISTRICT for the DISTRICT's records.

- G. Warranties and Bonds: Submit original documents as specified in Section 00700 - General Terms & Conditions, Supplemental Conditions, SECTION 01300, and technical specifications.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 FINAL CLEANING:

- A. General: The General Terms & Conditions require general cleaning during construction. Regular Site cleaning is included in SECTION 01530.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with MANUFACTURER's instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion.
 - a. Clean the Site of rubbish, litter, and other foreign substances. Rake grounds that are neither paved nor planted to a smooth, even-textured surface.
 - b. Remove temporary structures, tools, equipment, supplies, and surplus materials.
 - c. Remove temporary protection devices and facilities which were installed to protect previously completed WORK.
- C. Removal of Protection: Remove temporary protection and facilities installed for protection of the WORK during construction.
- D. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the DISTRICT's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the Site and dispose of lawfully.
 - 1. Where extra materials of value remain after completion of associated WORK, they become the DISTRICT's property. Dispose of these materials of no value to the DISTRICT as directed by the DISTRICT.
- E. Repairs:
 - 1. Repair damaged protective coated surfaces.
 - 2. Repair roads and other items damaged or deteriorated because of construction operations, including those which have been damaged, but are not located within the Project limits.
 - 3. Restore all ground areas affected by construction operations.

END OF SECTION

PART 1 - GENERAL

1.01 SCOPE: Operation and Maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.

A. O&M instructions must be submitted and accepted before on-site training may start.

1.02 TYPES OF INFORMATION REQUIRED:

A. General: O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. See SECTION 01300 for details on how to prepare and submit this data. In addition, one or more of the following items of information shall be provided as applicable.

B. Operating Instructions: Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:

1. Safety Precautions: List personnel hazards for equipment and list safety precautions for all operating conditions.
2. Operator Prestart: Provide requirements to set up and prepare each system for use.
3. Start-Up, Shutdown, and Post Shutdown Procedures: Provide a control sequence for each of these operations.
4. Normal Operations: Provide control diagrams with data to explain operation and control of systems and specific equipment.
5. Emergency Operations: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.
6. Operator Service Requirements: Provide instructions for services to be performed by the operator such as lubrication, adjustments and inspection.
7. Environmental Conditions: Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or each piece of equipment and describe conditions under which equipment should not be allowed to run.

C. Preventive Maintenance: The following information shall be provided for preventive and scheduled maintenance and repair:

1. Lubrication Data: Provide the following lubrication data, other than instructions for lubrication in accordance with paragraph 2.B.6.
 - a. A table showing recommended lubricants for specific temperature ranges and applications
 - b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities
 - c. A lubrication schedule showing service interval frequency
2. Preventive Maintenance Plan and Schedule: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and

economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

- D. **Corrective Maintenance:** Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.
1. **Troubleshooting Guides and Diagnostic Techniques:** Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
 2. **Wiring Diagrams and Control Diagrams:** Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits, including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.
 3. **Maintenance and Repair Procedures:** Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.
 4. **Removal and Replacement Instructions:** Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test illustrations.
 5. **Spare Parts and Supply Lists:** Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.
 6. **Corrective Maintenance Man-Hours:** Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.
- E. **Appendices:** The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance of the product or equipment.
1. **Parts Identification:** Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.
 2. **Warranty Information:** List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.
 3. **Personnel Training Requirements:** Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.
 4. **Testing Equipment and Special Tool Information:** Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.03 TRANSMITTAL PROCEDURE:

- A. Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with SECTION 01300. Only complete sets of O&M instructions will be reviewed for acceptance.
- B. Three copies of the specified O&M information shall be provided. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment numbers it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information. Binders shall be 3-inch, D-ring, presentation type with locking mechanism and clear view vinyl cover for insertion of graphic identifying contents of binder.
- C. If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

1.04 PAYMENT:

- A. Acceptable O&M information for the project must be delivered to the DISTRICT prior to the project being 85percent complete. Progress payments for work in excess of 85 percent completion may be reduced until the specified acceptable O&M information has been delivered to the DISTRICT.

1.05 FIELD CHANGES:

- A. Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the CONTRACTOR to reflect any field changes or information requiring field date.

END OF SECTION

SECTION 02050 DEMOLITION

PART 1 - GENERAL

1.01 SCOPE:

- A. Summary of Work: The CONTRACTOR shall include the removal of existing construction as indicated on the Drawings where construction operations are to be performed as specified herein. The DISTRICT shall not be responsible for the condition of any items to be removed or salvaged.

1.02 APPLICABLE PUBLICATIONS: (Not Used)

1.03 DEFINITIONS: (Not Used)

1.04 SUBMITTALS:

A. Schedule of Demolition:

- 1. Submit proposed methods and operations of demolition for review and approval by the DISTRICT prior to the start of WORK. The CONTRACTOR shall provide protection from dust and debris contamination, excessive vibration, impact, moisture and electrical interference for all and new equipment, including, but not limited to, chillers, pumps, condensers, CRAC units, UPS's, ATS's generators, and air handlers.

B. Permits:

- 1. The CONTRACTOR shall be responsible for acquiring appropriate necessary permits for the work. Copies of the permits shall be submitted to the DISTRICT prior to commencement of demolition.

1.05 QUALIFICATIONS: (Not Used)

1.06 RESPONSIBILITIES:

- A. The CONTRACTOR shall not commence demolition of structure(s) prior to receiving written permission from the DISTRICT.

B. Condition of structures to be demolished:

- 1. The DISTRICT assumes no responsibility for actual condition of structures to be demolished.
- 2. Conditions existing at time of inspection for bidding purposes will be maintained by DISTRICT insofar as practicable.

- C. The CONTRACTOR shall remove existing components as indicated in the Drawings.

- D. Explosives: The use of explosives will not be permitted.

- E. The CONTRACTOR shall ensure the safe passage of persons around the area of demolition. The CONTRACTOR shall conduct operations to prevent injury to existing equipment, adjacent structures, other facilities, and any persons.

- 1. The CONTRACTOR shall protect existing finish work that is to remain in place from damage due to demolition operations.

F. Traffic:

- 1. The CONTRACTOR shall conduct operations and the removal of debris to ensure minimum interference with existing access roads and other adjacent, occupied or used facilities.

2. Do not close, block or otherwise obstruct access roads or other occupied or used facilities without permission from the DISTRICT.
- G. The CONTRACTOR shall promptly repair damages caused to adjacent facilities by demolition operations at no cost to the DISTRICT.
- H. Utilities Disconnection:
1. The CONTRACTOR shall perform all necessary coordination to locate, disconnect, relocate, and/or protect as needed all existing underground, aboveground, and overhead utilities within the limits of demolition prior to commencement of demolition operations. All expenses incurred for the coordination with utility companies and agencies, shall be at no cost to the DISTRICT.
 2. The CONTRACTOR shall promptly repair damages to existing utilities that are to remain, at no cost to the DISTRICT.

1.07 CERTIFICATIONS AND TESTING: (Not Used)

1.08 INSPECTION COORDINATION: The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The CONTRACTOR shall provide 48 hours advance notice of its intention to begin new WORK activities.

1.09 WARRANTY: (Not Used)

PART 2 - PRODUCTS

2.01 SALVAGE MATERIALS:

- A. (Not Used)

PART 3 - EXECUTION

3.01 DEMOLITION:

- A. The CONTRACTOR shall provide services for effective air and water pollution controls as required by local authorities having jurisdiction.
- B. The CONTRACTOR shall provide protection from dust and debris contamination, excessive vibration, impact, moisture and electrical interference for all and new equipment, including, but not limited to, chillers, pumps, condensers, CRAC units, UPS's, ATS's generators, and air handlers. Use roll filter media at fresh air intakes on Generator Building and around existing chiller and condenser coil enclosures. CONTRACTOR shall only use SFWMD electrical power from electrical circuits identified to be used by CONTRACTOR and authorized by the SFWMD representative. If no circuits are identified/authorized, CONTRACTOR shall provide all alternative power for the project.
- C. If hazardous materials are found, the CONTRACTOR shall notify the DISTRICT immediately.
- D. The CONTRACTOR shall completely backfill below-grade areas and voids resulting from demolition work. The CONTRACTOR shall provide fill consisting of approved soil, gravel or sand (free of trash and debris) and compact fill to approximate density of surrounding native soil. Structural fill shall be clean sand compacted to 97% dry density.

3.02 DISPOSAL OF DEMOLISHED MATERIALS:

- A. The CONTRACTOR shall remove debris, rubbish, and other materials resulting from demolition operations.

- B. If hazardous materials are encountered during demolition operations, the CONTRACTOR shall comply with all applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
- C. The CONTRACTOR shall transport materials removed from demolished structures and properly dispose of them at an approved site according to the State, Federal, and local regulations.

3.03 CONNECTIONS TO EXISTING CONSTRUCTION:

- A. The CONTRACTOR shall cut and remove portions of existing construction as required to allow proper installation of new construction as shown in the Drawings.
- B. The CONTRACTOR shall shore, brace and maintain existing structure(s) in a safe condition until permanent supports are completed.
- C. The CONTRACTOR shall repair all damage as a result of installation of shoring and bracing.

3.04 CLEANUP AND REPAIR:

- A. Upon completion of demolition work, the CONTRACTOR shall remove all tools, equipment, and demolished materials from site; see SECTION 1.01 and SECTION 3.02 of this specification.
- B. The CONTRACTOR shall repair demolition performed in excess of that required and return structures and surfaces to conditions existing prior to commencement of demolition work. The CONTRACTOR shall repair adjacent construction or surfaces soiled or damaged by demolition work to the satisfaction of the DISTRICT.
- C. The CONTRACTOR may not burn or dispose of any products of the demolition operation on site.
- D. The CONTRACTOR shall remove and modify components as indicated on the Drawings and not exceed the limits as indicated on the Drawings. The CONTRACTOR shall properly dispose of the material at an approved site according to the State, Federal, and local regulations.

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END OF SECTION

SECTION 02200 EARTHWORK

PART 1 - GENERAL

1.01 SCOPE:

- A. Summary of Work: The CONTRACTOR shall furnish all labor, equipment, and materials for all excavating, trenching, filling, construction of embankment, backfilling, compacting, grading, and all related items of earthwork necessary to complete the WORK indicated or specified.

1.02 APPLICABLE PUBLICATIONS:

- A. American Society of Testing Materials (ASTM):
1. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using the Standard Effort (12,400 ft-lbf/ ft³ (600 kN-m/m³)).
 2. D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
 3. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using the Modified Effort (56,000 ft-lbf/ ft³ (2,700 kN-m/m³)).
 4. D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 5. D2937 – Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
 6. D3740 – Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 7. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 8. D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 9. D4564 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sleeve Method.
 10. D4914 – Standard Test Methods for Density and Unit Weight of Soil and Rock in Place by the Sand Replacement Method in a Test Pit.
 11. D5030 – Standard Test Method for Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit.
 12. D6938 – Standard Test Method for In-place Density and Water Content of Soil and Soil-Aggregate by Nuclear Method Shallow Depth.
 13. E329 – Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
- B. Florida Department of Transportation (FDOT):
1. Standard Specifications for Road and Bridge Construction (latest edition).
- C. American Association of State Highway Transportation Officials (AASHTO):
1. AASHTO T 27 – Sieve Analysis of Fine and Course Aggregates.
 2. AASHTO T 99 - Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
- D. Florida Method (FM) of Test:
1. FM T-1 011 – Florida Method of Test for Sampling Aggregates.

1.03 DEFINITIONS:

- A. **Select Backfill:** Select backfill shall be clean, well-graded material free from debris, peat, roots, seeds of nuisance or exotic species, organic material, clods, and stones with a diameter greater than 3 inches (76 mm) in any direction. Select backfill shall have an average organic content of not more than 2%. Select backfill shall be placed where indicated on the Drawings. Select backfill is required where higher control of materials and placement is needed such as water retaining embankment cores, roadway embankments, and adjacent to structures.

Select backfill may be material excavated for the WORK (native) or may be imported. The CONTRACTOR may blend native materials to achieve a material that meets the requirements for select backfill. Select backfill shall meet the following Unified Soil Classification System (ASTM D2487) designations:

1. Levee and Water Retaining Embankments: (Not used)
2. Structure Backfill: SW, SP, SC (These are coarse-grained soils with greater than 50% by dry weight retained on a No. 200 sieve; SP and SW have less than 5% finer than a No. 200 sieve; SC has 12-50% finer than a No. 200 sieve.)

Select Backfill shall meet the following FDOT gradation limits (AASHTO T27 and FM 1-T 011):

BACKFILL GRADATION LIMITS	
SIEVE SIZE	PERCENT PASSING (%)
3 ½ inches [90 mm]	90-100
¾ inch [19 mm]	70-100
No. 4 [4.75 mm]	30-100
No. 40 [425 µm]	15-100
No. 100 [150 µm]	5-65
No. 200 [75 µm]	0-15

- B. **Random Backfill:** Random backfill shall be clean, well-graded material, that is thoroughly mixed and free from debris, clods, seeds of nuisance or exotic species, and stones with a diameter in any direction greater than those specified in the below table. Random backfill shall have an organic content of less than 5% by weight. Tighter restrictions on stone size are considered in the top layer of fill, as per subsection 3.03 F. Final Dressing of Slopes, if the area is to be seeded, sodded, or landscaped. Random backfill shall be placed where indicated on the Drawings. Random backfill is required where stable backfill is needed to maintain slopes and grades, but shall not retain water or be adjacent to structures.

Random backfill may be material excavated for the WORK (native) or may be imported. The CONTRACTOR may blend native materials to achieve a material that meets the requirements for random backfill. Random backfill shall meet the CH (inorganic clays of high plasticity) Unified Soil Classification System (ASTM D2487) designation in addition to the classifications identified for select backfill.

Random backfill shall meet the below requirements with the largest particle diameter not exceeding 0.9 of the compacted layer thickness.

RANDOM BACKFILL		
MAXIMUM PARTICLE SIZE	SURFACE DEPTH	MAXIMUM COMPACTED LIFT THICKNESS
3 ½ inches	< 12 inches	6 inches

- C. **Unclassified Fill:** Unclassified Fill may be material used to bring areas to grade where there is no potential for slope erosion and the fill will not support a structure of critical function. Unclassified backfill shall be placed where neither select backfill nor random backfill are shown on the Drawing. Unclassified Backfill shall be free from seeds of nuisance or exotic species, and will be composed of material excavated for the WORK or imported material that can be compacted to the required density.
- D. **Levee Fill Material:** (Not used)
- E. **Drain/Filter Sand:** (Not used)
- F. **Unified Soil Classification System (USCS):** USCS is a two-letter classification system used to describe the texture and grain size of a soil. In the USCS system, letters are representative as follows: G stands for gravel, S stands for sand, M stands for silt, C stands for clay, O stands for organic, P stands for poorly graded, W stands for well graded, H stands for high plasticity, and L stands for low plasticity.
- G. **Chimney Drain:** (Not used)
- H. **Blanket Drain:** (Not used)
- I. **Core:** (Not used)
- J. **Excavation:** Excavation shall be the removal of all materials within the defined configuration to the limits of excavation shown on the Project Drawings, excluding stripping material.
- K. **Unsuitable Fill:** Soil that does not meet the requirements for fill (or backfill) addressed thus far in this SECTION shall be considered unsuitable fill soil.
- L. **Cohesive materials:** (Not used)

1.04 **SUBMITTALS:** (Not used)

1.05 **QUALIFICATIONS:**

- A. **Geotechnical Testing Agency Qualifications:** The CONTRACTOR will engage and pay for an independent testing agency qualified according to ASTM E 329 to perform Quality Control. This Quality Control involves conducting soil materials and rock-definition testing during earthwork operations, as documented according to ASTM D 3740.
- B. **Earthwork Contractor Qualifications:** The CONTRACTOR shall use an adequate number of skilled laborers and installers who are thoroughly trained and have a minimum of 5 years of successful experience in the necessary crafts and are completely familiar with the code requirements, the contract provisions, and the methods needed for the proper performance of the WORK of this SECTION. The CONTRACTOR shall employ the adequate resources and equipment necessary to successfully perform the WORK of this SECTION on schedule.

1.06 **RESPONSIBILITIES:**

- A. The CONTRACTOR shall excavate any material encountered to the depth and grades required, shall backfill such excavations as required, and shall dispose of excess or unsuitable materials from

excavation as approved by the DISTRICT. The CONTRACTOR shall provide and place necessary borrow material to properly backfill excavations as indicated on the Drawings, specified herein, or as directed by the DISTRICT.

- B. Excavation, dewatering, sheeting, and bracing required shall be carried out so as to prevent any possibility of undermining or disturbing the foundations of any existing structure or WORK, and so that all WORK may be accomplished and inspected in the dry, except as directed by the DISTRICT. Aqueous construction may be performed only with prior written approval of the DISTRICT. Excavation and backfilling shall be in accordance with SECTION 02200 - Excavation and Backfilling.
 - C. The CONTRACTOR shall furnish the services of a State of Florida licensed land surveyor for the field layout of all work indicated or specified in this section. The CONTRACTOR'S licensed land surveyor shall perform all initial site layout and shall provide follow-up verification of all work underway at a frequency of no less than once a week.
- 1.07 CERTIFICATIONS AND TESTING: CONTRACTOR shall furnish, at his own expense, all field density testing required to establish and maintain individual Quality Control (QC) processes required or specified in this SECTION. Field density tests shall be in accordance with ASTM Standards (some referenced herein) appropriate to each type of material used in backfilling. Failure to meet the specified density will require the CONTRACTOR to recompact and retest, at his own expense, those areas directed by the DISTRICT.
- 1.08 INSPECTION COORDINATION: The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The CONTRACTOR shall provide 48 hours advanced notice of his intention to begin new WORK activities.
- 1.09 WARRANTY:
- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this SECTION against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of SECTION 00700 - General Terms and Conditions.
 - B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of SECTION 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

- 2.01 MATERIALS ENCOUNTERED:
- A. The CONTRACTOR shall consider all materials encountered in excavations as suitable for use in random fill, provided that they consist of two or more well-graded soils and achieve the required compaction as specified in this SECTION.
 - B. The CONTRACTOR shall consider all materials encountered, regardless of type, character, composition and condition thereof unclassified other than as indicated in Article 1.03 Definitions. The CONTRACTOR shall estimate the quantity of various materials included prior to submitting the Bid Form. Rock encountered shall be handled by the CONTRACTOR at no additional cost to DISTRICT.

PART 3 - EXECUTION:

- 3.01 SITE PREPARATION:
- A. Clearing and Demolition: The CONTRACTOR shall perform clearing and demolition as specified in SECTION 02110 - Clearing and Land Preparation and SECTION 02050 - Demolition.

- B. Levee Roads: The CONTRACTOR shall place and compact a 6 inch thick by 14 foot wide layer of lime rock or shell rock gravel along the entire top length of the perimeter and intermediate levees to create the levee road and meet the design grade.

3.02 EXCAVATION AND TRENCHING:

- A. Trenching for Pipes: The CONTRACTOR shall perform trenching for pipes as shown, required, and specified in accordance with SECTION 02221 - Trenching, Backfilling and Compacting,
- B. Excavation for Structures: The CONTRACTOR shall perform excavation for structures as shown, required and specified below:
 - 1. Excavate area adequate to permit efficient erection and removal of forms.
 - 2. Trim to neat lines where details call for concrete to be deposited against earth.
 - 3. Excavate by hand in areas where confined space and access restricts the use of machines.
 - 4. Notify the DISTRICT immediately when excavation has reached the depth indicated on plans.
 - 5. Restore bottom of excavation to proper elevation with concrete in areas that are over excavated.
 - 6. Conform to the requirements of SECTION 02221 – Trenching, Backfilling, and Compacting.
- C. Canal Excavation: (Not used)
- D. Canal Cleaning: (Not used)
- E. Excavation of Existing Levees and Embankments: (Not used)
- F. Cross-Sections: For pay quantity and record purposes, the Contractor shall submit field measured cross-sections as required by the DISTRICT.

3.03 EMBANKMENT: (Not used)

3.04 BACKFILLING:

- A. Pipe Embedment and Backfill: The CONTRACTOR shall perform pipe embedment and backfill as required, shown, and specified in accordance with SECTION 02221 - Trenching, Backfilling and Compacting.
- B. Structure Backfill: The CONTRACTOR shall place structural backfill in accordance with the lines, grades, and cross-sections shown in the Drawings or as ordered by the DISTRICT. The CONTRACTOR shall backfill using select fill. Stones or rocks greater than 2 inches (51 mm) in any dimension shall not be placed within 12 inches of the structure. Lifts shall not exceed 12 inches. The following procedures shall be adhered to:
 - 1. Structure backfill shall be compacted to not less than 95% maximum dry density as measured by ASTM D1557.
 - 2. Backfill shall not be placed against fresh concrete without the approval of the DISTRICT. Once approved, backfill only after concrete has attained at least 70% design strength. Backfill adjacent to structures only after a sufficient portion of the structure has been built to resist the imposed load.
 - 3. Remove all debris from excavation prior to placement of material.
 - 4. Place backfill in level layers of thickness within the compacting ability of equipment used.
 - 5. Perform backfilling simultaneously on all sides of structures. For walls, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall.

- C. Unclassified Backfill: The CONTRACTOR shall ensure that unclassified backfill be placed in 12 inch loose lifts to the lines and grades shown on the Drawings or as approved by the DISTRICT. The CONTRACTOR shall compact unclassified backfill to a density approximating the density of surrounding native material and in a manner that will prevent settlement of the completed area.

3.05 MAINTENANCE:

- A. The CONTRACTOR shall protect newly graded areas from actions of the elements.
- B. The CONTRACTOR shall fill, repair, and re-establish grades to the required elevations and slopes for any area that shows settling or erosion occurring prior to seeding.

END OF SECTION

SECTION 02221 TRENCHING, BACKFILLING AND COMPACTING

PART 1 - GENERAL

1.01 SCOPE: The CONTRACTOR shall furnish all labor, materials and equipment necessary for complete and proper trenching, backfilling and compacting as specified herein.

1.02 APPLICABLE PUBLICATIONS:

A. American Society of Testing Materials (ASTM):

1. D698 - Standard Test Methods for Laboratory compaction Characteristics of Soil Using the Standard Effort (12,400 ft-lbf/ ft³ (600 kN-m/m³))
2. D1557 - Standard Test Methods for Laboratory compaction Characteristics of Soil Using the Modified Effort (56,000 ft-lbf/ ft³ (2,700 kN-m/m³))
3. D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
4. D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

B. Florida Department of Transportation (FDOT):

1. Standard Specifications for Road and Bridge Construction, latest edition, (FDOT)

C. Miscellaneous Project Data:

1. Subsurface soil data logs are provided for the CONTRACTOR'S reference:

1.03 DEFINITIONS: (Not Applicable)

1.04 SUBMITTALS: (Not Applicable)

1.05 QUALIFICATIONS: (Not Applicable)

1.06 RESPONSIBILITIES:

A. The CONTRACTOR shall make all excavations for piping and appurtenant structures in any material encountered to the depth and grades required, shall backfill such excavations and dispose of excess or unsuitable materials from excavation, and shall provide and place necessary borrow material to properly backfill excavations, all as indicated on the drawings, specified herein, or as directed by the DISTRICT.

B. Excavation, dewatering, sheeting and bracing required shall be carried out so as to prevent any possibility of undermining or disturbing the foundations of any existing structure or work, and so that all work may be accomplished and inspected in the dry, except as directed by the DISTRICT. Aqueous construction may be performed only with prior approval of the DISTRICT.

1.07 CERTIFICATIONS AND TESTINGS: (Not Applicable)

1.08 INSPECTION COORDINATION: The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The CONTRACTOR shall provide 48 hours notice of its intention to begin new WORK activities.

1.09 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 MATERIALS: The CONTRACTOR shall furnish materials as required to complete the Work under this Section.

PART 3 - EXECUTION

3.01 EXTENT OF OPEN EXCAVATION: The CONTRACTOR shall perform the excavation such that at any time the amount of excavation open will be held to a minimum consistent with normal and orderly prosecution of the work, or as restricted by permit conditions.

3.02 CUTTING PAVEMENT: When excavations are required in paved areas the CONTRACTOR shall conform to the following.

- A. When excavations are to be made in paved surfaces, the pavement shall be cut ahead of the excavation by means of suitable sharp tools to provide a uniform sharp edge with minimum disturbance of remaining materials.
- B. Asphalt paving and other improvements in the right-of-way and on other private property affected by this construction shall be duly protected and, where disturbed, shall be restored or replaced to meet original conditions.

3.03 TRENCH EXCAVATION: The CONTRACTOR shall perform trench excavation in accordance with the following.

- A. All excavation for piping shall be open cut. Trench sides shall be approximately vertical between an elevation of one foot above the top of the pipe and the centerline of the pipe; otherwise, trench sides shall be as vertical as possible or as required. Trenches may be excavated by machinery to a depth that will not disturb the finish grade.
- B. Trench width shall be as narrow as practical and shall not be widened by scraping or loosening material from the sides.

3.04 EXCAVATION BELOW NORMAL GRADE:

- A. In the event the CONTRACTOR through error or carelessness excavates below the elevation required, the CONTRACTOR shall at his own expense backfill with selected gravel and compact to obtain a suitable pipe bedding all as directed and to the satisfaction of the DISTRICT.
- B. In the event unstable or unsuitable bedding material is encountered at or below the pipe bedding level, the CONTRACTOR shall remove such material and replace it with suitable compacted material.

3.05 BACKFILLING TRENCHES:

- A. The CONTRACTOR shall be responsible for obtaining the necessary inspections before, during and after backfilling and shall re-excavate, refill and perform all such related work to obtain satisfactory test results.

- B. The CONTRACTOR shall use excavated materials classified as embankment fill for backfilling and such grading on the site as is required. The CONTRACTOR shall dispose of any excess fill or unstable material in areas approved by the DISTRICT. Pipe trenches shall be backfilled with fine, loose embankment fill (see SECTION 02220, paragraph 2.02), free from large stones, carefully deposited on both sides of pipe and thoroughly and carefully rammed until enough fill has been placed to provide a cover of at least one foot above the pipe. The remainder of the backfill material may then be thrown in and tamped. Water settling may be permitted. The CONTRACTOR shall submit written request detailing the need to perform water settling and reasons why work in the dry is not possible. The CONTRACTOR shall also submit detailed procedures for the review and approval of the DISTRICT. Whenever trenches have not been properly filled, or if settlement occurs, they shall be refilled, smoothed off and finally, made to conform to the surface of the ground. Backfilling shall be carefully performed and the surface restored to the elevation shown on the plans. In unpaved areas the surface of trenches shall conform and be equal to quality, character and material of the surface immediately prior to making the excavation.
- C. Place earth embedment as follows:
1. With level bottom layer at proper grade to receive and uniformly support pipe barrel throughout its length.
 2. Form shallow depression under each joint to facilitate jointing.
 3. Add second layer simultaneously to both sides of the pipe with care to avoid displacement of the pipe.
 4. Place material in maximum 12-inch lifts.

- 3.06 BACKFILLING OF TRENCH UNDER SLABS AND AREAS TO BE PAVED: The CONTRACTOR shall place material in 12-inch maximum layers after filling one foot above pipe as previously described. Each layer shall be compacted to 95 percent maximum dry density as measured by ASTM D1557 so that pavement can be placed promptly. Any pavement cut or area disturbed by this work shall be replaced to match existing.
- 3.07 BACKFILLING OF TRENCH OPEN AREAS: The CONTRACTOR shall place material in 12-inch maximum lifts after filling one foot above pipe as previously described. The top one-foot layer shall be compacted to 90 percent maximum dry density as measured by ASTM D1557. Each layer shall be compacted to the density of adjacent soils. Restore the surface to original grade and place sod or seed as required by the contract documents.

END OF SECTION

SECTION 03100 CONCRETE FORMWORK AND ACCESSORIES

PART 1 - GENERAL

1.01 SCOPE: The CONTRACTOR shall provide all labor, materials and equipment for the following:

1. Design and construction of all necessary formwork including the required bracing, supports, scaffolding, shoring, and other falsework to produce cast-in-place concrete in the finished structure within the required tolerances for line, grade dimension and detail.
2. Joints in concrete, complete and in place, in accordance with the Contract Documents. Joints in concrete structures shall be the types defined below and will be permitted only where indicated, unless specifically accepted by the DISTRICT.
3. Provide formwork and accessories as required, as indicated in the Drawings and as specified herein including providing backing rod and joint filler between existing concrete and new cast-in-place beam at north-east and south-east corners of chillers enclosure.
4. All penetrations through existing reinforced concrete for chilled water pipes shall be oversized to accommodate 1-1/2" cementitious mortar cover over all steel reinforcing. All penetrations through existing EOC reinforced concrete for refrigerant piping shall not cut existing steel reinforcing and shall provide 1-1/2" existing concrete cover over all steel reinforcing.

1.02 APPLICABLE PUBLICATIONS: The following standard specifications shall apply to the WORK of this SECTION:

- A. American Concrete Institute (ACI)
 1. ACI 347 - Recommended Practice for Concrete Formwork
 2. ACI 117 - Standard Tolerances for Concrete Construction and Materials
- B. American Society of Testing and Materials (ASTM)
 1. A775 - Epoxy Coated Reinforcing Steel Bars
 2. C920 - Elastomeric Joint Sealant
 3. D412 - Standard Test Method for Vulcanized Rubber and Thermoplastic Elastomers - Tension
 4. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
 5. D638 - Standard Test Method for Tensile Properties of Plastics
 6. D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
 7. D747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
 8. D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber
 9. D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
 10. D2000 - Standard Classification System for Rubber Products in Automotive Applications
 11. D2240 - Standard Test Method for Rubber Property - Durometer Hardness
 12. D2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
- C. US Product Standards (PS)
 1. PS-1 - Construction and Industrial Plywood for Concrete Forms

2. PS-20 - American Softwood Lumber Standard
- D. NSF International
 1. NSF 61 - Drinking Water System Components - Health Effects
- E. United States Army Corps of Engineers (USACE)
 1. CRD-C572 - PVC Waterstops
- F. Federal Specifications
 1. TT-S-0227 E(3) - Sealing Compound, Elastomeric Type, Multicomponent, for Caulking, Sealing, and Glazing Buildings and Other Structures
- G. Occupational Safety and Health Association (OSHA)
 1. CFR Title 29 Part 1926 - Safety and Health Regulations for Construction

1.03 DEFINITIONS:

- A. Construction Joints:
 1. When fresh concrete is placed against a hardened concrete surface, the joint between the two pours is called a construction joint.
- B. Contraction Joints:
 1. Contraction joints are similar to construction joints except that the fresh concrete shall not bond to the hardened surface of the earlier pour, which shall be coated with a bond breaker. The slab reinforcement shall be stopped 4-1/2 inches from the joint, which is provided with a sleeve-type dowel, to allow shrinkage of the concrete of the later pour.
- C. Expansion Joints:
 1. To allow the concrete to expand freely, a space is provided between the two pours, and the joint shall be formed as indicated. The space is obtained by placing a filler joint material against the earlier pour, to act as a form for the later pour.
 2. Premolded expansion joint material shall be installed with the edge at the indicated distance below or back from finished concrete surface, and shall have a slightly tapered, dressed, and oiled wood strip secured to or placed at the edge thereof during concrete placement, which shall later be removed to form space for sealing material.
 3. The space so formed shall be filled with a joint sealant material as indicated herein. In order to keep the two walls or slab elements in line the joint shall also be provided with a sleeve-type dowel as indicated.
- D. Control Joints:
 1. The function of the control joint is to provide a weaker plane in the concrete, where shrinkage cracks will probably occur. A groove, of the shape and dimensions indicated, is formed or saw-cut in the concrete. This groove is afterward filled with a joint sealant material.

1.04 SUBMITTALS:

- A. Falsework Calculations and Drawings: The CONTRACTOR shall submit calculations and drawings prepared and sealed by a Professional Civil Engineer registered in the State of Florida, which indicate the falsework complies with the requirements of OSHA Title 29, Part 1926.703. The submission of design details and calculations for falsework is for information only.

- B. The plans of falsework proposed to be used shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions.
- C. The CONTRACTOR shall submit placement drawings showing the location and type of all joints for each structure.
- D. The CONTRACTOR shall submit MANUFACTURER's information demonstrating compliance with requirements for the following:
 - 1. Form ties and related accessories, including taper tie plugs, if taper ties are used
 - 2. Form gaskets
 - 3. Form release agent, including NSF certification if not using mineral oil
 - 4. List of form materials and locations for use
 - 5. Bearing Pads
 - 6. Neoprene Sponge
 - 7. Preformed Joint Filler
 - 8. Backing Rod
 - 9. Bond Breaker
 - 10. Slip Dowels
 - 11. PVC Tubing

1.05 QUALIFICATIONS: (Not used)

1.06 RESPONSIBILITIES: The CONTRACTOR is fully responsible for the design and construction of all forms and falsework to be in compliance with all applicable OSHA requirements, and the requirements of all agencies having jurisdiction on the project. The submission of design details and calculations for falsework is for information only.

1.07 CERTIFICATIONS:

- A. Form materials, which may remain or leave residues on or in the concrete, shall be certified as compliant with NSF 61.
- B. Joint materials shall be certified as compliant with NSF 61.
- C. The CONTRACTOR shall submit certified test reports from the sealant MANUFACTURER on the actual batch of material being supplied indicating compliance with requirements herein before the sealant is used on the job.

1.08 INSPECTIONS:

- A. Falsework shall be inspected for conformance with the accepted submittal. No workers will be allowed to use falsework for access and no concrete placement to related forms will be permitted until the falsework is inspected by the CONTRACTOR for conformance with the submittals and appropriately tagged. No variations or alterations to falsework, as compared to the reference submittal, will be allowed without certification of the variation by the original Professional Engineer.
- B. The following waterstop defects represent a partial list of defects which shall be grounds for rejection: (not used)

1.09 WARRANTY:

- A. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 FORM AND FALSEWORK MATERIALS:

- A. Except as otherwise expressly accepted by the DISTRICT, lumber brought on the Site for use as forms, shoring, or bracing shall be new material. Forms shall be smooth surface forms and shall be of the following materials:
- Walls - Steel, fiberglass, or plywood panel
 - Columns - Steel, plywood, PVC, fiberglass, or spiral wound fiber forms
 - Roof and floor - Plywood
 - All other work - Steel panels, fiberglass, or plywood
- B. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:
1. Plywood shall be new, waterproof, synthetic resin bonded, exterior type, manufactured especially for concrete formwork and shall conform to Plyform Class I, B-B EXT, of PS-1, and shall be edge sealed.
 2. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with PS 20.
 3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade indicated. Metal forms shall accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO EXT Grade.
- C. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to 1/2-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.
- D. Forms and falsework to support the roof and floor slabs shall be designed in accordance with ACI 347.

2.02 FORM TIES:

- A. Ties shall be standard crimped snap ties with one-inch (1") snapback. Ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming.
- B. Removable taper ties may be used when approved by the DISTRICT. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie.

2.03 FORM RELEASING AGENT:

- A. Form release agent shall be non-staining and shall leave no residues on or in the concrete unless certified as compliant with NSF 61 and shall not adversely affect the adhesion of paint or other coatings.

2.04 WATERSTOPS: (Not used)

2.05 JOINT MATERIALS:

- A. Bearing Pad: (Not used)
- B. Neoprene Sponge: (Not used)
- C. Joint Filler
 - 1. Joint filler for expansion joints in waterholding structures: (Not used)
 - 2. Joint filler material in other locations shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752, for Type I, except as otherwise indicated.

2.06 BACKING ROD:

- A. Backing rod shall be an extruded closed-cell, polyethylene foam rod. The material shall be compatible with the joint sealant material and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at eight (8) psi. The rod shall be 1/8-inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.07 BOND BREAKER:

- A. Bond breaker shall contain a fugitive dye so that areas of application will be readily distinguishable.
- B. Bonding agent for hydrophilic waterstop shall be the MANUFACTURER's recommended adhesive for wet, rough concrete.

2.08 SLIP DOWELS:

- A. Slip dowels in joints shall be smooth epoxy-coated bars, conforming to ASTM A 775.

2.09 PVC TUBING:

- A. PVC tubing in joints shall be Schedule SDR 13.5, conforming to ASTM D 2241.

2.10 CHAMFER STRIP:

- A. Provide three quarter inch triangular fillets, milled clear straight grained wood, surfaced each side, or extruded vinyl type, with or without nail flange to form all exposed concrete edges such as columns, pilasters, beams, curbs, equipment pads, tops of walls, and as indicated. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4" chamfers. Re-entrant corners in concrete members shall not have fillets, unless otherwise indicated.

PART 3 - EXECUTION

3.01 FORMS:

- A. Forms shall conform to the shape, lines, and dimensions as shown on the Drawings and shall be substantial and sufficiently tight to prevent leakage. Forms shall be properly braced or tied so as to maintain position and shape. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the DISTRICT and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.

- B. The CONTRACTOR shall be fully responsible for the adequacy of the formwork in its entirety and any forms that are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced. The CONTRACTOR shall provide worker protection from protruding reinforcement bars in accordance with applicable safety codes.
- C. The CONTRACTOR may reuse forms only if in good condition and only if acceptable to the DISTRICT. Reused forms shall be thoroughly cleaned and may require light sanding between uses to obtain a uniform surface texture on all exposed concrete surfaces. Forms shall not be reused if they have developed defects that would affect the surface texture of exposed concrete. Exposed concrete surfaces are defined as surfaces, which are permanently exposed to view.
- D. Forms shall be sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.
- E. Immediately before the placing of reinforcing, faces of all forms in contact with concrete shall receive a thorough coating of form release agent. Any excess agent shall be satisfactorily removed before placing concrete. If using mineral oil, the CONTRACTOR shall oil the forms at least two weeks in advance of their use. Care shall be exercised to keep oil/release agent off the surfaces of steel reinforcement and other items to be embedded in concrete.
- F. The CONTRACTOR shall supply sufficient number of forms of each kind to permit the required rate of progress to be maintained.
- G. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations.

3.02 WATERSTOPS: (Not used)

3.03 SPLICES IN PVC WATERSTOPS: (Not used)

3.04 FORM DESIGN:

- A. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete.
- B. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement, and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1- to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form.
- C. The CONTRACTOR shall provide adequate clean-out holes at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the DISTRICT. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of SECTION 03300. The size, number, and location of such form windows shall be as acceptable to the DISTRICT.

3.05 FORM CONSTRUCTION:

- A. Vertical Surfaces: All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the

indicated thickness of a concrete member, where concrete is permitted to be placed against trimmed ground, in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

- B. Construction Joints: Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the DISTRICT. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.
- C. Form Ties
 - 1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties, which cause spalling of the concrete upon form stripping or tie removal, will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.
 - 2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls, which are dry on both sides. Exposed faces of walls shall have the outer 2 inches of the exposed face filled with a cement grout, which shall match the color and texture of the surrounding wall surface.

3.06 JOINT CONSTRUCTION:

- A. Setting Waterstops: (Not used)
- B. Joint Location:
 - 1. Construction joints and other types of joints shall be provided where indicated. When not indicated, construction joints shall be provided at 25-foot maximum spacing for all concrete construction. Where joints are indicated spaced greater than 40 feet apart, additional joints shall be provided to maintain the 25-foot maximum spacing. The location of all joints, of any type, shall be submitted for acceptance by the DISTRICT.
- C. Joint Preparation:
 - 1. The CONTRACTOR shall take special care in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required. Unless otherwise indicated, such bonding will be required at all horizontal joints in walls. Surfaces shall be prepared in accordance with the requirements of SECTION 03300.
- D. Retrofit Joint Preparation:
 - 1. Existing surfaces to receive a retrofit waterstop shall be clean and free from any loose or foreign material. Surface shall be given a light sandblast or hydroblast finish to 1/8-inch amplitude prior to application of epoxy and waterstop.
- E. Construction Joint Sealant:

1. Construction joints in water-bearing floor slabs, and elsewhere as indicated, shall be provided with tapered grooves which shall be filled with a construction joint sealant. The material used for forming the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant. After removing the forms from the grooves, all laitance and fins shall be removed, and the grooves shall be sandblasted. The grooves shall be allowed to become thoroughly dry, after which they shall be blown out; immediately thereafter, they shall be primed, bond breaker tape placed in the bottom of the groove, and filled with the construction joint sealant. The primer shall be furnished by the sealant MANUFACTURER. No sealant will be permitted to be used without a primer. Care shall be used to completely fill the sealant grooves. Areas designated to receive a sealant fillet shall be thoroughly cleaned, as outlined for the tapered grooves, prior to application of the sealant.
2. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the MANUFACTURER, taking special care to properly mix the sealant prior to application. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the sealant. Sealant shall achieve final cure at least 7 days before the structure is filled with water.
3. Sealant shall be installed by a competent waterproofing specialty contractor who has a successful record of performance in similar installations.
4. Thorough, uniform mixing of 2-part, catalyst-cured materials is essential; special care shall be taken to properly mix the sealer before its application. Before any sealer is placed, the CONTRACTOR shall arrange to have the crew doing the WORK carefully instructed on the proper method of mixing and application by a representative of the sealant MANUFACTURER.
5. Any joint sealant which fails to fully and properly cure after the MANUFACTURER's recommended curing time for the conditions of the WORK hereunder shall be completely removed; the groove shall be thoroughly sandblasted to remove all traces of the uncured or partially cured sealant and primer, and shall be re-sealed with the indicated joint sealant. Costs of such removal, joint treatment, re-sealing, and appurtenant WORK shall be the CONTRACTOR's responsibility.

F. Hydrophilic Waterstop

1. Where a hydrophilic waterstop is called for in the Contract Documents, it shall be installed with the MANUFACTURER's instructions and recommendations except as modified herein.
2. When requested by the DISTRICT, the CONTRACTOR shall arrange for the MANUFACTURER to furnish technical assistance in the field.
3. Hydrophilic waterstop shall only be used where complete confinement by concrete is provided. Hydrophilic waterstop shall not be used in expansion or contraction joints or in the first 6 inches of any non-intersecting joint.
4. The hydrophilic waterstop shall be located as near as possible to the center of the joint and it shall be continuous around the entire joint. The minimum distance from the edge of the waterstop to the face of the member shall be 5 inches.
5. Where the thickness of the concrete member to be placed on the hydrophilic waterstop is less than 12 inches, the waterstop shall be placed in grooves formed or ground into the concrete. The groove shall be at least 3/4 inch deep and 1-1/4 inches wide. When placed in the groove, the minimum distance from the edge of the waterstop to the face of the member shall be 2.5 inches.
6. Where a hydrophilic waterstop is used in combination with PVC waterstop, the hydrophilic waterstop shall overlap the PVC waterstop for a minimum of 6 inches and shall be adhered to PVC waterstop with single component water-swelling sealant as recommended by MANUFACTURER.

7. The hydrophilic waterstop shall not be installed where the air temperature falls outside the MANUFACTURER's recommended range.
8. The concrete surface under the hydrophilic waterstop shall be smooth and uniform. The concrete shall be ground smooth if needed. Alternately, the hydrophilic waterstop shall be bonded to the surface using an epoxy grout which completely fills all voids and irregularities beneath the waterstop material. Prior to installation, the concrete surface shall be wire brushed to remove any laitance or other materials that may interfere with the bonding of epoxy.
9. The hydrophilic waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing. This shall be in addition to the adhesive recommended by the MANUFACTURER.

3.07 REMOVAL OF FORMS:

- A. Careful procedures for the removal of forms shall be strictly followed, and this WORK shall be done with care so as to avoid injury to the concrete or workers. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28-day strength (0.75f_c) in SECTION 03300. No forms shall be disturbed or removed under an individual panel or unit before the concrete in all the adjacent panels or units have attained 0.75f_c strength and have been in place for a minimum of 7 days. The time required to establish said strength shall be determined by the DISTRICT, who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7-day minimum, then that time shall be used as the minimum length of time.
- B. Forms for parts of the WORK not specifically mentioned herein shall remain in place for periods of time as recommended in ACI 347.

3.08 FALSEWORK:

- A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of all falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements herein.
- B. The CONTRACTOR shall design and construct falsework to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.
- C. The CONTRACTOR shall place falsework upon a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall be as recommended by the CONTRACTOR's geotechnical engineer and shall not exceed 20 tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

3.09 TOLERANCES:

- A. The variation from plumb, level and required lines shall not exceed 1/4-inch in any ten feet (10') of length, non cumulative, and there shall be no offsets or visible waviness in the finished surface. All other tolerances shall be within the tolerances of ACI 117 - Standard Tolerances for Concrete Construction and Materials.

END OF SECTION

SECTION 03200 CONCRETE REINFORCEMENT

PART 1 - GENERAL

- 1.01 SCOPE: The CONTRACTOR shall furnish all labor, materials and equipment to provide and properly place all concrete reinforcement steel, welded wire fabric, couplers, and concrete inserts for use in the reinforced concrete and masonry construction and all appurtenant work, including all the wires, clips, supports, chairs, spacers, and other accessories as shown on the drawings and as specified herein. All penetrations through existing reinforced concrete for chilled water pipes shall be oversized to accommodate 1-1/2" cementitious mortar cover over all steel reinforcing. All penetrations through existing EOC reinforced concrete for refrigerant piping shall not cut existing steel reinforcing and shall provide 1-1/2" existing concrete cover over all steel reinforcing.
- 1.02 APPLICABLE PUBLICATIONS: The most recent revision of the following standard specifications shall apply to the WORK of this SECTION:
- A. American Concrete Institute (ACI):
 - 1. ACI 318 - Building Code Requirements for Reinforced Concrete
 - 2. ACI SP-66 - Detailing Manual
 - B. American Society of Testing and Materials (ASTM):
 - 1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
 - 2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
 - C. Concrete Reinforcing Steel Institute (CRSI):
 - 1. Recommended Practice for Placing Reinforcing Bars
 - D. Florida Building Code, Latest Edition
- 1.03 DEFINITIONS: (Not Used)
- 1.04 SUBMITTALS: The CONTRACTOR shall submit the following:
- A. Mill Certifications of Grade 60 reinforcing steel or stainless steel, as required
 - B. Complete bar schedule, bar details and erection drawings in conformance with ACI SP-66
 - C. Mill certificates shall be delivered with each shipment of reinforcing bars.
- 1.05 QUALIFICATIONS: (Not Used)
- 1.06 RESPONSIBILITIES: (Not Used)
- 1.07 CERTIFICATIONS:
- A. International Code Council Evaluation Service (ICC-ES) Certifications for mechanical couplers, if allowed
 - B. Mill Certifications of Grade 60 reinforcing steel
- 1.08 INSPECTION COORDINATION:
- A. The CONTRACTOR shall provide sufficient notice and opportunity to the DISTRICT to review the placement of the reinforcing steel before the concrete is placed. The CONTRACTOR shall provide

access to the WORK for the DISTRICT as requested for inspection. The CONTRACTOR shall provide 48 hours advance notice of its intention to begin new WORK activities.

1.09 WARRANTY:

- A. The CONTRACTOR shall warrant the WORK against defects for one (1) year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 REINFORCING BARS:

- A. Metal reinforcement shall be deformed type bars conforming to ASTM A615, Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, Grade 60, unless otherwise specified. Reinforcing steel shall be fabricated for the shapes and dimensions indicated on the Drawings and in compliance with ACI 318. All bars shall be bent cold.
- B. Replace all reinforcement with bends and kinks not shown on fabrication Shop Drawings. Remove from job site all such reinforcing and replace with new fabricated steel. Field bending of reinforcement at the work site is prohibited.
- C. Welded wire fabric reinforcement shall conform to the requirements of ASTM A185, and the details indicated. Do not use fabric that has been rolled. Install flat sheets only.
- D. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A82.
- E. Mechanical couplers shall be provided where indicated and where approved by the DISTRICT. The couplers shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be provided. This shall apply to all mechanical splices, including those splices intended for future connections. Reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

2.02 ACCESSORIES: All chairs and bolsters shall conform to ACI SP-66 and the CRSI Manual of Standard Practices and shall have galvanized or plastic legs.

PART 3 - EXECUTION

3.01 PLACEMENT AND ANCHORAGE:

- A. Bar supports shall be spaced in accordance with CRSI.
 - 1. Reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers that are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. Concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties that are embedded in the blocks. For concrete over formwork, the CONTRACTOR shall provide concrete, metal, plastic, or other acceptable bar chairs and spacers.
 - 2. Limitations on the use of bar support materials shall be as follows.

- a. Concrete Dobies: permitted at all locations except where architectural finish is required.
 - b. Wire Bar Supports: permitted only at slabs over dry areas, interior non-hydraulic wall surfaces, and exterior wall surfaces.
 - c. Plastic Bar Supports: permitted at all locations except on grade.
- B. Reinforcement shall be accurately placed in accordance with the Drawings and shall be adequately secured in position with not less than 16-gauge annealed wire. The placement tolerances shall be in accordance with ACI 318, paragraph 7.5, Placing Reinforcement and the CRSI Manual of Standard Practices.
- C. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.
- D. Bars additional to those indicated which may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at its own expense.
- E. Additional reinforcement around openings:
- 1. Place an equivalent area of steel around pipe or opening and extend on each side and top and bottom sufficiently to develop bond in each bar.
 - 2. Refer to details on Drawings for bar extension length on each side of opening.
 - 3. Where welded wire fabrics are used, provide extra reinforcing using fabric or deformed bars.
- F. Unless otherwise indicated, reinforcement placing tolerances shall be within the limits in Section 7.5 of ACI 318 except where in conflict with the requirements of the Building Code.
- G. Bars may be moved as necessary to avoid interference with other reinforcement steel continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane indicated.
- H. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than three (3) feet on centers in any direction. Welded wire fabric shall not be placed on the ground and hooked into place in the freshly placed concrete.
- I. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters. Slab bolsters shall be spaced not more than 30 inches on center. The construction practice of placing welded wire fabric on the ground and hooking it into place in the freshly placed concrete shall not be used.

3.02 CONCRETE COVER:

- A. The concrete cover over reinforcement shall conform to ACI 318, paragraph 7.7, Concrete Protection for Reinforcement, unless otherwise indicated. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.

3.03 SPLICING:

- A. All lap splices of bar reinforcement shall be as indicated and conform to Chapter 12 of ACI 318 or as otherwise approved by the DISTRICT. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.
- B. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each two running feet. Wires shall be staggered and tied in such a manner that they cannot slip.
- C. Splices in column spiral reinforcement, when necessary, shall be made by a lap of 1-1/2 turns.

- D. Reinforcing shall not be straightened or rebent in a manner which will injure the material. Bars shall be bent or straight as indicated. Do not use bends different from the bends indicated. Bars shall be bent cold, unless otherwise permitted by the DISTRICT. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the DISTRICT.
- E. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as indicated. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. Couplers intended for future connections shall be recessed a minimum of 1/2 inch from the concrete surface. After the concrete is placed, the coupler shall be plugged with plastic plugs which have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged.

3.04 CLEANING AND PROTECTION:

- A. Unless indicated otherwise, mechanical coupler spacing and capacity shall match the spacing and capacity of the reinforcing indicated for the adjacent section.
- B. Reinforcement shall be free of all materials that will reduce bond.
- C. Reinforcement steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.
- D. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be re-inspected and, if necessary, re-cleaned or sandblasted.
- E. Properly cap all vertical reinforcement steel if area is subject to having workers above the reinforcement area.

END OF SECTION

SECTION 03300 CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SCOPE: The work of this Section consists of furnishing all labor, equipment, supplies, and materials necessary for the proper placement, curing, finishing, protection, and repair of the cast-in-place concrete required by the Contract Documents. Mortar placed on vertical and overhead existing concrete surfaces shall be in accordance with these specifications including SECTION 03600 2.02 A. All penetrations through existing reinforced concrete for chilled water pipes shall be oversized to accommodate 1-1/2" cementitious mortar cover over all steel reinforcing. All penetrations through existing EOC reinforced concrete for refrigerant piping shall not cut existing steel reinforcing and shall provide 1-1/2" existing concrete cover over all steel reinforcing.

1.02 APPLICABLE PUBLICATIONS: The following standard specifications shall apply to the Work of this Section:

A. American Concrete Institute (ACI)

1. ACI 117 - Standard Tolerance for Concrete Construction and Materials
2. ACI 301 - Structural Concrete for Buildings
3. ACI 304.2R - Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete
4. ACI 305 - Committee Report on Hot-Weather Concreting
5. ACI 306 - Committee Report on Cold-Weather Concreting
6. ACI 308 - Standard Specification for Curing Concrete
7. ACI 309 - Consolidation of Concrete
8. ACI 318 - Building Code Requirements for Reinforced Concrete
9. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures

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

1. C31 - Making and Curing Concrete compression and Flexure Test Specimens in the Field
2. C33 - Concrete Aggregates
3. C39 - Compressive Strength of Cylindrical Concrete Specimens
4. C94 - Ready-Mixed Concrete
5. C127 - Test Method for Specific Gravity and Absorption of Coarse Aggregate
6. C128 - Test Method for Specific Gravity and Absorption of Fine Aggregate
7. C136 - Method for Sieve Analysis of Fine and Coarse Aggregates
8. C143 - Test Method for Slump of Hydraulic Cement Concrete
9. C150 – Standard Specification for Portland Cement
10. C156 - Test Method for Water Retention by Concrete Curing Materials
11. C157 - Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete
12. C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
13. C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

14. C260 - Specification for Air Entraining Admixtures for Concrete
 15. C309 - Liquid Membrane-Forming Compounds for Curing Concrete
 16. C494 - Chemical Admixtures for Concrete
 17. C566 - Test Method for Total Moisture Content of Aggregate by Drying
 18. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
 19. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 20. C1077 - Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation
 21. C1157 - Performance Specification for Hydraulic Cements
 22. C1240 - Standard Specification for Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout
 23. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
 24. D2419 - Test Methods for Sand Equivalent Value of Soils and Fine Aggregate
 25. E96 - Water Vapor Transmission of Materials
 26. E1643 - Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
- C. Federal Specifications
1. UU-B-790A - Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant)
- D. Florida Building Code and Local Building Codes as appropriate

1.03 DEFINITIONS:

- A. Structural Concrete: Concrete to be used in all cases except where indicated otherwise in the Contract Documents.
- B. Pea Gravel Concrete: Concrete in thin sections and areas with congested reinforcing, at the option of the CONTRACTOR and with written approval of the DISTRICT for the specific location.
- C. Sitework Concrete: Concrete to be used for curbs, gutters, catch basins, sidewalks, pavements, fence and guard post embedment, underground pipe encasement, underground duct bank encasement and all other concrete appurtenant to electrical facilities unless otherwise indicated.
- D. Lean Concrete: Concrete to be used for thrust blocks, pipe trench cut-off blocks and cradles that are indicated on the Drawings as unreinforced. Lean concrete shall be used as protective cover for dowels intended for future connection.
- E. Hydraulic Structure: An environmental engineering concrete structure for the containment, treatment, or transmission of water, wastewater, other fluids, or gases.

1.04 SUBMITTALS:

- A. Mix Designs:
 1. Prior to beginning the WORK and within 14 days of the Notice to Proceed, the CONTRACTOR shall submit preliminary concrete mix designs which shall show the proportions and gradations of all materials proposed for each class and type of concrete.

2. Test data relating to the cement, aggregate, and admixtures shall be less than six months old. Furnish the submittals in accordance with ACI 301 for the following:
 - a. Mill tests for cement
 - b. Admixture certification. Chloride ion content shall be included.
 - c. Aggregate gradation test results and certification
 - d. Delivery Tickets: Where ready-mix concrete is used, the CONTRACTOR shall furnish delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate added at the batching plant, and the amount allowed to be added at the Site for the specific design mix. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.
- B. Other
1. The CONTRACTOR shall submit bonding agent product and installation information.
 2. The CONTRACTOR shall submit materials and methods for curing.
 3. The CONTRACTOR shall submit product specifications, data, and installation instructions for all miscellaneous products called for in this specification.
- 1.05 QUALIFICATIONS: Truck mixers shall be equipped with electrically actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
- 1.06 RESPONSIBILITIES: (not used)
- 1.07 CERTIFICATIONS AND TESTING:
- A. General
1. Concrete and other materials for testing shall be furnished by the CONTRACTOR, and the CONTRACTOR shall assist the DISTRICT in obtaining samples, and disposal and cleanup of excess material.
 2. The testing laboratory will meet or exceed the requirements of ASTM C1077.
 3. The cost of trial batch, laboratory, and shrinkage tests on cement, aggregates, and concrete, will be the CONTRACTOR'S responsibility.
- B. Trial Batch and Laboratory Tests: (Not used)
- C. Field Tests
1. The responsibility to retain the services of an independent testing laboratory shall be as defined in SECTION 01410.
 2. The CONTRACTOR shall pay the cost of any additional tests and investigation on WORK that does not meet the specifications.
 3. Tests on pumped concrete shall be taken at the point of final placement.
 4. Compressive Test: Compressive test specimens shall be taken during construction from the first placement of each class of concrete placed each day and for each 150 cubic yards or fraction thereof each day.

- a. Each set of test specimens shall consist of 5 cylinders. Specimens shall be made in accordance with ASTM C31. Specimens shall be 6-inch diameter by 12-inch high cylinders.
 - b. Compression tests shall be performed in accordance with ASTM C39. Two (2) cylinders shall be broken at 7 days and two (2) at 28 days, and the remaining cylinder shall be held to verify test results, if needed.
 - c. The acceptance of the test results shall be the average of the strengths of the two specimens tested at 28 days as per ACI 318. Evaluation and acceptance of the concrete shall be per ACI 318, Chapter 5.
5. Slump Tests: One (1) slump test shall be taken per truckload in accordance with ASTM C143.
 6. Air Content: Air content shall be determined for each compressive test taken in accordance with ASTM C231 or by ASTM C173.
 7. Concrete that fails to meet the ACI requirements and these Specifications is subject to removal and replacement.
 9. Temperature: Concrete temperature shall be recorded in accordance with ASTM C1064.

1.08 WARRANTY: The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - MATERIALS

2.01 GENERAL:

- A. All materials shall be classified as acceptable for potable water use according to NSF Standard 61.
- B. Cement for concrete that will contact potable water shall not be obtained from kilns that burn metal rich hazardous waste fuel.
- C. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Cement reclaimed from cleaning bags or leaking containers shall not be used. Cement shall be used in the sequence of receipt of shipments.
- D. Materials shall comply with the requirements of Sections 201, 203, and 204 of ACI 301, as applicable.
- E. Storage of materials shall conform to the requirements of Section 205 of ACI 301.

2.02 CEMENT:

- A. Cement shall be standard Portland Cement Type II conforming to ASTM C150.
- B. A minimum of 85 percent of cement by weight shall pass a 325 screen.
- C. A single brand of cement shall be used throughout the WORK, and prior to its use, the brand shall be accepted by the DISTRICT.
- D. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the DISTRICT, if requested, regarding compliance with these Specifications.

2.03 AGGREGATES:

- A. Aggregates shall be obtained from pits acceptable to the DISTRICT, shall be non-reactive, and shall conform to the requirements of ASTM C33.

- B. When tested in accordance with ASTM C33, the loss resulting after 5 cycles of the soundness test, shall not exceed 10 percent for fine aggregate and 12 percent for coarse aggregate, when using sodium sulfate.
- C. When tested in accordance with ASTM C33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.
- D. Course Aggregates:
 - 1. Coarse aggregates shall be crushed stone, gravel or other approved inert material having clean, hard, durable, uncoated particles conforming to ASTM C33.
 - 2. The coarse aggregates shall be prepared and handled in 2 or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete, the 2 size groups shall be combined.
 - 3. When tested in accordance with ASTM C33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions, or 10.5 percent after 100 revolutions.
- E. Fine Aggregates:
 - 1. Fine aggregates shall be clean sand conforming to ASTM C33.
 - 2. When tested in accordance with ASTM D2419, the sand equivalency shall not be less than 75 percent for an average of 3 samples, nor less than 70 percent for an individual test. Gradation of fine aggregate shall conform to ASTM C33 when tested in accordance with ASTM C136 for the fineness modulus of the sand used, including the optional grading in Section 6.2. The fineness modulus of sand used shall not be over 3.1.
 - 3. When tested in accordance with ASTM C33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

2.04 WATER:

- A. The water used in the concrete mix and for curing shall be clean, potable, and in accordance with ACI 318. Water shall be free from objectionable quantities of silty organic matter, alkali, salts, and other impurities.
- B. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/l TDS) shall not be used.

2.05 ADMIXTURES:

- A. General: All admixtures shall be compatible and be furnished by a single manufacturer capable of providing qualified field service representation. Admixtures shall be used in accordance with manufacturer's recommendations. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures shall not contain thiocyanates or more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.
- B. Air Entraining Admixtures:
 - 1. Air entraining admixture shall conform to ASTM C260. Air content shall be tested at the point of placement.
 - 2. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement.
 - 3. Sufficient air-entraining agent shall be used to provide a total air content of [3 to 5] percent. Concrete floors to receive a shake-on floor hardener shall have an air content not to exceed 3 percent or as recommended by the hardener manufacturer.

C. Set Controlling and Water Reducing Admixtures:

1. Admixtures may be added at the CONTRACTOR'S option, subject to the DISTRICT'S approval, to control the set, effect water reduction, and increase workability. The cost of adding an admixture shall be the CONTRACTOR'S responsibility. Concrete containing an admixture shall be first placed at a location determined by the DISTRICT. Admixtures shall conform to the requirements of ASTM C494. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.
2. Concrete shall not contain more than one water-reducing admixture.
3. Set retarding admixture may be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently greater than 80 degrees F, a set retarding admixture shall be used. Set retarding admixture shall conform to ASTM C494 Type B or D.
4. Set accelerating admixture may be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently less than 40 degrees F, a non-corrosive set accelerating admixture shall be used. Set accelerating admixture shall conform to ASTM C494 Type C or E.
5. Normal range water reducer shall conform to ASTM C494, Type A. The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.
6. High range water reducer shall conform to ASTM C494, Type F or G. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified. No more than 14 ounces of water reducer per sack of cement shall be used. Water reducer shall be considered as part of the mixing water when calculating the water/cement ratio.
 - a. If the high range water reducer is added to the concrete at the Site, it may be used in conjunction with the same water reducer added at the batch plant. Concrete shall have a slump of 3 inches plus or minus 1/2-inch prior to adding the high range water reducing admixture at the Site. The high range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the primary system.
 - b. Concrete shall be mixed at mixing speed for a minimum of 70 mixer revolutions or 5 minutes after the addition of the high range water reducer, unless recommended otherwise by the manufacturer.

2.06 CURING MATERIALS:

- A. Curing compound shall conform to ASTM C309, Type I. Curing compound shall be white pigmented, resin based and compliant with local VOC requirements. When curing compound must be removed for finishes or grouting, it shall be of a dissipating type. Sodium silicate compounds shall not be allowed.
- B. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 grams per square centimeter of surface.
- C. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, have a minimum thickness of 2 mils, and be permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A. The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 gram per square centimeter of surface.
- D. Polyethylene-coated burlap for use as concrete curing blanket shall be minimum 4-mil thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not

less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C156, shall not exceed 0.055 grams per square centimeter of surface.

- E. Curing mats for use in Curing Method 6 below, shall be heavy shag rugs or carpets or cotton mats quilted at 4-inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

2.07 MISCELLANEOUS MATERIALS:

- A. Damp proofing agent shall be an asphalt emulsion conforming to ASTM D1227, Type III, Class 1.
- B. Evaporation retardant shall create a monomolecular film on the concrete. The retardant shall have no effect on cement hydration and shall meet local VOC requirements. Evaporation retardant shall not affect adhesion of curing compounds or other treatments and shall not affect the color of the concrete.
- C. Reinforcement shall be per SECTION 03200 Concrete Reinforcement.
- D. Water Stops shall be per SECTION 03100 Concrete Formwork.
- E. Damp proofing agent shall be a waterborne emulsified-asphalt. Damp proofing shall be suitable for "green" or slightly damp surfaces and shall withstand normal expansion and contraction of the concrete. Damp proofing agent shall breath to allow vapors to escape. Damp proofing agent shall meet local VOC requirements.
- F. Bonding agents shall be 100% solids, epoxy adhesives conforming to the following:
 - 1. For bonding freshly-mixed, plastic concrete to hardened concrete, bonding agent shall be a medium viscosity adhesive conforming to ASTM C881 Type II, Grade 2, Class C,
 - 2. For bonding hardened concrete or masonry to steel, bonding agent shall be a non-sagging gel adhesive conforming to ASTM C881 Type I or IV, Grade 3, Class C.
- G. Vapor Barrier:
 - 1. Vapor Barrier shall consist of a composite of, asphalt, fiberglass, or polyethylene film. The composite shall be laminated under heat and pressure.
 - 2. Vapor Barrier shall comply with federal specification UU-B-790A, Type I, Grade A, Style 4. Vapor Barrier shall have a water vapor permeance of less than 0.30 perms when tested per ASTM E96.
 - 3. Vapor Barrier shall be installed under concrete slabs where indicated in the Drawings. Barrier shall be installed per the manufacturer recommendations and per ASTM E1643.
- H. Non-Waterstop Joint Material:
 - 1. Preformed Joint Material: Preformed asphalt-impregnated fiber conforming to ASTM D1751.
 - 2. Bond Breaker: All bond breakers shall be roofing felt or 15 mils minimum dry film thickness of bituminous paint as indicated.

2.08 CONCRETE DESIGN REQUIREMENTS:

- A. General: Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. The exact proportions in which these materials are to be used for different parts of the WORK will be determined during the trial batch process. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage, and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be

changed whenever necessary or desirable to meet the required results. All changes shall be subject to review by the DISTRICT.

B. Fine Aggregate Composition:

1. In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table.

Fine Aggregate	
Fineness Modulus	Maximum Percent
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

2. For other concrete, the maximum percentage of fine aggregate of total aggregate, by weight, shall not exceed 50.

C. Duct bank concrete shall contain an integral red-oxide coloring pigment. Concrete shall be dyed red throughout. Surface treatment to color duct banks will not be acceptable.

D. Water/Cement Ratio and Compressive Strength:

1. Water/cement ratio is given for aggregates in saturated-surface dry condition, and total moisture of all aggregates, calculated by ASTM C566, less the absorption of the aggregate as calculated by ASTM C127 and C128, shall represent total free moisture in the aggregate to determine the water/cement ratio. Total free moisture of aggregates shall be added to batch water to estimate water content of concrete. Concrete shall have the following minimum properties:

E. Concrete Proportions:

Type of Work	Min 28-Day Compressive Strength (psi)	Maximum Size Aggregate (in)	* Cement Content per cubic yd (lbs)	* Maximum W/C Ratio (by weight)
Structural Concrete				
Roof, floor slabs, columns, walls, and all other concrete items not indicated elsewhere.	4,500	1	564 to 600	0.45
12-inch and thicker walls, slabs on grade, and footings	(Not used)	(Not used)	(Not used)	(Not used)
Thin sections and areas with congested reinforcing, at the CONTRACTOR'S option and with the written approval of the DISTRICT for the specific location.	(Not used)	(Not used)	(Not used)	(Not used)
Sitework concrete	(Not used)	(Not used)	(Not used)	(Not used)
Lean concrete	(Not used)	(Not used)	(Not used)	(Not used)

* The cement content and water cement ratio are based on total cementitious material including silica fume, slag or flyash.

NOTE: The CONTRACTOR is cautioned that the limiting parameters above are not a mix design. Admixtures may be required to achieve workability required by the CONTRACTOR'S construction methods and aggregates. The CONTRACTOR is responsible for providing concrete with the required workability and strength.

- F. Adjustments to Mix Design: The CONTRACTOR may elect to decrease the water/cement ratio to achieve the strength and shrinkage requirements and/or add water reducers, as required to achieve workability. The mixes shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish, and the CONTRACTOR shall be entitled to no additional compensation because of such changes. Any changes to the accepted concrete mix design shall be submitted to the DISTRICT for review and shall be tested again in accordance with these Specifications.
- G. When using a floor hardener, the water/cement ratio shall not be greater than specified by the hardener manufacturer.

2.09 CONSISTENCY:

- A. The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete which can be worked properly into place without segregation and which can be compacted by vibratory methods to give the desired density, impermeability, and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C143. The slumps shall be as follows:

Part of Work	Slump (in)
All concrete, unless indicated otherwise	3-inches plus or minus 1-inch
With high range water reducer added	7-inches plus or minus 2-inches
Pea gravel mix	7-inches plus or minus 2-inches
Ductbank and pipe encasement	5-inches plus or minus 1-inch
Concrete with hardener	Per Hardener Manufacturer

2.10 MEASUREMENT:

- A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the DISTRICT.
- B. Weighing tolerances:

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

- C. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the DISTRICT and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any required amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism shall prevent leakage when the valves are closed.

PART 3 - EXECUTION

3.01 PROPORTIONING AND MIXING:

- A. Proportioning of the mix shall conform to the requirements of Chapter 3 "Proportioning" of ACI 301.
- B. Mixing shall conform to the requirements of Chapter 7 of ACI 301.
- C. Slumps shall be as indicated herein.
- D. Retempering of concrete or mortar that has partially hardened shall not be permitted.

3.02 PREPARATION OF SURFACES FOR CONCRETING:

- A. General: Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.
- B. Vapor Barrier

1. Vapor Barrier shall be installed under on-grade floor slabs (non-hydraulic) structures and at other locations indicated.
 2. Base shall be leveled, compacted, and tamped per SECTION 02200 Earthwork. Remove sharp edges, projection materials and roughness that might penetrate vapor barrier. Install barrier with width parallel with the direction of the pour of the concrete.
 3. Place, protect, and repair defects in sheet according to ASTM E1643, and the manufacturer's written instructions. Seams shall be lapped and sealed in accordance with ASTM E1643.
 4. The CONTRACTOR shall exercise care to avoid puncturing or tearing the vapor barrier during installation. Patch punctures and tears as they occur.
- C. Joints in Concrete:
1. All joints shall be installed where indicated on the Drawings or where otherwise approved by the DISTRICT. The surface of the construction joint shall be rough and prior to placement shall be cleaned and moistened with water.
 2. Concrete surfaces upon or against which concrete is to be placed, where the placement of the concrete has been stopped or interrupted so that, as determined by the DISTRICT, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of all laitance, loose or defective concrete, foreign material, and be roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. The existing concrete shall be dampened with water prior to placing the new concrete. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.
- D. Placing Interruptions: When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means that will secure proper union with subsequent work; provided that construction joints shall be made only where acceptable to the DISTRICT.
- E. Embedded Items:
1. No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the DISTRICT at least 4 hours before placement of concrete. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.
 2. Inserts or other embedded items shall conform to the requirements herein.
 3. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations indicated on the Drawings or shown by Shop Drawings and shall be acceptable to the DISTRICT before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.
- F. Casting New Concrete Against Old: Where concrete is to be cast against old concrete (any concrete which is greater than 60 days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate. The joint surface shall be coated with an epoxy bonding agent unless indicated otherwise by the DISTRICT.
- G. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the WORK. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure

the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to the review of the DISTRICT.

- H. Corrosion Protection: Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 1-1/2 inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.
- I. Openings for pipes, inserts for pipe hangers and brackets, and anchors shall, where practicable, be provided during the placing of concrete.
- J. Anchor bolts shall be accurately set and shall be maintained in position by templates while being embedded in concrete.
- K. Cleaning: The surfaces of metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.
- L. Existing Concrete Removal: Concrete that is to be removed adjacent to areas that are to be saw cut, and not accessible for cutting, shall be removed with no greater than a 15 lb chipping hammer or other suitable method. The perimeter of the area shall be saw cut 3/4 inch deep. The interior of the removed area shall be chipped out to produce a rectangular-shaped bottom. Feathered edges shall be avoided.

3.03 CONVEYING:

- A. Concrete shall be conveyed from the mixer to the place of final deposit by methods that will prevent separation or loss of material.
- B. No aluminum materials shall be used in conveying any concrete.
- C. Ends of chutes, hopper gates, and all other points of concrete discharge throughout the CONTRACTOR'S conveying, hoisting, and placing system shall be designed and arranged so that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the DISTRICT. Chutes longer than 50 feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. All conveyor belts and chutes shall be covered.
- D. Pumping:
 - 1. If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
 - 2. The pumping equipment shall have 2 cylinders and be designed to operate with one cylinder in case the other one is not functioning. In lieu of this requirement, the CONTRACTOR may have a standby pump on the Site during pumping.
 - 3. The minimum diameter of the hose conduits shall be in accordance with ACI 304.
 - 4. Pumping equipment and hose conduits that are not functioning properly shall be replaced.
 - 5. Aluminum conduits for conveying the concrete shall not be permitted.
 - 6. Concrete samples for slump, air content, and test cylinders will be taken at the placement end of the hose.

3.04 DELIVERY:

- A. Ready-mixed concrete shall be batched, mixed, transported and delivered in accordance with these specifications and ASTM C94 including the following supplementary requirements.
1. Concrete shall be discharged within 1-1/2 hours from the time concrete was mixed, if centrally mixed, or from the time the original water was added, if transit-mixed, or before the drum has been revolved 300 revolutions, whichever is first.
 2. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one-inch when the required slump is 3-inches or less, or if they differ by more than 2-inches when the required slump is more than 3-inches, the mixer shall not be used on the WORK unless the causative condition is corrected and satisfactory performance is verified by additional slump tests. Mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.
 3. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the DISTRICT.
 4. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolution of mixing.

3.05 PLACING:

- A. Non-Conforming Work or Materials: Concrete which during or before placing is found not to conform to the requirements indicated herein shall be rejected and immediately removed from the WORK. Concrete which is not placed in accordance with these Specifications, or which is of inferior quality, shall be removed and replaced.
- B. Unauthorized Placement: No concrete shall be placed except in the presence of a duly authorized representative of the DISTRICT. The CONTRACTOR shall notify the DISTRICT in writing at least 24 hours in advance of placement of any concrete.
- C. Concrete shall not be dropped more than four feet (4') without use of chutes or tremies. Concreting shall be a continuous operation until placement of the section is complete. All concrete shall be worked around reinforcement and embedded items. If vibrators are used, care shall be taken not to segregate concrete. Vibrators will not be allowed to move concrete within the form. All forms and subgrade shall be dampened prior to placement and excess water removed.
- D. Placing of concrete shall conform to the applicable requirements of Chapter 8 of ACI 301 and the requirements of this Section.
- E. Placement in Slabs: Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement. As the work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.
- F. Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, means such as hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6-feet

- in horizontal direction. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2-feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in wall forms shall not exceed 5-feet of vertical rise per hour. Sufficient illumination shall be provided in the interior of all forms so that the concrete at the places of deposit is visible from the deck or runway.
- G. Concrete with hardener shall be placed per the hardener manufacturers written recommendations.
 - H. Casting New Concrete Against Old: Epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations. This provision shall not apply to joints where waterstop is provided, see SECTION 03100 Concrete Formwork.
 - I. Temperature of Concrete: The temperature of concrete when it is being placed shall be not more than 90 degrees F or less than 55 degrees F for sections less than 12-inches thick, nor less than 50 degrees for all other sections. The CONTRACTOR shall be entitled to no additional compensation on account of the temperature requirements.
 - J. Hot Weather Placement
 1. Placement of concrete in hot weather shall conform to ACI 305 and the following:
 2. When the temperature of the concrete is 85 degrees F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed [60] minutes.
 3. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the CONTRACTOR shall employ effective means, such as pre-cooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete below 90 degrees F as it is placed.
 - K. Cold Weather Placement
 1. Placement of concrete in cold weather shall conform to ACI 306.1, and the following:
 2. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the minimum temperature.
 3. Remove all snow, ice, and frost from the surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6-inches. Reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.
 4. Maintain the concrete temperature above 50 degrees F for at least 72 hours after placement.
 - L. Order of Placing Concrete
 1. The order of placing concrete in all parts of the WORK shall be acceptable to the DISTRICT. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints at the indicated locations. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 days for hydraulic structures and 2 days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 days for hydraulic structures and 4 days for all other structures.
 2. The surface of the concrete shall be level whenever a run of concrete is stopped. To insure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and laitance shall be removed.

3.06 TAMPING AND VIBRATING:

- A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete. Vibrators shall be Group 3 per ACI 309, high speed power vibrators (8,000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required. Group 2 vibrators may be used only at specific locations when accepted by the DISTRICT.
- B. Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that all air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.
- C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall not contact the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.07 CURING AND DAMPPROOFING: Concrete shall be cured for a minimum of five (5) days after placement in accordance with the methods indicated below for the different parts of the WORK.

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Wall sections with forms removed	6
Construction joints between footings and walls, and between floor slab and columns	2
Encasement and ductbank concrete and thrust blocks	3
All concrete surfaces not specifically indicated in this Paragraph	4
Floor slabs on grade in hydraulic structures	5
Slabs on grade to receive an adhered floor finish	6 (Omit curing compound)
Slabs not on grade	6

- A. Method 1: Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 days of placing the concrete, curing shall be continued in accordance with Method 6 below.
- B. Method 2: The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.
- C. Method 3: The surface shall be covered with moist earth not less than 4 hours or more than 24 hours after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.
- D. Method 4: The surface shall be sprayed with a liquid curing compound.

1. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.
2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7-day curing period. If the seal is damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.
3. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.
4. Curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces and within 2 hours after removal of forms. Repairs to formed surfaces shall be made within the 2 hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.
5. At locations where concrete is placed adjacent to a panel which has been coated with curing compound, the panel shall have curing compound reapplied to an area within 6-feet of the joint and to any other location where the curing membrane has been disturbed.
6. Prior to final acceptance of the WORK, all visible traces of curing compound shall be removed from all surfaces in such a manner that does not damage the surface finish.

E. Method 5:

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4 above. Not less than one hour or more than 4 hours after the curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting, or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3-inches and fastened together with a waterproof cement to form a continuous watertight joint.
2. The curing blankets shall be left in place during the 7-day curing period and shall not be removed until after concrete for adjacent work has been placed. If the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections. During the first 3 days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces at all times.

F. Method 6: This method applies to both walls and slabs.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 consecutive days beginning immediately after the concrete has reached final set or forms have been removed.
2. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.

3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held substantially in contact with the concrete surface to prevent being dislodged by wind or any other causes. Edges shall be continuously held in place.
4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.
5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, the entire concrete surface shall be wetted, and curing compound shall be immediately applied to the entire surface in accordance with Method 4 above.
6. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the WORK.

G. Damp proofing

1. The exterior surfaces of backfilled dry well walls and buried roof slabs shall be damp proofed as follows.
2. Immediately after completion of curing the surface shall be sprayed with a damp proofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to one-half strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the undiluted material, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Damp proofing material shall be as indicated above.
3. As soon as the material has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be used if it produces a uniformly coated white surface and remains until placing of the backfill. If the whitewash fails to remain on the surface until the backfill is placed, the CONTRACTOR shall apply additional whitewash.

3.08 CONCRETE FINISHES:

- A. General: Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions indicated are defined as tolerances and are indicated herein. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used
- B. Formed Surfaces:
 1. No treatment is required after form removal except for curing, repair of defective concrete, and treatment of surface defects. Where architectural finish is required, it shall be as indicated.
- C. Unformed Surfaces:

After proper and adequate vibration and tamping, unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each work operation as necessary to prevent drying shrinkage cracks. The classes of finish for unformed concrete surfaces are designated and defined as follows:

Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2

Water bearing slabs with slopes 10 percent and less	U3
Water bearing slabs with slopes greater than 10 percent	U4
Slabs not water bearing	U4
Slabs to be covered with built-up roofing	U2
Interior slabs and floors to receive architectural finish	U3
Top surface of walls subject to foot traffic	U4
Top surface of walls not subject to foot traffic	U3
Floors to receive surface hardener	U5

1. Finish U1 - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.
2. Finish U2 - (Float Finish)
 - a. Compact, accurately screed and float to a true uniform surface.
 - b. Surfaces shall be floated with wood or metal floats or a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted.
 - c. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Test surface with straightedge and eliminate high and low spots of more than 1/8 inch in 10 feet. Surface irregularities shall not exceed 1/4-inch.
 - d. Joints and edges shall be tooled where indicated or as determined by the DISTRICT.
3. Finish U3 - (Hand-Troweled Finish)
 - a. Finish surface as in Finish U2 - Float Finish and after the surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, trowel with steel trowel to obtain a smooth dense finish after concrete has hardened to ring under the trowel.
 - b. The finish shall produce a smooth dense uniform surface free of all irregularities, blemishes, ripples, and trowel marks.
4. Finish U4 - (Nonskid Finish)
 - a. Trowel the Finish U3 - Hand-trowel Finish surface to remove local depressions or high points. In addition, the surface shall be given a light broom finish with brooming perpendicular to drainage unless otherwise indicated.
 - b. The resulting surface shall be rough enough to provide a nonskid finish.
5. Finish U5 - (Surface hardener)
 - a. Immediately after screeding, shake on hardener shall be applied per the manufacturer's written recommendations.
 - b. Surface shall receive a minimum of two coats of a liquid hardener per the manufacturer's written recommendations.
 - c. CONTRACTOR shall notify hardener manufacturer three (3) working days prior to hardened concrete floor being placed.
 - d. Hardener manufacturer shall provide continuous supervision of concrete and hardener placements, supplying DISTRICT with a report of each day's placement. Cost of supervision is to be borne by CONTRACTOR.

3.09 ARCHITECTURAL FINISH:

- A. General: Architectural finishes shall be provided only where specifically indicated below. In all other locations, the paragraph entitled Concrete Finishes shall apply.

Location	Finish
(Not used)	(Not used)

- B. Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and form-tie holes filled as indicated herein.
- C. Architectural finishes shall not be applied until the concrete surface has been repaired as required and the concrete has cured at least 14 days.
- D. Architecturally treated concrete surfaces shall conform to the accepted sample in texture, color, and quality. It shall be the CONTRACTOR'S responsibility to maintain and protect the concrete finish.

3.10 PROTECTION:

- A. The CONTRACTOR shall protect concrete against injury until final acceptance.
- B. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

3.11 DEFECTIVE SURFACE TREATMENTS:

A. Patching Concrete:

1. Patch all tie holes, honeycombs or other defects with a Portland Cement and sand grout.
2. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, plus not less than 1/32-inch depth of the surface film from all hard portions by means of an efficient sandblast.
3. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends.
4. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. Holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section and other imperfections having a depth greater than their least surface dimension shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.
5. The grout shall not be richer than one (1) part cement and three (3) parts sand with the amount of mixing water enough to produce a workable mix. For exposed walls, the cement shall contain such a proportion of white Portland cement as is required to make the color of the patch match the color of the surrounding concrete. The patch shall be finished in such a manner as to match the adjoining surfaces.
6. Surfaces of repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

B. Defective Concrete:

1. Any concrete which is not formed as shown on the Drawings or does not conform to the Contract tolerances or shows defects which reduce its structural adequacy, shall be removed

from the job by the CONTRACTOR at his expense unless the DISTRICT grants permission to patch the defective area.

C. Exposed Concrete Surfaces:

1. As soon as forms are removed, exposed surfaces shall be carefully examined and all ridges, ribs and other imperfections shall be rubbed with an abrasive stone or ground in a satisfactory manner in order to secure a smooth, uniform and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted
2. No repairs shall be made until after inspection by the DISTRICT.
3. In no case will extensive patching of honeycombed concrete be permitted
4. Concrete containing minor voids, pinholes, honeycombing, or similar depression defects shall be repaired as indicated below.
5. Concrete containing extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced. Repairs and replacements shall be performed promptly.

3.12 **REINFORCEMENT:** Reinforcement shall be in accordance with SECTION 03200 Concrete Reinforcement, of these Specifications. Concrete protection for the reinforcement shall conform to the requirements ACI 318, paragraph 7.7.1.

3.13 **CONSTRUCTION TOLERANCES:**

- A. The CONTRACTOR shall set and maintain concrete forms and perform finishing operations to ensure that the completed WORK is within tolerances. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated on the Drawings. Where tolerances are not stated in the specifications, permissible deviations will be in accordance with ACI 117.
- B. The following non-cumulative construction tolerances apply to finished walls and slab unless otherwise indicated:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation from the level or from the grades indicated.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation from plumb	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation in the thickness of slabs and walls.	Minus 1/4-inch; Plus 1/2-inch
Variation in the locations and sizes of slabs and wall openings	Plus or minus 1/4-inch

3.14 **CARE AND REPAIR OF CONCRETE:**

- A. The CONTRACTOR shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed WORK, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete.

END OF SECTION

SECTION 03600 GROUT

PART 1 - GENERAL

1.01 SCOPE: The CONTRACTOR shall furnish all equipment, labor and material for the proper placement and curing of grout and mortar as indicated on the Drawings and as specified herein. Mortar placed on vertical and overhead existing concrete surfaces shall be in accordance with these specifications including 2.02 A below.

1.02 APPLICABLE PUBLICATIONS: The following standard specifications shall apply to the WORK of this SECTION:

- A. American Society of Testing and Materials (ASTM)
 - 1. C109 - Test Method for Compressive Strength of Hydraulic Cement Mortars
 - 2. C307 - Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing
 - 3. C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
 - 4. C531 - Test Method for Linear Shrinkable and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing
 - 5. C579 - Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing and Polymer Concretes
 - 6. C580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
 - 7. C827 - Test Method for Early Volume Change of Cementitious Mixtures
 - 8. C881 - Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 - 9. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
 - 10. C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
 - 11. C1090 - Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout
 - 12. C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)
 - 13. C1339 - Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts
 - 14. D648 - Test Method for Deflection Temperature of Plastics Under Flexural Load
 - 15. D695 - Test Method for Compressive Properties of Rigid Plastics
- B. International Concrete Repair Institute (ICRI)
 - 1. Technical Guide for Selecting and Specifying Concrete Surface preparation for Sealers, Coatings, and Polymer Overlays
- C. American Institute of Steel Construction (AISC)
 - 1. Manual of Steel Construction
- D. American Concrete Institute (ACI)
 - 1. Building Code Requirements for Structural Concrete (ACI 318, latest edition)
- E. International Code Council (ICC), formerly the International Conference of Building Officials (ICBO)

1.03 DEFINITIONS: (Not Used)

1.04 SUBMITTALS: The CONTRACTOR shall submit the following:

- A. MANUFACTURER's literature containing instructions and recommendations on the surface preparation, mixing, handling, placement, curing, compressive strength, tensile strength, bond strength and appropriate uses for each type of grout or mortar used in the WORK, and location of use.

1.05 QUALIFICATIONS: (Not used)

1.06 RESPONSIBILITIES: (Not used)

1.07 CERTIFICATIONS AND TESTING: The CONTRACTOR shall provide to the DISTRICT three (3) copies of certified test results for all tests required herein.

- A. Certification that all grout used on the project contains no chlorides or other chemicals that cause corrosion.
- B. MANUFACTURER's certification that their non-shrink grout does not contain aluminum, zinc, or magnesium powders, used as a method of expansion.
- C. ICC certifications for all adhesive anchors.

1.08 INSPECTION COORDINATION:

- A. All adhesive anchor installations shall have special inspections as recommended by the ICC report on the adhesive anchors and local codes.

1.09 WARRANTY:

- A. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 APPLICATION:

- A. Unless indicated otherwise, grouts shall be provided as listed below:

TYPE OF GROUT	APPLICATION
Cement Grout	Surface repairs
Non-Shrink - Class I	All anchor bolts and reinforcing steel required to be set in grout in which the average working or operating temperature will be over 100 degrees F, or in high fire risk areas.
	Beam and column (1 or 2 story) base plates less than 16 inches in the least dimension.
	Storage tanks and other non-motorized equipment and machinery under 30 horsepower
	Filling knockout spaces for embedded items such as railing posts, gate guide frames, etc. (Where placement time is less than 20 min.)
	Repair of holes and defects in concrete members which are not water bearing and not in contact with soil or other fill material
	Any application not listed, where grout is called for on the Drawings
Non-Shrink - Class II	Column base plates (greater than 2 story or larger than sixteen (16) inches in the least dimension)
	Filling knockout spaces for embedded items such as railing posts, gate guide frames, etc. (where placement time exceeds 20min.)
	Under precast concrete elements
	Repair of holes and defects in concrete members which are water bearing or in contact with soil or other fill materials
Non-Shrink Epoxy	Machinery over 30 horsepower and equipment under 30 horsepower but subject to severe shock loads and high vibration

TYPE OF GROUT	APPLICATION
Epoxy Anchor Grout	All anchor bolts and reinforcing steel required to be set in grout that are not in high temperature or high fire risk areas.
Topping Grout	Toppings and concrete/grout fill less than three (3) inches thick
Structural Concrete per 03300	Toppings and concrete/grout fill greater than three (3) inches thick

2.02 MATERIALS:

- A. All vertical and overhead concrete repair materials identified on the Drawings as cementitious grout or mortar, including sawcutting existing reinforced concrete walls, with an application thickness less than eight (8) inches shall be in accordance with the following:
1. The product literature shall specify use for vertical and overhead concrete surfaces.
 2. The 28 day splitting tensile strength shall be no less than 610 psi when tested in accordance with ASTM C496.
 3. The 28 day compressive strength shall be no less than 5000 psi when tested in accordance with ASTM C39.
 4. The 28 day bond strength shall be no less than 1500 psi when tested in accordance with ASTM C882.
 5. The product shall be Sika Sikacrete 211, BASF Gel Patch, or a product that meets the equivalent minimum performance of these two products.
 6. The existing concrete surface shall be prepared, and the product shall be mixed, placed, and cured in accordance with the manufacturer's requirements and recommendations.
- B. Cement Grout:
1. Cement grout shall be composed of one part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 days shall be 4000 psi, unless indicated otherwise.
 2. Cement grout materials shall be as indicated in SECTION 03300 – Cast-in-Place Concrete.
- C. Non-Shrink Grouts (Cement Based):
1. General:
 - a. Cement Based Non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas-liberating, non-ferrous, grout, requiring only the addition of water.
 - b. MANUFACTURER's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout indicated herein shall be that recommended by the MANUFACTURER for the particular application.
 - c. Grout shall not contain chlorides or additives, which may contribute to corrosion.
 - d. Grout shall be formulated to be used at any consistency from fluid to plastic.
 - e. Non-Shrink grout shall have the following minimum properties when tested at a fluid consistency at 28 days:

Tensile Splitting Strength	ASTM C496	500 psi minimum
Flexural Strength	ASTM C580	1000 psi minimum
Bond Strength (concrete to grout)	ASTM C882 modified	1900 psi minimum
 2. Class I Non-Shrink Grout:
 - a. Class I Non-Shrink Grout shall have a minimum 28-day compressive strength of 5000 psi, when mixed at a fluid consistency.

- b. Class I Non-Shrink grout shall meet the requirements of ASTM C1107, Grade B or C, when mixed to fluid, flowable and plastic consistencies.
 - c. Grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C827. The grout when tested shall not bleed or segregate at maximum allowed water.
 - d. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C1090.
 - e. Provide certification together with independent test data that the expansion at 3 or 14 days does not exceed the 28-day expansion and that its non-shrink property is not based on gas production or gypsum expansion.
3. Class II Non-Shrink Grout:
- a. Class II Non-Shrink grout shall be a high precision, fluid, extended working time grout. The minimum 28-day compressive strength shall be 7500 psi, when mixed at a fluid consistency.
 - b. Grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C827.
 - c. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C1090.
 - d. Class II grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C1107.
 - e. Class II Non-Shrink grouts shall meet the requirements of ASTM C1107; Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C939.
 - f. The grout when tested shall not bleed or segregate at maximum allowed water.
 - g. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.
- D. Non-Shrink Epoxy Grout:
- 1. Non-Shrink Epoxy grout shall be a flowable, non-shrink, 100 percent solids system. The epoxy grout system shall have three components: resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the MANUFACTURER. MANUFACTURER's instructions shall be printed on each container in which the materials are packaged.
 - 2. Epoxy grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C827, (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1).
 - 3. Epoxy grout shall have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than 0.00003 in/in F when tested according to ASTM C531.
 - 4. The epoxy grout shall develop a minimum compressive strength of 9000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C579, method B.
 - 5. The mixed epoxy grout shall have a minimum working life of 90 to 120 minutes at 70 degrees F.
 - 6. The effective bearing area shall be a minimum of 95% EBA in accordance with ASTM C1339.
 - 7. The chemical formulation of the epoxy grout shall be that recommended by the MANUFACTURER for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.
 - 8. Non-Shrink Epoxy grout shall have the following minimum properties when tested at 7 days:

Bond Strength to Concrete	ASTM C882 modified	3000 psi minimum
Bond Strength to Steel	ASTM C882 modified	1700 psi minimum
Flexural Strength	ASTM C580	2500 psi minimum
Tensile Strength	ASTM C307	2000 psi minimum

E. Epoxy Anchor Grout: Epoxy anchor grout shall be provided in accordance with the requirements shown below unless indicated otherwise in the Drawings or by the product manufacturer identified in the Drawings.

1. Epoxy anchor grout shall be a non-sag paste conforming to ASTM C881 Type IV, Class A, B, and C, Grade 3 with the exception of gel time.
2. Heat deflection temperature per ASTM D648 shall be a minimum 120 degrees F.
3. MANUFACTURER shall certify that the epoxy grout will maintain 90 percent of its strength up to a temperature of 125 degrees F.
4. Grout shall come in a two-chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.
5. Epoxy anchor grout shall be capable of being used in submersed applications once cured.
6. Compressive strength per ASTM D695 shall be 10,000-psi minimum.
7. In vertical and overhead locations, anchor seal plugs shall be used unless indicated otherwise by the epoxy anchor grout product manufacturer.
8. If the average working or operating temperature will be over 100° F or in a high fire risk area, use cement based non-shrink grout and oversized holes.
9. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar. Embedment shall not exceed 67% of the member depth.

F. Topping Grout and Concrete/Grout Fill:

1. Where fill is thicker than 3 inches, structural concrete as specified in SECTION 03300, may be used if approved by the DISTRICT.
2. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tank, channel, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as specified herein. All materials and procedures indicated for normal concrete in SECTION 03300, shall apply unless indicated otherwise.
3. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water cement ratio of 0.45.
4. Coarse aggregate shall be graded as follows:

U.S. STANDARD SIEVE SIZE	PERCENT BY WEIGHT PASSING
1/2"	100
3/8"	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

5. Final mix design shall be as determined by trial mix design as indicated in SECTION 03300, except that drying shrinkage tests are not required.
6. Strength: Minimum compressive strength of topping grout and concrete/grout fill at 28 days shall be 4000 psi.

2.03 CURING: Curing materials shall be as specified in SECTION 03300, and as recommended by the MANUFACTURER of prepackaged grouts.

2.04 CONSISTENCY:

- A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.
- B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4 inches.

2.05 MEASUREMENT OF INGREDIENTS:

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.
- B. Prepackaged grouts shall have ingredients measured by means recommended by the MANUFACTURER.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the DISTRICT.
- B. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of saturation period excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.
- C. Surface preparation, curing, and protection of cement grout shall be in accordance with SECTION 03300. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.
- D. All surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete or other deleterious materials.
- E. Shade the WORK sites from sunlight for at least 24 hours before and 48 hours after grouting.
- F. Contact the grout MANUFACTURER's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.02 GROUTING PROCEDURES:

- A. General: All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the MANUFACTURER.
- B. All structural, equipment, tanks, and piping support bases shall be grouted, unless indicated otherwise.
 - 1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout, or a thickness as indicated on the Drawings.
 - 2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against all surfaces, and joints shall be sealed as recommended by the grout MANUFACTURER to be liquid-tight. Forms shall be coated as recommended by the grout MANUFACTURER for easy form release. Where this method of placement is not practical or where required by the DISTRICT, alternate grouting methods shall be submitted for acceptance by the DISTRICT.
- C. Drilled anchors and Reinforcing Bars:

1. General: Drilled anchors and reinforcing bars shall be installed in strict accordance with the MANUFACTURER's instructions. Holes shall be roughened with a brush on a power drill, and cleaned. Drilled anchors shall not be installed until the concrete has reached the required 28-day compressive strength. Anchors shall not be loaded until the grout has reached its indicated strength in accordance with the MANUFACTURER's instructions.
 2. Epoxy Adhesive Anchors:
 - a. Grout shall be proportioned and mixed with automatic equipment.
 - b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the AISC Manual of Steel Construction and ACI 318, Appendix D., but shall not be less than eight (8) diameters for threaded rod, or 12 diameters for reinforcing or smooth bars.
 - c. The hole diameter shall be as recommended by the epoxy MANUFACTURER but shall be no larger than 0.25 inch greater than the diameter of the outer surface of the bolt threads or the reinforcing bar deformations.
 - d. Holes shall be drilled by methods that do not interfere with the proper bonding of the epoxy.
 - e. Existing reinforcing steel in the vicinity of the proposed holes shall be located prior to drilling. The location of holes shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.
 - f. Holes shall be blown clean with clean, dry compressed air to remove all dust and loose particles. Holes shall be dry.
 - g. Reinforcing bars and anchors shall be installed per the MANUFACTURER's written installation instructions.
 3. Cement Based Non-Shrink Grout:
 - a. In places of high temperature or fire hazard, anchor bolts shall be grouted in using Cement Based Non-Shrink Grout, Class I.
 - b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the AISC Manual of Steel Construction and ACI 318, Appendix D., but shall not be less than sixteen (16) diameters for threaded rod, or 24 diameters for reinforcing or smooth bars.
 - c. When the bolt diameter is one inch or less, the hole diameter should be a minimum of two inches. When the bolt's diameter is greater than one inch, the hole diameter should be at least twice the bolt diameter.
 - d. Drilled holes shall be saturated with water for not less than 24 hours before installation of anchor/rod/rebar.
 - e. The non-shrink grout should be placed in the holes in a non-sag (trowellable) consistency. The grout should be placed in the holes before the anchor and then the anchor inserted and vibrated to ensure proper coverage.
- D. Topping Grout and Concrete/Grout Fill:
1. All mechanical, electrical, and finish WORK shall be completed prior to placement of topping or concrete/grout fill. To ensure bonding to the base slab, the base slab shall be given an exposed aggregate finish. Alternatively where accepted by the DISTRICT, the base slab shall be given a roughened textured surface by a close-spaced rake while the surface is green. After curing, high pressure washing shall expose the aggregates and produce not less than a 3/16-inch amplitude roughness. Jackhammers or chipping hammers shall not be used.
 2. The minimum thickness of grout topping and concrete/grout fill shall be one inch. Where the finished surface of concrete/grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2-inches wide by 1-1/2-inches deep.

3. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per International Concrete Repair Institute Standards for Surface Preparations, prior to placing topping and fill. No topping concrete shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment MANUFACTURER after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.
4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots, which shall be immediately eliminated. When the topping and/or fill have hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.
6. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the DISTRICT, the tank shall be filled with sufficient water to cover the entire floor for fourteen (14) days.

3.03 CONSOLIDATION:

- A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

3.04 CURING:

- A. Cement based grouts shall be cured per SECTION 03300 and per the MANUFACTURER's recommendations.

3.05 FIELD TESTING: (Not used)

3.06 CONSTRUCTION TOLERANCES: Construction tolerances shall be as indicated in SECTION 03300, unless indicated otherwise.

END OF SECTION

SECTION 05060 WELDING

PART 1 - GENERAL

- 1.01 SCOPE: The CONTRACTOR shall provide all labor, equipment, and materials for all shop and field welding as required by the Drawings and/or Specifications.
- 1.02 SHOP DRAWINGS AND ERECTION PROCEDURES:
- A. Drawing shall include all shop and erection details, including welds. All welds, both shop and field, shall be indicated by standard welding symbols as noted by American Welding Society (AWS) A2.0. Drawings shall show the size, length and type of each weld.
- 1.03 STANDARD REFERENCES: The following standard specifications shall apply to the WORK of this SECTION as indicated:
- A. American Welding Society, Structural Welding Code, (AWS)
 - B. American Institute of Steel Construction Manual for Steel Construction, 9th Edition, (AISC)
 - C. American Society for Testing and Materials (ASTM)
 - D. American Welding Society:
 - 1. D1.1 - Code for Welding in Building Construction
 - E. Welding shall be in accordance with American Welding Society Standard Code D1.1.
- 1.04 WELDERS QUALIFICATIONS: All welders, including tack welders, shall be qualified in accordance with Section 5, Part C of AWS D1.1. The CONTRACTOR shall certify by name, to the DISTRICT, the welders so qualified including the code and procedures under which the individual qualified.
- A. Welders and Welding Operators, shop and field, shall be qualified by an independent laboratory using test procedures covered by an independent laboratory using test procedures covered in AWS D1.1, and shall have been employed as a welder using the positions for which he is qualified during the previous 90 days. The CONTRACTOR shall provide the DISTRICT and the laboratory inspector with the names of welders to be employed in the shop and field on the WORK, certification of the position, date of the last qualification test and the name of the qualifying laboratory.
 - 1. All welders employed in the shop on the fabrication of the steel work shall be qualified for the most difficult welding position during shop fabrication.
 - 2. All welders employed in the field on the erection of the steel work shall be qualified for the most difficult welding position during field erection.
 - 3. The CONTRACTOR shall require any welder to retake the test, when, in the opinion of the DISTRICT, the WORK of the welder creates a reasonable doubt as to the proficiency of the welder. Recertification of the welder shall be made to the DISTRICT only after the welder has taken and passed the specified test. The DISTRICT may require radiographic or ultrasonic testing or may require coupons to be cut from any location in any joint for testing.
 - 4. Should any two radiographic or ultrasonic tests or coupons cut from the work of any welder show strengths, under tests, less than that of the base metal, it will be considered evidence of negligence or incompetence and such welder shall be removed from the WORK.
 - 5. When coupons are removed from any part of a structure, the members cut shall be repaired, at no additional cost to the DISTRICT, in a neat and workmanlike manner with joints of type to develop the full strength of the members and joints cut, with peening to relieve residual stress.

All SECTIONS of welds found defective shall be chipped or cut out to base metal and rewelded before proceeding with the WORK.

6. Costs of all qualifications, tests and retests shall be borne by the CONTRACTOR.

1.05 INSPECTION AND TESTING:

- A. Shop inspections and tests shall include fit-up, preparation of surfaces and welding.
- B. Field inspections and tests shall include fit-up, preparation of surface and welding.

1.06 WARRANTY:

- A. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - MATERIALS

2.01 WELD METAL: The chemical and mechanical properties of all deposited weld metal shall be compatible to the base metal and conform to AWS specifications for electrodes.

2.02 BASE METAL: The parent structural steel shall be a weldable grade with the chemical and mechanical properties to produce a sound and serviceable welded joint.

2.03 FABRICATION:

- A. Surfaces of joints for welded and bolted connections shall be clean, bright metal.
 - 1. Welded connections will be permitted only where indicated on the drawings. Welded construction shall conform to the AISC and AWS Specifications.

PART 3 - EXECUTION

3.01 WELDING METHODS: Unless otherwise approved by the DISTRICT, welding of steel shall be by an electric arc welding process and shall conform to AWS, Structural Welding Code, and the applicable sections of the AISC.

3.02 WELDING EQUIPMENT: Welding equipment shall be capable of providing the welding required by the drawings or specifications herein in accordance with the requirements of joint qualifications in AWS D1.1.

3.03 WELDING ELECTRODES:

- A. Electrodes and flux used for submerged arc welding shall be of the same manufacture. The flux shall be free of contamination from dirt, mill scale and foreign material. Fused flux used in welding shall not be reused. Bare electrodes and flux used in combination shall conform to the requirements of AWS D1.1.
- B. Electrodes for manual shielded metal-arc welding shall conform to AWS D1.1.

3.04 QUALIFIED WELDS: Only qualified welded joints shall be permitted in accordance with AWS, Structural Welding Code, and applicable sections of AISC.

3.05 PAINTING:

- A. After cleaning and connections are approved by the laboratory inspector, all surfaces to be welded shall be given a shop coat of primer. After erection, all field connections shall be cleaned.

- B. All connections, including welds and all abraded surfaces on the shop primer shall be painted to give one complete coat primer. Paint for field touch-up shall be the same paint used for the shop coat.

END OF SECTION

SECTION 05070 BOLTED FASTENERS

PART 1 - GENERAL

- 1.01 SCOPE: The WORK of this SECTION consists of furnishing all labor, materials and equipment necessary for installation of bolted fasteners as shown on the Drawings.
- 1.02 SHOP DRAWINGS:
- A. Shop Drawings shall include bolted connections and the type, size and length of bolts including washers.
- 1.03 STANDARD REFERENCES: The following standard specifications shall apply to the WORK of this SECTION as indicated:
- A. American Society of Testing Materials (ASTM)
 - 1. A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
 - 2. A325 – Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - 3. A490 – Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
 - 4. A563 – Standard Specification for Carbon and Alloy Steel Nuts
 - 5. F436 – Standard Specification for Hardened Steel Washers
 - 6. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
 - 7. F594 - Standard Specification for Stainless Steel Nuts
 - B. American National Standards Institute (ANSI)
 - C. American Institute of Steel Construction (AISC)
 - D. Specifications for Structural Joints Using ASTM A325 or A490 bolts, approved April 1978, by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation
- 1.04 WARRANTY: The CONTRACTOR shall warrant the WORK against defects for one (1) year from the date of Substantial Completion and as described in Article 13 of SECTION 00700 - General Terms and Conditions.
- 1.05 TEMPLATES: Templates shall be furnished by the Fabricator to the job, together with instructions for the setting of anchors, anchor bolts and bearing plates.
- 1.06 INSPECTION AND TESTING: Field inspections and tests shall include fit-up, preparation of surface and bolting.

PART 2 - MATERIALS

2.01 GENERAL

- A. All bolts, nuts and washers not designated stainless steel in the Drawings or otherwise specified herein shall comply with ASTM A325. All epoxy-set anchors shall be AISI 304 stainless steel.
- B. All stainless steel bolts, nuts and washers shall comply with ASTM F593.
- C. ASTM F593 bolts and anchors shall be a Group 1 Type 304 alloy in the CW condition.

2.02 HIGH STRENGTH BOLTS:

- A. High strength bolts and anchors shall meet the requirements of 2.01 above.

2.03 ALLOY STEEL BOLTS: (Not used)

2.04 NUTS:

- A. Nut dimensions shall conform to ANSI B18.2.2 for heavy hex nuts. Nuts for bolts not designated stainless steel shall conform to ASTM A563.
- B. Nuts for stainless steel bolts shall conform to ASTM F594. ASTM F594 nuts alloy group shall match the stainless steel bolt alloy group.

2.05 WASHERS:

- A. Flat, circular and square washers for bolts not designated stainless steel shall conform to ASTM F436.
- B. Flat, circular and square washers for stainless steel bolts shall conform to ASTM F593 and meet the dimensional requirements of ASTM F436. ASTM F593 washers alloy group shall match the stainless steel bolt alloy group.

2.06 TAMPER RESISTANT FASTENERS: Fasteners removable only by use of a special tool.

2.07 FABRICATION:

- A. Structural material shall be fabricated and assembled in the shop. Assembled pieces shall be taken apart for the removal of burrs and shavings produced by the reaming operation. Parts not connected in the shop shall be secured by bolts to prevent damage in shipment and handling.
- B. Surfaces of joints for bolted connections shall be clean, bright metal. Fit-up of the parts shall be inspected and approved by the laboratory inspector prior to making final connection.
 - 1. Holes for bolts shall be 1/16 inch larger than the diameter of the bolt.
 - 2. ASTM A307 bolts transmitting shear shall be threaded to such a length that no more than one thread will be within the grip of the metal. The bolts shall be of the length that will extend through, but no more than 1/4 inch beyond the nut. Nuts shall be tightened while bolt heads are tapped with a hammer. Tightening shall progress outward from the center of the joint. Nuts shall be locked after final tightening.
 - 3. Bolted connections using ASTM A325 bolts shall conform to the Specifications for Structural Joints using ASTM A325 or A490 bolts. Bolt threads shall be excluded from the shear planes of the contact surfaces between the connected parts and the bolts shall be tightened by the "Turn-of-Nut" method.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fasteners shall be tightened in properly aligned holes to provide, when all fasteners in the joint are tight, at least the minimum tension required by AISC Specification for Bolted Connections. The turn-of-the-nut method shall be utilized for all high-strength bolts as defined by AISC Specification for Bolted Fasteners.
- B. Anchor bolts and anchors shall be located and built into connecting work. Bolts and anchors shall be preset by the use of templates to locate the anchors and anchor bolts.

- 3.02 REUSE: A490 bolts and galvanized A325 bolts shall not be reused. Other A325 bolts may be reused, if approved by the DISTRICT.
- 3.03 BOLTED PARTS: The slope of the bolted parts in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to the bolt axis. Holes shall be punched and reamed, or drilled, and shall have a diameter nominally 1/16-inch in excess of the nominal bolt diameter. Over-size, short slotted and long slotted holes shall conform to the requirements of AISC Specifications for Structural Joints.
- 3.04 GALVANIZING: The galvanizing of the bolts, nuts and washers shall conform to the requirements of ASTM A153.

END OF SECTION

PART 1 - GENERAL

1.01 SCOPE: The WORK of this SECTION shall consist of furnishing all the labor, materials, and equipment necessary for installation of structural steel as shown on the Drawings and as specified herein. All existing galvanized steel framing and bar grating in the chiller and condenser enclosures with incipient rust shall be cleaned and coated in the affected location with a zinc-based solder as specified herein.

1.02 SHOP DRAWINGS AND ERECTION PROCEDURES:

- A. Prepare and submit shop and erection plans covering all structural steel and related items. All dimensions for checking of structural steel details shall be shown on the Drawings.
- B. The CONTRACTOR shall be responsible for the conformation of all steel details to the typical and special details shown on the Drawings. All details, notes and schedules appearing on the Drawings, and giving information for the fabrication and erection of the structural steel and related items shall be shown also on the erection or Shop Drawings. Shop Drawings shall include all fabrication and erection details, including cuts, copes, connections and holes. Shop Drawings for steel assemblies containing hollow structural shape tube or pipe sections shall indicate drain hole locations and sizes in accordance with ASTM A385.
- C. Prepare and submit, for information, two copies of a detailed erection procedure with the shop and erection drawings. The procedure shall include the sequence of erection with temporary staying and bracing, including bracing of existing components. No copies of such procedures will be returned.
- D. Prepare and submit zinc-based solder product information and detailed application procedures.

1.03 APPLICABLE SPECIFICATIONS AND CODES: The following specifications and codes form a part of this SECTION of these specifications:

- A. American Institute of Steel Construction (AISC) Publications, Eighth Edition, with Commentary
 - 1. Code of Standard Practice for Steel Buildings and Bridges
 - 2. Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, with Commentary
 - 3. Manual of Steel Construction
- B. American Society for Testing and Materials (ASTM):
 - 1. A36 – Specifications for Structural Steel
 - 2. A53 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
 - 3. A385 – Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
 - 4. A500 – Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 5. A501 – Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
 - 6. A572 – Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
 - 7. A992 – Specification for Structural Steel Shapes
 - 8. E329 - Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction
- C. American Building Society (AWS)

1. D1.1 Structural Welding Code - Steel

D. Unless otherwise indicated on the Drawings, the Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings of the American Institute of Steel Construction, hereafter designated AISC, shall govern structural steel WORK.

1.04 SUBSTITUTIONS OF SECTIONS: Substitutions of sections or modifications of details, or both, and the reasons therefore, shall be submitted with the Shop Drawings for approval. Approved substitutions, modifications, and changes in related portions of the WORK shall be coordinated by the CONTRACTOR and shall be accomplished at no additional cost to the DISTRICT.

1.05 RESPONSIBILITY FOR ERRORS: The CONTRACTOR shall be responsible for all errors of detailing, fabrication, and for correct fitting measurements in the field to verify or supplement dimensions shown on the Drawings and shall assume responsibility for fitting new WORK to existing WORK.

1.06 TEMPLATES: Templates shall be furnished by the Fabricator to the job, together with instructions for the setting of anchors, anchor bolts and bearing plates. The CONTRACTOR shall ascertain that the items are set during the progress of the WORK.

1.07 QUALIFICATION:

A. Fabrication Shop and Erection personnel shall have fabricated and erected projects of similar size and complexity for at least five (5) years.

B. Joint Qualification: All joints shall comply with AWS D1.1.

1.08 INSPECTION AND TESTING:

A. Inspections and tests shall be performed by an independent laboratory complying with ASTM E329, selected, directed, and paid by the DISTRICT. All material to be furnished shall be subject to inspections and tests in the shop and field.

B. Reports of shop and field inspections and testing shall be made by the laboratory on a weekly basis and submitted directly as follows: One (1) copy each to the DISTRICT, Inspector, Contractor, Fabricator and Erector.

1.09 WARRANTY:

A. The CONTRACTOR shall warrant the WORK against defects for one (1) year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 GENERAL: Materials shall be of domestic manufacture, within trade tolerances, new, undamaged and without splices. Structural material, plain or fabricated, shall be stored above the ground upon platforms, skids or supports. Material shall be kept free of dirt, grease and foreign matter and shall be protected from corrosion.

2.02 STRUCTURAL STEEL:

A. Structural steel shall comply with ASTM A36, A53 Grade B, and A500 Grade B, A501, A572 Grade 50, and A992 as applicable. Refer to the Drawings for the locations of each type of structural steel.

1. W shapes: A992 50 ksi minimum yield stress

2. C shapes: A36 36 ksi minimum yield stress

3. MC shapes: A36 36 ksi minimum yield stress
 4. L shapes: A36 36 ksi minimum yield stress
 5. HSS rectangular shapes: A500 46 ksi minimum yield stress
- B. The CONTRACTOR shall furnish two copies of all mill reports covering the chemical and physical properties of the steel used.

2.03 PAINT: (Not used)

2.04 GROUT: Non-shrink grout beneath base and bearing plates shall be Five Star Grout by U.S. Grout Corp., SonogROUT by L. Sonneborn Inc., Horn Non-Metallic Grout by A.C. Horn Inc., Non-Ferrous Non-Shrink Grout by the Burke Co., or as indicated in the Drawings.

2.05 FABRICATION:

- A. Structural material shall be fabricated and assembled in the shop. Assembled pieces shall be taken apart for the removal of burrs and shavings produced by the reaming operation. Parts not connected in the shop shall be secured by bolts to prevent damage in shipment and handling.
- B. Connections shall be as shown on the Drawings. Connections not indicated shall be made to conform to the AISC Specifications. One-sided or other types of eccentric connections will not be permitted except where shown on the plans. Fit-up of the parts shall be inspected and approved by the laboratory inspector prior to making final connection.
1. Holes shall be cut, drilled or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Holes in base or bearing plates shall be drilled. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling or reaming operation shall be removed.
 2. Assemblies containing hollow structural shape tube or pipe sections shall receive drain holes prior to the hot-dip galvanizing process in accordance with ASTM A385. Holes shall not be located on the exterior facing sides of the assembly. Holes shall be located along the centerline of the members. All moving components, such as hinges and latches, shall be attached after the hot-dip galvanizing process.
- C. Milled surfaces shall comply with the AISC Specifications and the Drawings.
- D. Allowance shall be made for draw in all tension bracing.

2.06 NEW STEEL GRATING:

- A. One-piece, resistance-welded hot-dip galvanized carbon steel construction
- B. Bearing Bars:
1. Thickness: 3/16 inch minimum
 2. Depth: 1-3/4 inch
 3. Smooth with no serrations
 4. Spacing: 1-3/16 inches on centers
- C. Cross Bars: 4 inches on centers spacing
- D. Fabrication:
1. Main bars shall be horizontal within a tolerance of 0.10 inch per inch of depth.
 2. Longitude bow (before fastening to supports) shall be less than 1/200 of the length.

3. Transverse bow before fastening to supports shall be less than 3/8-inch in 3 feet.
4. Crossbars shall not deviate from a straight line perpendicular to the main bars by more than 3/16-inch in 3 feet.
5. Crossbars shall match crossbars of adjacent sections to form a continuous pattern of straight lines.
6. Panel width and length tolerances shall be +/- 1/4 inch.
7. Trim-band all edges

PART 3 - EXECUTION

3.01 STRUCTURAL STEEL:

- A. Splices and field connections shall be made as shown or noted on the Drawings. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the assembly and fitting of parts shall be reported immediately to the DISTRICT for directions as to method of correction. Corrections shall be made at no additional cost to the DISTRICT.
- B. Leveling plates shall not be used under base plates.
- C. Column bases and bearing plates shall be attached as shown on the Drawings. Plates shall be supported and aligned on steel wedges or shims. After the supported members have been plumbed and positioned and the anchor nuts tightened, the entire bearing area under the plate shall be dry-packed solidly with non-shrink grout. Wedges and shims shall be cut off flush with edge of column base and bearing plates, and shall be left in place.
- D. After assembly, the various members forming parts of a completed frame or structure shall be aligned and adjusted before being fastened. Tolerance shall conform to AISC. Fastening of splices of compression members shall be done after the abutting surfaces have been brought completely into contact. Bearing surfaces and surfaces that will be in permanent contact shall be cleaned before the members are assembled. As erection progresses, the WORK shall be fastened to take care of all dead load, wind and erection stresses. Splices will be permitted only where indicated on the Drawings. Erection bolts used in welded construction shall be tightened and left in place. Welding for redrilling will not be permitted.
- E. Drift pins may be used only to bring together the several parts, and shall not be used in such manner as to distort or damage the metal.
- F. The use of a gas-cutting torch in the field for correcting fabrication errors is prohibited unless the DISTRICT has specifically approved such procedures for each case individually in writing.

3.02 PAINTING: (Not used)

3.03 GALVANIZING:

- A. The galvanizing of structural steel shall conform to the requirements of ASTM A123, Grade 100.
- B. Field welded and abraded or blemished areas of all non-stainless ferrous steel components shall receive a zinc-based solder in accordance with ASTM A780 and the following:
 1. Provide a zinc-tin copper alloy solder. The solder product shall be Kapp Alloy and Wire, Inc., Kapp Galvanite or an equivalent product.
 2. Repair procedures:
 - a. Repair procedures shall be in strict accordance with the manufacturer's instructions.

- b. Surfaces must be mechanically cleaned using a wire brush or a light grinding action. To ensure a smooth reconditioned coating can be affected, surface preparation shall extend into the surrounding, undamaged galvanized coating.
- c. Where the area to be repaired includes welds, all weld flux residue and weld spatter shall be removed by wire brush, chipping or grinding.
- d. Areas to be repaired shall be preheated to at least 600°F. The surface shall not be heated over 750°F as verified by heat sticks or heat gun. The surrounding galvanized coating shall not be burned. Wire brush the surface again to be reconditioned during the preheating and pre-flux if needed. Pre-flux is needed when there is an adhesion problem.
- e. Rub the cleaned, preheated welds/areas with the repair stick to deposit an evenly distributed layer of zinc alloy. When powdered zinc alloys are used, sprinkle the powder on the cleaned preheated surface and spread out with a spatula.
- f. The thickness shall be adequate and as originally specified.
- g. When the repair is complete, rinse with water or wipe with a damp cloth to remove flux residue.

END OF SECTION

SECTION 09900 PROTECTIVE COATINGS

PART 1 - GENERAL

1.01 SCOPE:

- A. Summary of Work: The CONTRACTOR shall provide coating on exterior and interior surfaces throughout the Project and which are listed in PART 2, with systems specified on "coating system" sheets at the end of this Section.
- B. Regulatory Requirements: In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local and regional jurisdiction. Notify the DISTRICT of any coating specified herein that fails to conform to the requirements for the location of the project or location of application.
 - 1. Lead Content: Use only coatings that are totally lead free.
 - 2. Chromate Content: Do not use coatings containing zinc-chromate or strontium chromate.
 - 3. Asbestos Content: Materials shall not contain asbestos.
 - 4. Mercury Content: Materials shall not contain mercury or mercury compounds.
 - 5. The specified maximum VOC content shall apply to the unthinned product.

1.02 APPLICABLE PUBLICATIONS:

- A. American National Standards Institute (ANSI):
 - 1. A 13.1 - Scheme for the Identification of Piping Systems
 - 2. Z 53.1 - Safety Color Code for Marking Physical Hazards
- B. American Society for Testing and Materials (ASTM):
 - 1. D4258 - Standard Practice for Surface Cleaning Concrete for Coating
 - 2. D4259 - Standard Practice for Abrading Concrete
 - 3. D4260 - Standard Practice for Acid Etching Concrete
 - 4. D4261 - Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating
- C. Society for Protective Coatings (SSPC) Surface Preparation Specifications:
 - 1. SP1 - Solvent Cleaning: Removes oil, grease, soil, drawing and cutting compounds, and other soluble contaminants.
 - 2. SP2 - Hand Tool Cleaning: Removes loose mill scale, loose rust, loose paint and other loose foreign matter.
 - 3. SP3 - Power Tool Cleaning: Removes loose material. Not intended to remove all scale or rust.
 - 4. SP5 - White Metal Blast Cleaning: Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
 - 5. SP6 - Commercial Blast Cleaning: Two-thirds of each square inch free of all visible residues; remainder only light discoloration.
 - 6. SP7 - Brush-Off Blast Cleaning: Removes only loose material, remaining surface tight and abraded to give anchor pattern.
 - 7. SP10 - Near-White Blast Cleaning: At least 95% of each square inch shall be free of all visible residues.

8. SP11 - Power Tool Cleaning to Bare Metal

1.03 DEFINITIONS:

- A. Coating systems include surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat, and finish coats to be shop-applied may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.
1. Where surface preparation and first (prime) coat are specified in other Sections to be shop-applied, such as for structural steel, hollow metal doors or equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat regardless if done in shop or field.
 2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
 3. Concealed surfaces are generally not required to have finish-coats unless otherwise specified, but prime coat should be applied and touched up prior to concealment.
 4. Where equipment and materials are provided with shop-applied finished coating system, only touch-up is a part of field painting.
 5. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop-applied.
 6. The term "DFT" means minimum dry film thickness, with no tolerance for thinner films.

1.04 SUBMITTALS:

- A. Submit as specified in DIVISION 1.
- B. Submittals include, but are not limited to, the following:
1. Schedule of products and paint systems to be used. Schedule shall include the following information:
 - a. Surfaces for system to be applied
 - b. Surface preparation method and degree of cleanliness
 - c. Product manufacturer, name, and number
 - d. Method of application
 - e. Dry film thickness per coat of coating to be applied
 2. Color charts for selection and acceptance
 3. Product information
 - a. Manufacturer's data sheet for each product proposed
 - b. Technical and performance information that demonstrates compliance with the system performance and material requirements
 - c. Manufacturer's instructions and recommendations on surface preparation and application
 - d. Compatibility of shop and field applied coatings (where applicable)
 - e. Material Safety Data Sheet for each product used
 4. Certification by coating manufacturers that each coating is suitable for service intended as stated on each coating system sheet.

5. CONTRACTOR shall certify in writing to the DISTRICT that applicators have previously applied all the systems in this Specification and have the ability and equipment to prepare the surfaces and apply the coatings correctly.
6. Samples
 - a. Sample of each paint, finish, and other coating material on 8-1/2 inch by 11-inch sheet metal. Each sheet shall be completely coated over its entire surface with one coating material, type, or color.
 - b. Two sets of color samples that match each color selected by the DISTRICT from the manufacturer's color charts. The color designation shall be shown on the back of the color sample.
 - c. For the exterior textured coating, submit samples from both manufacturers indicated in System C-2. The texture and color shall match the adjacent walls' textured finish.
7. Manufacturer's written recommendation, proportion mixes, and installation instructions for factory prepared cement plaster (stucco) system materials.

1.05 QUALIFICATIONS:

- A. Coating work shall be performed by an SSPC certified contractor having a minimum of Category QP 1 certification for work without hazardous paint removal, and Category QP 2 certification for work involving hazardous paint removal.

1.06 RESPONSIBILITIES: (Not Used)

1.07 CERTIFICATES AND TESTING: (Not Used)

1.08 INSPECTION COORDINATION:

- A. Prepainting Conference:
 1. Before field painting starts, representatives for the DISTRICT, CONTRACTOR, coating applicator, and coating manufacturer's technical representative shall meet with the DISTRICT'S personnel.
 2. Agenda for the meeting will include details of surface preparations and coating systems to ensure understanding and agreement by all parties for compliance.
- B. A coating report shall be completed daily by CONTRACTOR at each phase of the coating system starting with surface preparation. Reports shall be submitted on the form attached at end of this Section.
- C. In the event a problem occurs with coating system, surface preparation, or application, coating applicator and coating manufacturer's technical representative shall promptly investigate the problem and submit results to the DISTRICT.
- D. Whenever water tightness in a water-retaining structure is dependent upon work in other sections, the CONTRACTOR shall assume full responsibility for water tightness of the integrated assembly. Prior to starting work, CONTRACTOR shall meet with installers involved and with manufacturers of all materials involved to review Drawings and Specifications to insure that materials are being used properly and details are correct. A written report of this meeting shall be submitted to the DISTRICT. The report shall contain at least:
 1. Meeting date and names and affiliations of those present and written statements from each installer and manufacturer of their acceptance of Drawings, Specifications and conditions, and of proposed use of their materials as proper for purposes shown.

1.09 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than five years from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions. If the MANUFACTURER'S standard warranty is less than the stipulated period, the MANUFACTURER shall provide a special MANUFACTURER'S extended warranty for the stipulated period, or a Maintenance Bond in the form attached herein, to extend the MANUFACTURER'S warranty period for the stipulated period.
- B. The CONTRACTOR shall warranty the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Proprietary names and product numbers are specified in most systems for material identification from these manufacturers.
 - 1. Ameron International Performance Protective Coatings and Finishes Group
 - 2. Carboline Company, Inc.
 - 3. Chemrex
 - 4. ICI Devoe Coating Company
 - 5. Tnemec Company, Inc.
 - 6. Xypex Chemical, Ltd.
 - 7. Textured Coatings of America, Inc.
 - 8. Akzo Nobel Paints, LLC

2.02 GENERAL:

- A. Materials furnished for each coating system must be compatible with the substrate.
- B. Single Manufacturer: All materials in each coating system shall be by the same coating manufacturer to assure compatibility of coatings.
- C. Compatibility: When shop-painted surfaces are to be field coated, the CONTRACTOR shall ascertain whether finish materials will be compatible with shop coating. Coatings of uncertain composition shall be removed completely before applying new coatings
- D. Colors:
 - 1. Color of finish coatings shall match accepted color samples.
 - 2. When second and finish coats of a system are of same type, CONTRACTOR shall tint or use an alternate color on second coat to enable visual coverage inspection of the third coat. When first and second coats only are specified and are of same or different types, tint or use an alternate color on first coat to enable visual coverage inspection of the second coat.
- E. Include on label of material containers:
 - 1. Manufacturer's name, product name, and number
 - 2. Type of paint and generic name
 - 3. Color name and number
 - 4. Storage and temperature limits

5. Mixing and application instructions, including requirements for precautions which must be taken
6. Drying, recoat, or curing time

2.03 COATING SYSTEMS: Specified on the "Coating System" sheets at the end of this Section.

2.04 SURFACES TO BE COATED:

<u>Generic Description</u>	<u>Specific Surfaces</u>	<u>System</u>
Concrete, mild exposure, non-immersion, exterior exposure	<ol style="list-style-type: none"> 1. Existing interior concrete surfaces affected by construction 2. New interior cementitious surfaces 3. Cementitious surfaces at new pipe penetrations 	C-1
Concrete, mild exposure, non-immersion, exterior exposure	<ol style="list-style-type: none"> 1. Existing exterior concrete surfaces affected by construction 2. New exterior concrete or cement plaster (stucco) 3. Top of new concrete perimeter beam 4. New exterior, jamb, and overhead header mortar or cement plaster (stucco) 	C-2

2.05 SURFACES NOT TO BE COATED:

- A. Factory finished equipment, except for touch-up or noted otherwise
- B. Metal surfaces of stainless steel, bronze, aluminum, and fiberglass
- C. Concrete, unless listed on specific surfaces above
- D. Machined surfaces
- E. Grease fittings
- F. Glass
- G. Equipment nameplates
- H. Platform gratings, stair treads, door thresholds, and other walking surfaces unless listed on specific surfaces above
- I. Concrete Floors unless listed above

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING:

- A. Manufacturer Recommendations: Unless this specification requires otherwise, CONTRACTOR shall strictly follow the manufacturer's printed recommendations and instructions for storing and handling coating system materials.
- B. Delivery of Materials:
 1. Deliver in sealed containers with labels and information legible and intact. Containers shall also have correct labels with required information.

2. CONTRACTOR shall allow sufficient time for testing if required.
- C. Storage of Materials: CONTRACTOR shall store under conditions recommended by the Material Safety Data Sheets
1. All protective coating materials shall be used within the manufacturer's recommended shelf life.
 2. Store only acceptable materials on project site.
 3. Provide separate area and suitable containers for storage of coatings and related coating equipment.
 4. Dispose of used or leftover containers, thinners, rags, brushes, and rollers in accordance with applicable regulations.

3.02 PREPARATION FOR COATING:

- A. General: All surfaces to receive protective coatings shall be clean prior to application of coatings. The CONTRACTOR shall examine all surfaces to be coated, and shall correct all surface defects before application of any coating material. All marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any coating application. Surfaces to be coated shall be dry and free of visible dust.
- B. Protection of surfaces not to be coated: Surfaces that are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.
- C. Hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked, or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.
- D. Care shall be exercised not to damage adjacent work during blast cleaning operations. Spray painting shall be conducted under carefully controlled conditions. The CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent work or adjoining property occurring from blast cleaning or coating operations.
- E. Protection of painted surfaces: Cleaning and coating shall be coordinated so that dust and other contaminants from the cleaning process will not fall on wet, newly coated surfaces.

3.03 SURFACE PREPARATION:

- A. General
1. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparation specifications listed.
 - a. If grease or oils are present, SSPC-SP1 must precede any other method specified.
 - b. Remove surface irregularities such as weld spatter, burrs, or sharp edges, prior to specified surface preparation.
 2. Depth of profile shall be as specified for each system, but in no instance shall it exceed one-third of the total dry-film thickness of complete system.
 3. Prepare only those areas which will receive the first coat of the system on the same day.
- B. Metals
1. The minimum abrasive blasting surface preparation shall be as indicated in the coating system sheets included at the end of this Section. Where there is a conflict between these specifications

and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

2. All sharp edges shall be rounded or chamfered, and all burrs, surface defects, and weld splatter shall be ground smooth prior to blast cleaning.
 3. The type and size of abrasive shall be selected to produce a surface profile that meets the system sheet requirements for the particular coating and service conditions. Abrasives for submerged and severe service coating systems shall be clean, hard, sharp cutting crushed slag. Automated blasting systems shall not be used for surfaces that will be in submerged service. Metal shot or grit shall not be used for surfaces that will be in submerged service, even if subsequent abrasive blasting is planned to be one with hard, sharp cutting crushed slag.
 4. Abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.
 5. The CONTRACTOR shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.
 6. Compressed air for air blast cleaning shall be supplied at adequate pressure from well maintained compressors equipped with oil and moisture separators that remove at least 95 percent of the contaminants.
 7. Surfaces shall be cleaned of all dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another method prior to painting.
 8. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.
 9. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.
 10. If the required abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP2 or SSPC SP3 may be used.
 11. Shop applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP1 before the abrasive blast cleaning work is started.
 12. Shop primed equipment shall be solvent cleaned in the field before finish coats are applied.
- C. Concrete and Concrete Masonry Units
1. Surface preparation shall not begin until at least 30 days after the concrete or masonry has been placed.
 2. All oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC SP1 before abrasive blast cleaning.
 3. Concrete, concrete block masonry surfaces and deteriorated concrete surfaces to be coated shall be abrasive blast cleaned to remove existing coatings, laitance, deteriorated concrete, and to roughen the surface equivalent to the surface of the No. 80 grit flint sandpaper.
 4. If acid etching is required by the coating application instructions, the treatment shall be made after abrasive blasting. After etching, CONTRACTOR shall rinse surfaces with water and test the pH. The pH shall be between neutral and 8.
 5. Surfaces shall be clean and as recommended by the coating manufacturer before coating is started.

6. Unless required for proper adhesion, surfaces shall be dry prior to coating. The presence of moisture shall be determined with a moisture detection device such as Delmhorst Model DB, or equal.
- D. Exterior Cement Plaster (Stucco):
1. New exterior cast-in-place concrete and grouted surfaces shall receive a stucco coating matching the existing condition only if a stucco coating is present on the adjacent existing exterior concrete. The contractor shall verify the presence or absence of a stucco coating on the existing adjacent concrete. For bidding purposes, it shall be assumed that stucco will be provided.
 2. Stucco system shall be in compliance with ASTM C926 and C1063.
 3. Provide a two-coat smooth stucco system consisting of a 1/4 inch first coat and a 1/8 inch finish coat.
 4. Taper total thickness to match existing thickness at adjacent surfaces.
 5. Provide a three-coat system if needed to match the existing system thickness.
 6. Provide a bonding agent conforming to ASTM C932 as specified in ASTM C926 or roughen the existing surface using sand blasting or wire brushing in accordance with ASTM C926.

3.04 APPLICATION:

- A. CONTRACTOR shall apply coatings in accordance with coating manufacturer's recommendations. Materials shall be thoroughly stirred, strained, and kept at uniform consistency during application. Coatings from different manufacturers shall not be mixed together.
- B. Use properly designed brushes, rollers, and spray equipment for all applications.
- C. On unprimed surfaces apply first coat of the system the same day as surface preparation.
- D. Cleaned surfaces and all coats shall be inspected prior to each succeeding coat. The CONTRACTOR shall schedule such inspection with the DISTRICT in advance.
- E. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same working day.
- F. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Use stripe painting for these areas.
- G. Dry-film thickness of each system shall be at least as thick as the minimum specified. Maximum dry-film thickness shall not exceed the minimum more than 20% or coating manufacturer's requirements, whichever is less. Where a dry-film thickness range is specified, the thickness shall not be shall not be outside the range.
- H. Shop and field painting shall not be applied within 3 inches of unprepared surface of any substrate such as areas to be welded or bolted.
- I. Environmental Conditions:
 1. Atmospheric temperature must be 50 degrees Fahrenheit or higher during application, unless approved in writing by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur during the curing time interval.
 2. Wind velocities for exterior applications shall be at a minimum to prevent overspray or fallout and not greater than coating manufacturer's limits.

3. Relative humidity must be less than 85% and the temperature of the surface to be painted must be at least 5 degrees above the dew point.
 4. Provide adequate ventilation in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.
- J. Recoat Time: In the event a coating, such as an epoxy, has exceeded its recoat time limit, prepare the previously applied coating in accordance with manufacturer's recommendations.
- K. Protection:
1. Cover or otherwise protect surfaces not to be painted. Remove protective materials when appropriate.
 2. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
 3. Provide cover or shields to prevent surface preparation media and coatings from entering orifices in electrical or mechanical equipment. Where ventilation systems must be kept in operation at time of surface preparation, take precautions to shield intakes and exhausts to prevent the materials from entering system or being dispersed.
 4. Provide signs to indicate fresh paint areas.
 5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, and thinners. Dispose of leftover containers, thinners, rags, brushes, and rollers that cannot be reused in accordance with applicable regulations.
 6. Do not remove or paint over equipment data plates, code stamps on piping, or UL fire-rating labels.

3.05 INSPECTION:

- A. CONTRACTOR shall provide and use a wet-film gauge to check each application approximately every 15 minutes in order to immediately correct film thickness under or over that specified.
- B. On ferrous surfaces, measurements shall be made with one of the thickness gauges listed below. The gauge shall be calibrated on metal practically identical in composition and surface preparation to that being coated and be of substantially the same thickness, except that for measurements on metal thicker than 1/4 inch, the instrument may be calibrated on metal with a minimum thickness of 1/4 inch. When calibrating any of the gauges for making film measurements of over 3 mils, the calibrating thickness standards (shims) shall be of non-metallic composition. Where only one thickness criterion is specified, the calibrating shim thickness shall closely approximate the specified thickness, but where both thicknesses are specified, the shim's thickness shall closely approximate an average of the two. Calibrating instructions, thickness standards and, in the case of the Mikrotest gauge, a calibrating tool, should be obtained from the manufacturer or supplier of the gauge. Authorized thickness gauges are:
 1. General Electric, Type B, General Electric Company
 2. Mikrotest, Elektrophysik - Koln
 3. Elcometer, Elcometer Instruments, Ltd.
 4. Inspector Gage, Elcometer Instruments, Ltd.
 5. Minitector, Elcometer Instruments, Ltd.
- C. Use holiday or pinhole detector on systems over metal substrates to detect and correct voids when indicated on system sheet.
- D. Furnish a sling psychrometer and perform periodic checks on both relative humidity and temperature limits.

- E. Check temperature of the substrate at regular intervals to be certain surface is 5 degrees Fahrenheit or more above the dew point.

3.06 CLEANING AND REPAIRS:

- A. Remove spilled, dripped, or splattered paint from surfaces.
- B. Touch up and restore damaged finishes to original condition. This includes surface preparation and application of coatings specified.

END OF SECTION

South Florida Water Management District 3301 Gun Club Road West Palm Beach, Florida 33406	PROTECTIVE COATING SYSTEM
	System C-1

<u>SERVICE:</u>	Concrete and Concrete Masonry Units, Mild Exposure, Non-Immersion, Exterior Exposure. Refer to specific surfaces in Section 09900 2.04.
Surface Preparation:	Concrete: ASTM D 4258, clean and dry, free from grease, oil, and any other contamination. Remove protrusions. Fill pits in concrete with patching compound as recommended by coating manufacturer. CMU: ASTM D 4261, clean and dry, free from grease, oil, and any other contamination. Remove protrusions.
First Coat:	Acrylic Latex block filler with minimum 44% solids by volume. Apply at approximately 800 square feet per gallon on concrete and as required to fill pores on CMU.
Second Coat:	Water reducible acrylic coating with minimum 34% solids by volume, gloss finish. Apply at 2.0 mils dry film thickness.
Third Coat:	Same as second coat.
System Total:	Minimum 4.0 mils dry film thickness in addition to filler.
Volatile Organic Content:	Maximum 2.8 lbs/gal (340 g/l).

COATING MANUFACTURER	PRODUCT DESIGNATION		
	FIRST COAT	SECOND COAT	THIRD COAT
Ameron	Nu-Klad 105A Nu-Klad 112A	Amercoat 220	Same as second coat
Carboline	Carbocrylic 650 Carbocrylic 120	Carbocrylic 3359	Same as second coat
ICI Devoe	Bloxfil 4000	Devflex 4208	Same as second coat
Tnemec	Envirofill 130	Tneme-Cryl 6	Same as second coat

South Florida Water Management District 3301 Gun Club Road West Palm Beach, Florida 33406	PROTECTIVE COATING SYSTEM
	System C-2

<u>SERVICE:</u>	Concrete and Concrete Masonry Units, Mild Exposure, Non-Immersion, Exterior Exposure. Refer to specific surfaces in Section 09900 2.04. Submit samples from both manufacturers indicated for District's selection and acceptance.
Surface Preparation:	Concrete: ASTM D 4258, clean and dry, free from grease, oil, and any other contamination. Remove protrusions. Fill pits in concrete with patching compound as recommended by coating manufacturer. CMU: ASTM D 4261, clean and dry, free from grease, oil, and any other contamination. Remove protrusions.
First Coat:	High-build, plasticized, epoxy acrylic or acrylic resin. Apply at approximately 45 square feet per gallon on concrete or as specified by manufacturer. Provide primer as specified by manufacturer.
Second Coat:	If a primer is specified by manufacturer, provide textured coating as second coat.
Third Coat:	None
System Total:	Minimum 15.0 mils dry film thickness.
Volatile Organic Content:	Maximum 2.8 lbs/gal (340 g/l).

COATING MANUFACTURER	PRODUCT DESIGNATION		
	FIRST COAT	SECOND COAT	THIRD COAT
Tex•Cote	Tex•Cote XL-70-W Fine Textured	None	None
Glidden	6001 Hydrosealer Exterior Primer	3230 Textured Coatings Flat	None

SECTION 15000 GENERAL PROVISIONS FOR MECHANICAL WORK

PART 1 - GENERAL

- 1.01 SCOPE: The provisions of Part 1, General Documents, and DIVISION 1, General Requirements, apply to this section. These general provisions for mechanical work shall apply to all sections of DIVISION 15.
- 1.02 CODES AND STANDARDS: All work shall comply with the Building Codes and Ordinances of the local governmental jurisdiction. Work shall also comply with the codes and standards of the following agencies and organizations as specifically referenced hereinafter:
- A. The American National Standards Institute (ANSI).
 - B. American Society of Mechanical Engineers (ASME).
 - C. The American Society for Testing and Materials (ASTM).
 - D. National Fire Protection Association (NFPA).
 - E. National Electrical Code (NEC).
 - F. National Electrical Manufacturers Association (NEMA).
- 1.03 GUARANTEE: All equipment and systems, unless otherwise specified herein, shall be guaranteed for a period of one (1) year from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier. This guarantee shall be against defective materials, design and workmanship. Upon receipt of notice from the DISTRICT of failure of any part of the guaranteed equipment during the guarantee period, the affected part or parts shall be replaced promptly with new parts by and at the expense of the CONTRACTOR.
- 1.04 WARRANTY:
- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
 - B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

- 2.01 STANDARD PRODUCTS: The equipment to be furnished under these specifications shall be essentially the standard products of the manufacturer. Where two (2) or more units of the same class of equipment are required under these specifications, these shall be the product of a single manufacturer.
- 2.02 MANUFACTURER'S DESCRIPTIVE LITERATURE: The CONTRACTOR shall, before ordering equipment, submit to the DISTRICT for approval four (4) copies of the manufacturer's descriptive literature for all equipment and materials he proposes to use to show that it meets the requirements set forth in these specifications. He shall also submit a layout plan showing the arrangement of his equipment, piping, ducts, etc. if it varies from the Contract Drawings. The DISTRICT must approve any variations.
- 2.03 SPECIFICATIONS AND DRAWINGS: The Contract Drawings indicate the extent and general arrangement of the mechanical systems. The specifications and Drawings shall be considered as supplementary one to the other. Materials and labor indicated, called for or implied by one and not the other shall be supplied and installed as though specifically called for in both. Equipment, ductwork and piping arrangement shall fit into

space allocated, providing clearances for servicing and maintenance. Capacities of all equipment shall be not less than those indicated on the Drawings.

2.04 ELECTRICAL WORK:

- A. General: The Mechanical Contractor shall, unless otherwise specified herein, furnish all equipment specified herein with motors, motor controllers and controls. The Mechanical Contractor shall set motors in place and shall furnish motor controllers to the Electrical Contractor for installation.
- B. Motors: Motors shall be built in compliance with applicable NEMA Standards and shall be in conformance with DIVISION 16. Motors shall be NEMA premium rated.

PART 3 - EXECUTION

- 3.01 GENERAL: Work shall be started as soon as possible. Work lines and established grades shall be in strict accordance with the Drawings. The CONTRACTOR shall be responsible for furnishing to all trades, in ample time, any information they may require to construct all bases, trenches, pits, chases and openings in floors, walls, and finishes and to provide clearances to accommodate the work. He shall set all sleeves, anchor bolts or inserts required to fasten equipment before adjacent concrete is poured.

The CONTRACTOR shall be responsible for the actions of his employees and for compliance with all laws and ordinances governing the work. He shall layout his work and establish elevations in strict accordance with the Drawings, be responsible for the accuracy of the laying out, and give his personal superintendence to the work. He shall have at all times a competent representative on the premises who shall be acceptable to the DISTRICT.

A continuous cleanup shall be maintained during the progress of the work and appointed storage areas shall be used for surplus materials and supplies. The premises shall be kept free from accumulations of waste materials and rubbish. At completion, refuse shall be removed from the site.

- 3.02 INTERFERENCES: The plans are generally diagrammatic and the CONTRACTOR shall harmonize the work of the different trades so that interference between piping, equipment and structural work will be avoided. All necessary offsets in piping and all fittings, etc. required to properly install the work shall be furnished complete in place. Piping, etc. shall be kept as close as possible to ceilings, walls, columns, etc., as indicated on mechanical drawings, so as to take the minimum amount of space. All offsets, fittings, etc. required shall be furnished and installed without additional expense to the DISTRICT. In case interference develops, the DISTRICT will decide which equipment shall be relocated, regardless of which apparatus was first installed.

- 3.03 WORKMANSHIP: All materials and equipment shall be installed in accordance with the approved recommendations of the manufacturer and the referenced standards to conform with the Contract documents and shall be subject to the approval of the DISTRICT. The installation shall be accomplished by workers skilled in the type of work involved. Workers shall have current certifications, when required, for a particular trade.

- 3.04 DRAWINGS: The CONTRACTOR shall prepare accurate sleeve and insert drawings for checking and approval, showing all sleeves, boxes and inserts for installation of the work covered in these specifications. The above drawings shall be prepared well in advance of the construction and be coordinated with the work of all trades.

The CONTRACTOR shall furnish the DISTRICT with "as-built" drawings. He shall keep day-to-day records of changes in locations of piping, fixtures and other items, and upon completion of the work, incorporate these changes on clean copies of the original drawings.

- 3.05 CONTRACTOR'S DIFFERENCES: If the CONTRACTOR proposes to deviate from the specifications or Drawings, he shall call attention to any deviations in his proposal; otherwise, it will be assumed that he accepts and agrees to follow the Contract Drawings and specifications.
- 3.06 VIBRATION AND NOISE CONTROL: Excessive vibration or objectionable noise created in any part of building by operation of any equipment installed under this Contract will not be permitted. CONTRACTOR shall isolate various items of equipment from building structure and take all steps that may be necessary to eliminate excessive vibration and objectionable noise produced by any equipment installed under this Contract.
- 3.07 EXAMINATION OF SITE: The CONTRACTOR shall examine the site and the Drawings before bidding and inform himself fully regarding the limitations of space available for the installation of materials and equipment, as well as all conditions regarding service connections, and all factors involved in his bidding and in the completion of the work.
- 3.08 PIPE SLEEVES: Pipe sleeves shall be provided where pipes and tubing pass through masonry or concrete walls, roofs, and partitions. Sleeves in outside walls above grade, shall be zinc-coated steel pipe. Sleeves in partitions shall be zinc-coated sheet steel having a nominal weight of not less than 0.906 pound per square foot. Plastic sleeves may be used when approved by the DISTRICT. Space between pipe, tubing, or insulation and the sleeve shall not be less than 1/4-inch. Sleeves shall be held securely in proper position and location before and during construction. All sleeves shall be of sufficient length to pass through entire thickness of walls, partitions or slabs. Space between the pipe or tubing and the sleeve shall be firmly packed with oakum and caulked on both ends of the sleeve with insulating cement.
- 3.09 INSPECTION: Inspection shall continue during installation and testing. The right is reserved to inspect any equipment at the manufacturer's facility during or after manufacture, and to require reasonable witness tests before shipment. All equipment rejected at the manufacturer's facility shall be corrected or replaced prior to shipment. A final inspection of the equipment shall be performed prior to installation to determine conformity to the type, class, grade, size, capacity, and other characteristics specified herein or indicated. All equipment rejected shall be corrected or replaced prior to installation.
- 3.10 TESTS: All materials, equipment and systems that are required to be tested by these specifications or by any applicable regulation shall be tested in the presence of the DISTRICT or DISTRICT's representative. All items requiring pressure or leakage tests shall be tested before being concealed from view. All defects disclosed by tests shall be rectified and the tests repeated. The CONTRACTOR shall provide all labor, materials and equipment used for tests.
- 3.11 OPERATING INSTRUCTIONS: The CONTRACTOR shall submit operation instruction manuals for the DISTRICT. Manuals shall include manufacturer's data books, parts lists, wiring diagrams, maintenance procedures and start-up/shut-down instructions. Manuals shall be provided for all equipment. The Mechanical Contractor shall also provide all necessary instruction to the DISTRICT's personnel concerning operation of the mechanical system.

END OF SECTION

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SECTION 15001 GENERAL COMPLETION

PART 1 - GENERAL: As a prerequisite to final inspection, all construction, testing, adjustments, balancing, start up and any required instruction periods will have been completed on all mechanical systems and equipment.

1.01 AIR CONDITIONING CHILLED WATER SYSTEM:

- A. All control system components shall be installed and tested for function.
- B. All system testing and balancing shall be completed.

1.02 PLUMBING:

- A. All plumbing system modifications shall be installed complete and all tests as required in other sections of this specification as related to the plumbing systems shall be completed.
- B. Piping leak tests and correction of defects shall be complete. Operating instructions and other data required for posting shall be in place.
- C. A final bacteriological test of the potable water system shall be made by a laboratory approved by the State of Florida Health Department and delivered to the District at the time of final inspection.

1.03 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION - NOT APPLICABLE.

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END OF SECTION

SECTION 15010 PIPING

PART 1 - GENERAL

1.01 SCOPE:

- A. The CONTRACTOR shall furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, expansion joints, flexible connectors, valves, accessories, lining and coating, and testing to provide a functional installation.
- B. Valves are specified in Section 15101 Valves and Appurtenances.
- C. Piping materials are specified in Section 15251 Piping for Heating Ventilating and Air Conditioning Systems.
- D. Hydronic Piping systems and Specialties are specified in Section 15183 Hydronic Piping.
- E. Refrigerant piping Systems and Specialties are specified in Section 15185 Refrigerant Piping.

1.02 GENERAL:

- A. See Conditions of the Contract and DIVISION 1, General Requirements, and SECTION 15020, entitled "Pipe Supports and Penetrations", which contain information and requirements that apply to the work specified herein and are mandatory for this project.
- B. Like items of material provided hereunder shall be the end products of one manufacturer.
- C. All equipment shall be properly installed, completely interconnected and placed in working order. Workmanship and materials not covered by the specifications or standards herein shall conform to the highest standards of modern practices for work of similar character.
- D. Coordination with Other Work: The piping shall be installed in the most direct manner. Interference between structural features and other trades shall be avoided.
- E. Workmanship: Pipe shall be cut accurately to measurements established at the structure by the CONTRACTOR and shall be installed without inducing stress into valves or fittings. Anchors and branches shall be located and installed with due consideration for pipe temperature and future expansion. Pipe shall have the burrs removed by reaming and shall be cut into proper lengths by the use of a wheel-type mechanical cutting tool or other approved device. Piping, valves, and fittings that have not been sealed at the factory shall be thoroughly cleaned with a solvent-soaked cloth or pipe brush prior to installation. Materials shall be installed in accordance with the manufacturer's recommendations. The pipe alignment shall be such that there will be no perceptible bends or kinks. Misalignment will be cause for rejection, and rework of the piping sections involved will be required.
- F. All special valves, controllers, fittings, equipment, etc., shall meet the following requirements:
 - 1. Furnished, installed, tested, and put into successful operation.
 - 2. Be complete with all necessary miscellaneous pipe, valves, unions, fittings, auxiliaries, etc., whether indicated or not, but required.
 - 3. Be insulated and covered in accordance with the pipe system to which they attach.
- G. Furnish and install piping connected to accessories, which must vary from the drawings because of requirements peculiar to the particular equipment furnished, as required to make a complete and workable installation at no additional cost to the DISTRICT. This requirement shall include changes required in the piping systems because of design changes made by the manufacturer between the time

of design and the time of Installation or because of equipment furnished of different manufacture than that specified.

- H. Furnish the necessary pipe and fittings required to install all safety and relief valves in a vertical position. Furnish and route tail pipes to a place where the discharge will not injure personnel or as indicated.
- I. Where spare, replacement, or additional parts are required for the equipment specified herein, deliver these items to the DISTRICT immediately upon receipt at the jobsite. Parts shall be packaged and sealed for long storage and be securely and visibly labeled as to part, function, and name of equipment to which they apply.
- J. Equip all Y-type strainers, 4 inches and larger, with blow-down valves and piping.

1.03 STANDARDS, SPECIFICATIONS, AND CODES:

- A. The DISTRICT will obtain any variances imposed by site constraints.

1.04 REFERENCES:

- A. American Society of Mechanical Engineers (ASME):
- B. American Society for Testing and Materials (ASTM):
- C. American National Standards Institute (ANSI).

1.05 SUBMITTALS:

- A. Submit as specified in DIVISION 1.
- B. Manufacturer's data for approval before any work is commenced.
- C. When any material is specified to comply with applicable standards, codes, or laws, manufacturer's submittal must clearly state such compliance.
- D. The CONTRACTOR shall submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems, in accordance with the requirements in the SECTION 01300 entitled, "Submittal," and as specified in the individual piping sections.
- E. Data to be submitted shall include, but not be limited to:
 - 1. Catalog Data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various piping components and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.
 - 2. Complete layout and installation drawings with clearly marked dimensions and elevations. Piece numbers, which are coordinated with the tabulated pipe layout schedule, shall be clearly marked. Piping layout drawings shall indicate the following additional information; pipe supports, location, support type, hanger rod size, insert type and the load on the hanger in pounds.
 - 3. Weight of all component parts.
 - 4. Design calculations above specified.
 - 5. Tabulated pipe layout schedule that shall include the following information for all pipefittings, service, pipe size, working pressure, wall thickness and piece number.
- F. Shop Drawings:

1. The CONTRACTOR shall submit to the DISTRICT for approval, in accordance with the special clauses, complete piping drawings of each piping system as shown on the Drawings. They shall be construction drawings showing locations, dimensions, and details of all runs of piping, with pipe sizes, fittings, valves, and supports shown. The manufacturer's catalog number of all valves, hangers, supports and other items shall be submitted for approval.
2. Each shop drawing submittal shall be complete in all aspects incorporating all information and data listed herein and all additional information required to evaluate the proposed piping material's compliance with the Contract Documents. Partial or incomplete submissions will be returned to the CONTRACTOR without review.

1.06 PRODUCT STORAGE AND HANDLING:

- A. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps in place through shipping, storage and handling to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.
- B. Special care in handling shall be exercised during delivery, distribution and storage of pipe to avoid damage and setting up stresses. Damaged pipe will be rejected and shall be replaced at the CONTRACTOR'S expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.
- C. No pipe shall be dropped from cars or trucks to the ground. All pipes shall be carefully lowered to the ground by mechanical means. In shipping, pipe and fittings shall be blocked in such manner as to prevent damage to castings or lining. Any broken or chipped lining shall be carefully patched. Where it is impossible to repair broken or damaged lining in pipe because of its size, the pipe shall be rejected as unfit for use.
- D. Where possible, store pipe, valves, fittings and equipment inside and protected from weather. Where necessary to store outside, elevate well above grade and enclose with durable waterproof wrapping.

1.07 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. All piping shown, but not sized on the Contract Drawings, shall be properly sized for the function to be performed. Valve types to be used are herein specified and shown on the Contract Drawings for their respective systems.
- B. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as defined on the Piping Schedule shown at the end of this section.
- C. The materials to be used for the piping systems shown on the Drawings are listed in Specification Section 15251 Piping for Heating and Air Conditioning Systems.

2.02 ACCEPTABLE MANUFACTURERS: Manufacturers and model numbers specified herein are to establish quality and performance only. Products of manufacturers regularly engaged in their manufacture are

acceptable if proven to the DISTRICT as equal or better quality and performance and as stated in the General Conditions.

2.03 PIPING REQUIREMENTS: The materials to be used for the piping systems shown on the Drawings are listed in Specification Section 15251 Piping for Heating and Air Conditioning Systems.

2.04 JOINTS:

A. Flanged Joints: Flanged joints shall be made up with full-face gaskets as specified in the piping paragraphs. Flange faces shall have a uniform bearing on the gaskets. Flanges shall be drawn together uniformly until the joint is tight. No washers shall be permitted for the bolt and nut assemblies. The length of the bolts shall be uniform and in accordance with the standards specified herein. The bolt's maximum projection beyond the end of the nut shall be 0.25-inch nor shall the bolt fall short of the end of the nut.

1. Flanges: Where the design pressure is 125 psi or less, flanges shall conform to either ANSI/AWWA C115/A21.15 Class D or ASME B16.1 125-lb class. Where the design pressure is greater than 150 psi, up to a maximum of 250 psi, flanges shall conform to either ANSI/AWWA C115/21.15 or ASME B16.1 250-lbs class. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe for miscellaneous small pipes shall be in accordance with the standards specified for these pipes.
2. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes. All blind flanges for pipe sizes 12-inches and over shall be provided with lifting eyes in the form of welded or threaded eyebolts.
3. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.
4. Flange Bolts: If studs are required, they shall be in accordance with ASTM A 307, Grade B, with heavy hex nuts. Machine bolts shall normally be used on all flanged connections and shall be in accordance with ASTM A 307, Grade A, with hex nuts. For corrosive areas use Type 316 stainless steel, ASTM A193 Grade B 8M hex head bolts & ASTM A194, Grade 8M hex head nuts.
5. If studs are required, they shall extend through the nuts a minimum of []-inch. All bolts and nuts shall conform to Section entitled "Miscellaneous Metalwork."
6. Flange Gaskets: Gaskets for flanged joint shall be of materials as specified in piping sections. Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.
7. Flange Gasket Suppliers, or equal:
 - a. John Crane, style 2160.
 - b. Carlock, style 3000.

B. Welded Joints:

1. Welded joints shall be shop-fabricated in accordance with the standards and specifications contained herein.
2. Field welding will be permitted for black carbon steel pipe where it can be demonstrated that the interior of the pipe can be satisfactorily lined and inspected. Welding in the field shall be performed only when requested on the shop drawings and accepted by the DISTRICT in writing as specified herein.
3. All welding shall be performed in accordance with ANSI/ASME B31.1 and AWWA C206 except as modified or supplemented herein. All welders shall be AWS certified in accordance with AWWA C206, and ANSI/ASME B31.1 requirements.

4. Pipe and fittings with wall thickness of 3/16-inch and larger shall have ends beveled for welding. Bevels shall be 30° with a maximum of 37°. The abutting pipe ends shall be separated before welding to permit complete fusion to the inside wall of the pipe without overlapping. Welding shall be continuous around the joint and shall be completed without interruption. Welds shall be of the single vee butt type, of sound weld metal thoroughly fused into the ends of the pipe and into the bottom of the vee. Welds shall be free from cold spots, pinholes, oxide inclusion, burrs, snags, rough projections or other defects.
 5. Filler metal for welding shall be of the same composition as the base metal. All welding of steel pipe flanges shall be in accordance with requirements of AWWA C207 and ANSI/ASME B31.1.
 6. Field repairs of cement mortar lining a welded joints shall be made in accordance with AWWA C205 Appendix A or AWWA C602.
 7. Field welds shall be "fixed position" type.
 8. All field welds shall be radiographically inspected by the CONTRACTOR if so ordered by the DISTRICT.
- C. Threaded Joints:
1. All threads shall be clean, machine cut and all pie shall be reamed before erection. Taps and dies shall be cleaned, sharpened and in good condition. All threaded joints shall be made tight with Teflon tape.
 2. After having been set up, a joint shall not be backed off unless the joint is broken, the threads cleaned and new tape applied.

2.05 PIPING SPECIALTIES:

- A. Gaskets:
1. Rubber gaskets for flanged joints, ASTM D1330:
 2. 1/16-inch thick full-faced red rubber for all pipe sizes 10 inches and smaller.
 3. 1/8-inch thick full-faced red rubber for all pipe sizes 12 inches and larger.
 4. 1/16-inch thick full-faced neoprene or equal for fuel oil and natural gas service.
 5. Furnish with bolt holes and pipe openings punched.
- B. Flange Bolt Thread Lubricant: An anti-seize compound and thread lubricant designed for 1,000 degrees F.
- C. Backing Rings for Butt-Welded Joints: Be machined split ring with knock-off spacer nubs for use in pipe having wall thickness 1/2-inch or less.
- D. Instrument Needle Valves:
1. 3,000-pound bronze, globe or angle needle or Kel-F, stainless-steel stem, "O" ring or Teflon seal and screwed ends. Hoke Series 300 or Whitey. Install an instrument needle valve with each pressure gauge.

2.06 METERS AND GAUGES:

- A. General:
1. Provide all instruments, meters, gauges, and thermometers, complete with interconnecting tubing, piping, valves as specified and as indicated.

2. Provide gauge cock in the piping for all instruments, meters, and gauges, both at point of takeoff and at the instruments, meters and gauges. Gauge cock shall be of the same design requirements as the lines they serve.
- B. Thermometers:
1. Terrice CX9 or Ashcroft
 2. Liquid in glass type.
 3. Adjustable angle type with a 12 inch scale.
 4. Cast aluminum case with epoxy powder coating.
 5. Stainless steel stem.
 6. Include thermowells and accessories.
 7. Range – 0 to 100F
- C. Indicating Pressure Gauges:
1. Ashcroft "Duragauge" Crosby or Marsh.
 2. Bourdon Tube:
 - a. 160-psi Maximum Graduation: Grade A phosphor bronze, brazed joints stress relieved.
 3. Socket and Tip:
 - a. 160-psi Maximum Graduation: Forged bronze.
 4. Case: High-impact glass-fiber-reinforced polypropylene, weatherproof with safety blowout discs or release back plate.
 5. Ring: Bayonet-locking type.
 6. Movement: All stainless steel mounted on socket with milled teeth on pinion and sector.
 7. Dial: 4-1/2 inches, white laminated phenol with black markings.
 8. Pointer: Aluminum with micrometer adjustment.
 9. Accuracy: 1/2 of 1 percent over full range of scale.
 10. Range: As shown on the drawings or as required for the pressure range to be measured.
 11. Mount all pressure gauges on rigid surfaces. Install an instrument needle valve with each gauge.
 12. Be solid-front type recalibrated from back without removing dial.

2.07 PIPE INSULATION:

- A. Chilled water and cold water make-up piping shall be insulated as shown on the Drawings and as specified in Specification Section 15080 Mechanical Insulation.

2.08 PIPE SUPPORTS:

- A. Pipe support materials in the chiller and condenser enclosures shall be galvanized steel. Where copper piping is used, copper or copper plated supports shall be provided.
- B. Pipe support materials in the EOC shall be standard materials.

2.09 PIPE IDENTIFICATION PAINTING:

- A. All exposed and non-submerged pipe, including insulated pipe, shall be painted, color coded, and labeled.

PART 3 - EXECUTION

3.01 GENERAL:

- A. The CONTRACTOR shall furnish all labor, tools, materials, and equipment necessary for installation and jointing of the pipe. All piping shall be installed in accordance with Drawings in a neat workmanlike manner and shall be set for accurate line and elevation. All piping shall be thoroughly cleaned before installation, and care shall be taken to keep the piping clean throughout the installation.
- B. Furnish and install sleeves for all pipes passing through concrete floors, and walls as noted in Section 15020.
- C. Before setting wall sleeves, pipes, castings and pipes to be case in place, the CONTRACTOR shall check the Drawings and equipment manufacturer's drawings which may have a direct bearing on the pipe locations. The CONTRACTOR shall be responsible for the proper location of the pipes and appurtenances during the construction of and renovation of the tanks and structures.
- D. All connections to equipment shall be made with unions or flanges. Piping shall be attached to pumps, valves, equipment, etc., as shown on the drawings and in accordance with the respective manufacturers' recommendations.
- E. For piping assembled with threaded, solvent cemented, welded or soldered joints, liberal use of unions shall be made. Unions shall be provided close to main pieces of equipment and in branch lines to permit ready dismantling of piping without disturbing main pipe lines or adjacent branch lines. A minimum of one union per straight run of pipe between fitting and/or valves with multiple lengths of pipe shall be used.
- F. All changes in directions or elevations shall be made with fittings.
- G. The design drawings are generally diagrammatic. They do not show every bend, off-set, elbow or other fitting that may be required in the piping for installation in the space allotted. Careful coordination of the work of this section with that of all Divisions is necessary to avoid conflicts.
- H. Jointing Pipe:
 - 1. Threaded Pipe: Ream all pipe after cutting and before threading. Use non-hardening pipe compound "Tite-Seal" on male threads only.
 - 2. Copper Tube: Ream all pipe after cutting and polish end to be soldered.
 - 3. Provide nipples of same material and weight as pipe used. Provide extra strong nipples when length of unthreaded part of standard weight nipple is less than 1-1/2 inches.
 - 4. Provide reducing fittings where changes in pipe sizes occur.
 - 5. Provide dielectric unions or flanges between copper and steel piping and between brassware and steel. Do not use steel and copper piping in the same system without such isolation.
- I. Unions or Flanges: Provide unions or flanges in all service lines at each piece of equipment, specialty, valves, or at other locations required for ready disconnect.
- J. Coordinate with the other trades before installation of materials.
- K. Properly align, adjust and lubricate all equipment before final acceptance.
- L. Provide vents and drains at high and low points of water system.

- M. Provide dielectric-type unions where copper piping is connected to ferrous material.
- N. Test, flush and balance all system. Install all vents, test tees, test connections and other items required by local practice, codes, and regulations.

3.02 PIPING INSTALLATION:

A. Pipe and Fittings:

1. Install pipe and fittings in accordance with recognized industry practice which all achieve permanently leak-proof piping systems, capable of performing each indicated service without piping failure.
2. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment.
3. Reduce sizes where indicated by use of reducing fittings.
4. Align pipe accurately at connections within 1/16-inch misalignment tolerance.
5. Comply with ASME - Code for Pressure Piping.
6. Locate piping runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible.
7. Orient horizontal runs parallel with walls.
8. Locate runs as indicated or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.
9. Hold piping close to walls, overhead construction, columns and other structural and permanent-enclosure elements of the building.
 - a. Limit clearance to 0.5 inch where furring is shown for enclosure or concealment of piping but allow for insulation thickness if any.
10. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings.
 - a. Do not encase horizontal runs in solid partitions except as indicated.

B. Piping System Joints:

1. Provide joints of the type indicated in each piping system.
2. Threaded Joints:
 - a. Thread pipe in accordance with ASME B1.20.1.
 - b. Cut threads full and clean using sharp dies.
 - c. Ream threaded ends to remove burrs and restore full inside diameter.
 - d. Apply pipe joint compound or pipe joint tape (Teflon) on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
3. Welded Joints:
 - a. Weld pipe joints in accordance with ASME Code for Pressure Piping.
 - b. Install forged branch-connection fittings wherever branch pipe is indicated or install regular "T" fitting unless indicated otherwise.
4. Flanged Joints:
 - a. Match flanges within piping system and at connections with valves and equipment.

- b. Clean flange faces and install gaskets.
 - c. Tighten bolts to provide uniform compression of gaskets.
- C. Cleaning and Protection:
- 1. Clean exterior surfaces of installed piping system of superfluous materials and prepare for application of specified coatings or insulation.
 - 2. Unless otherwise specified, flush out piping systems with clean water for a minimum of 10 minutes before proceeding with required tests.
 - 3. Inspect each run of each system for completion of joints, supports and accessory items.

3.03 PIPE PROTECTIONS:

- A. Coat all exposed threads on galvanized steel pipe with two coats of zinc chromate after assembly.
- B. Provide dielectric isolation between pipes and metal parts of structure.

3.04 PIPING, VALVES AND FITTINGS:

- A. Changes in supply-main sizes shall be made through eccentric reduced fittings. Pipe shall be cut to measurements established at the project site and shall be worked into place without springing or forcing, clearing all windows, doors, and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installations will not be permitted. Pipe burrs shall be removed by reaming. Pipe supports shall permit free expansion and contraction without damage to joints or hangers. Changes in direction shall be made with fittings. Piping connections to equipment shall be as indicated. Open ends of pipelines or equipment shall be properly capped or plugged during installation to keep dirt and other foreign material out of the system. Taps for pressure gage connections shall be provided with a nipple and a shutoff gage cock.
- B. Joints and Fittings: Mitering of pipe to form elbows, notching straight runs to form tees, or similar construction will not be permitted. Flanged joints shall be faced true, gasketed, and made up of square and tight. Gaskets shall be factory cut in one-piece 1/16-inch thick.
 - 1. Threaded: Pipe threads shall be full and cleanly cut with sharp dies. Not more than three (3) threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed, after threading and before assembly, to remove all burrs.
 - 2. Flanged: Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but not so tight as to distort the flanges.
 - 3. Welded: Welding shall conform to the specifications and recommendations contained in the "Code for Pressure Piping," ANSI/ASME B31.1.
- C. Pipe Sleeves: Pipe passing through masonry construction shall be fitted with sleeves. Each sleeve shall extend through its respective wall, or other masonry structure, and shall be cut flush with each surface unless otherwise specified. Unless otherwise specified, the inside diameter of the pipe sleeves shall in all cases be at least 1/2-inch larger than the outside diameter of the passing pipe or pipe covering. Sleeves shall be steel pipe, cast iron pipe, or terra-cotta pipe. Unless otherwise specified, piping passing through exterior walls shall be made dust-tight and gas-tight with special rubber gasketed sleeve and joint assemblies, or with sleeves sealed with modular rubber sealing elements, or sealed by caulking with oakum and sealing with polysulfide or urethane sealant.
- D. Valve Tags: Identification tags of brass or aluminum shall be provided for all valves. Tags shall be approximately 2 inches in diameter with markings stamped and spelled out in full and shall be secured to the valves with No. 12 AWG copper wire or plastic ties.
- E. Piping Supports: Expansion anchors shall be used to fasten supports to existing concrete and masonry.

1. Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.
2. Piping in the chiller and condenser enclosures shall be supported from the floor. Support materials in these locations shall be galvanized steel.
3. Piping in the EOC shall be conventionally supported. Support materials in these locations shall be steel.
4. Pipe supports shall be manufactured for the size and type of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have sufficient threading to permit the maximum adjustment available in the support item.
5. Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead-ending. Anchors shall be located as required to force expansion and contraction movement to occur at expansion joints, loops, or elbows, and as required to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints.

3.05 INSTALLATION OF EXPOSED PIPING:

- A. All pipe flanges shall be set level, plumb, and aligned. All flanged fittings shall be true and perpendicular to the axis of the pipe. All bolt holes in flanges shall straddle vertical centerline of pipes.
- B. Unions shall be installed where required for piping or equipment installation, even though they are not shown on the Drawings.
- C. Piping shall be installed without springing or forcing the pipe in a manner that would set up stresses in the pipe, valves, or connected equipment.
- D. Required straight runs of piping upstream and downstream of flow measuring devices shall be smooth.
- E. Where valve hand wheels are shown, valve orientation shall be as shown. Where valve hand wheels are not shown, valves shall be oriented to permit easy access to the hand wheels, and to avoid interferences.

3.06 INSTALLATION OF FLEXIBLE COUPLINGS AND SERVICE SADDLES:

- A. Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. If necessary, flexible couplings may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up uniform tightness. Workmen tightening bolts shall use torque-limiting wrenches.

3.07 VENTS AND DRAINS:

- A. Vent the high point and drain the low point of all pipelines, whether shown on the Drawings or not, with 3/4-inch gate valves on those pipelines 2-1/2 inches and larger and 1/2-inch gate valves on those pipelines 2 inches and smaller. Valve types shall be as shown in the Valve Schedule described in Section Valves and shown on the Drawings. Where gate valves do not appear in the Valve Schedule for a service listed, Type V102 valves shall be used.

3.08 PIPE CLEANING:

- A. Interim Cleaning: Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld spatter, pie cuttings and filings, gravel, cleaning rags, etc. within the piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop

cleaning may employ any conventional cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

- B. Final Cleaning: Following assembly and testing and prior to final acceptance, all pipelines installed under this section shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 feet per second. Cone strainers shall be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the DISTRICT. Accumulated debris shall be removed through drains 2 inches and larger or by dropping spools and valves.

3.09 TESTING:

- A. Conduct pressure and leakage tests on all newly installed pipelines. Furnish all necessary equipment and material and make all taps in the pipe, as required. Test pressure shall be as specified in the Piping Schedule shown herein.
- B. All leak tests as required in other sections of this specification or tests required by the latest edition of Standard Building Code shall be completed and witnessed by the DISTRICT prior to any application of insulation or wrapping of pipe or backfilling of pipe in trenches. CONTRACTOR shall present a letter of certification indicating completion of such tests signed by an authorized representative of the CONTRACTOR.
- C. Preparation and Execution:
 - 1. Exposed Pressure Piping: Conduct the tests on exposed piping after the piping has been completely installed, including all supports, hangers, and anchors.

D. Hydrostatic Leak Tests:

- 1. Equipment: Furnish the following equipment for the hydrostatic tests:

<u>Amount</u>	<u>Description</u>
2	Graduated Containers
2	Pressure Gauges
1	Hydraulic Force Pump
	Suitable Hose and Suction Pump as Required

- 2. Procedure: Water shall be used as the hydrostatic test fluid unless otherwise specified. Test water shall be clean and shall be of such quality as to minimize corrosion of the materials in the piping system. Vents at all high points of the piping system shall be opened to purge air pockets while the piping system is filling. Venting during the filling of the system also may be provided by the loosening of flanges having a minimum of four bolts or by the use of equipment vents. All parts of the piping system shall be subjected to the test pressure specified in the Piping Schedule. The hydrostatic test pressure shall be continuously maintained for a minimum time of 30 minutes and for such additional time as may be necessary to conduct examinations for leakage. Examination for leakage shall be made at all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the CONTRACTOR'S sole expense.

E. Initial Service Leak Tests:

- 1. Equipment: Equipment used for initial service leak test shall be performed by gradually bringing the piping system up to normal operating pressure and holding it there continuously for a minimum time of 10 minutes. Examination for leakage shall be made at all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the CONTRACTOR'S sole expense.

F. Hydraulic Testing of Pipelines:

1. Unless otherwise provided herein, water for testing pipelines will be furnished by the DISTRICT; however, the CONTRACTOR shall make all necessary provisions for conveying the water from the DISTRICT-designated source to the points of use.
2. Prior to hydrostatic testing, all pipelines shall be flushed or blown out as appropriate. The CONTRACTOR shall test all pipelines either in sections or as a unit. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained an age of 14 days. The test shall be made by closing valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. The CONTRACTOR shall be responsible for ascertaining that all test bulkheads are suitable restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Care shall be taken to see that all air vents are open during filling.
3. The pipeline shall be filled at a rate that will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. The CONTRACTOR is responsible for removing all air in the piping to be tested by whatever means is necessary including addition of temporary air vent piping and valving.
4. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the DISTRICT shall be taken.
5. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 4 hours. The test pressure for distribution and transmission pipelines shall be 150 percent of the pipe system design pressure or 25 psig. The maximum allowable leakage for pipelines shall be 20 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 20 ft. or less joint lengths. All visible leaks shall be repaired in a manner acceptable to the DISTRICT.

G. Test Records: Records shall be made of each piping system installation during the test. These records shall include:

1. Date of Test.
2. Description and Identification of Piping Tested.
3. Test Fluid.
4. Test Pressure.
5. Remarks, to include such items as:
 - a. Leaks (type, location).
 - b. Repairs made on leaks.
6. Certification by CONTRACTOR and signed acknowledgement by the DISTRICT.

3.10 CORROSION PROTECTION:

- A. Atmospheric Exposed Piping and Accessories: All atmospheric exposed surfaces of black and hot-dip galvanized steel, brass, copper, and bronze piping components including, but not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves and fasteners shall be painted in accordance with Section 09900, as applicable to the base metal material.

3.11 PIPE PAINTING:

- A. Painting of piping systems shall be as specified in SECTION 09900 Protective Coatings.

3.12 CLEANUP:

- A. After completion of the work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handled over in a clean and functional condition.

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SECTION 15020 PIPE SUPPORTS AND PENETRATIONS

PART 1 - GENERAL

1.01 SCOPE:

- A. The Work of this Section shall consist of furnishing all labor, material, and equipment for the installation of plant piping as shown on the Drawings and specified herein.

1.02 GENERAL:

- A. Like items of material provided hereunder shall be the end products of one manufacturer.
- B. See Conditions of the Contract and DIVISION 1, General Requirements, which contain information and requirements that apply to the work specified herein and are mandatory for this project.
- C. CONTRACTOR shall design, furnish and install a complete system of pipe supports for the piping systems provided under this Contract. The CONTRACTOR shall provide for piping expansion and contraction and anchoring as necessary. Contact between dissimilar metals shall be prevented.

1.03 REFERENCES:

- A. American Society of Mechanical Engineers (ASME):
 - 1. B31.1 - Power Piping
- B. Manufacturers Standardization Society (MSS):
 - 1. SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture
 - 2. SP-69 - Pipe Hangers and Supports - Selection and Application

1.04 SUBMITTALS:

- A. Submit as specified in DIVISION 1.
- B. Submit manufacturer's data for approval before any work is commenced.
- C. When any material is specified to comply with applicable standards, codes, or laws, manufacturer's submittal must clearly state such compliance.

1.05 MATERIAL DELIVERY, STORAGE, AND PROTECTION:

- A. All materials shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

1.06 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. Pipe Supports: All pipes shall be adequately supported in accordance with the requirements of this section and as shown on related drawings.

2.02 PIPING SUPPORT SYSTEMS:

A. General:

1. The CONTRACTOR shall design and install the necessary pipe supports to support the chilled water system and refrigerant system piping. All piping in the chiller and condenser enclosures shall be supported from the floor. No piping shall be supported from the grating structure or walls. Pipe support materials in the chiller and condenser enclosure and other outdoor locations shall be galvanized steel.
2. All support anchoring devices, including anchor bolts, inserts and other devices used to anchor the support onto a concrete base, roof, wall or structural steel works, shall be of the proper size, strength and spacing to withstand the shear and pullout loads imposed by loading and spacing on each particular support.
3. Detailed shop drawings of all supports, including support-anchoring devices, shall be supplied with the submittals specified hereinbefore.
4. Where piping connects to equipment it shall be supported by a pipe support and not by the equipment.
5. Pipe support system components shall withstand the dead loads imposed by the weight of the pipes filled with water. Commercial pipe supports and hangers shall have a minimum safety factor of 5.

B. Piping:

1. Pipe hangers and supports shall meet the requirements of Section 5, Chapter II of ANSI B31.1 and shall be types as given for MSS Standard Practice SP-58 and SP-69.
2. Constant Support, Spring and Rigid Hangers: Bergen, Blaw-Knox, Fee and Mason, Grinnell or NAVCO.
3. Pipe hanger and supports shall be of the types listed in Table 1 "Hanger and Support Selection," MSS Standard Practice SP-69 except that the following figure types given in Figure 1 will not be acceptable: Types 5, 6, 11, 12, 7, 9, 10 and 25.
4. Horizontal piping shall be supported with adjustable swivel-ring, or Clevis type hangers as shown, Grinnell Figure 104; Elcen Figure 92; or equal.
5. Pedestal pipe supports shall be adjustable, with stanchion, saddle, and anchoring flange as shown, Grinnell Figure 264; Elcen Figure 50; or equal. Provide a neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation. Pads shall be Mason Industries, Inc. Type W; Korfund Korpad 40; or equal.
6. Horizontal piping hanger support rods shall attach to steel beams with C-clamps or beam clamps; to concrete with inserts, brackets or flanges fastened with flush shells.
7. All hangers, rods, clamps, protective shields, metal framing support components, and hanger accessories shall be galvanized unless copper plates or noted otherwise on the Drawings.
8. Unless noted otherwise on the Drawings, horizontal pipe support or hanger spacing and hanger rod sizing for steel and ductile iron pipe shall be as follows:

<u>Pipe Size</u>	<u>Maximum Support and Hanger Span Hangers</u>	<u>Minimum Rod Size Single Rod</u>
1 inch & smaller	6 feet	1/4-inch
1-1/4 inches thru 2-1/2"	8 feet	1/4-inch
3" thru 6'	8 feet	3/8-inch

9. Vertical sway bracing shall be provided where shown, or on 10' maximum centers.

C. Concrete Inserts and Expansion Shields:

1. The load rating for universal concrete inserts shall not be less than that of the hanger rods they support.
2. Type A:
 - a. Unistrut Corporation, Series P-3200 inserts or Brinkley Company.
 - b. Inserts shall be galvanized and have a recommended load capacity of 2,000 pounds per foot of length in average good concrete with a safety factor of 3.
 - c. Inserts shall be continuous and located as required.
 - d. Provide end caps at each end. End caps shall have attached anchor if spacing from end of insert to next anchor is greater than 2 inches.
 - e. Inserts shall be 5-5/8 inches wide outside by 1-3/8 inches deep outside and constructed of minimum 12-gauge galvanized steel, adequate for a 7/8-inch rod and nut.
 - f. CONTRACTOR shall furnish Unistrut galvanized nuts with or without springs required for work under this contract.
3. Type B: Concrete inserts shall be malleable iron Type 18 listed in MSS Standard Practice SP-69, Grinnell, Fig. 282 or Fee and Mason.
4. Type C: Concrete inserts shall be malleable iron, Grinnell Fig. 152, Fee and Mason or approved equal.

D. When necessary to use expansion anchors, they shall conform to DIVISION 5.

E. All piping shall be supported in a manner that will prevent undue strain on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown. Pipe supports and hangers shall not be installed in equipment access areas or monorail runs.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:

1. Furnish all labor, materials and equipment necessary to make a complete installation as indicated and specified.
2. Provide all necessary supports, brackets or foundations for properly installing all equipment.
3. Coordinate with the other trades before installation of materials.
4. Provide sleeves and flashings for all piping penetrating walls or the roof. Provide all required openings in walls and floors.

3.02 HANGERS, SUPPORTS AND ANCHORS:

A. General:

1. The design, selection, spacing and application of pipe hangers, supports and anchors shall be in accordance with the codes and standards specified except the ANSI B31.1 - Code for Power Piping shall take precedence over the MSS SP-69 standard.
2. Hanger class and selection of components shall be in accordance with those specified.
3. Furnish and install all rigid and spring supports, whether or not they are shown and detailed, but are required to adequately support the piping system.
4. Furnish and install for all pipe installed under this contract.
5. Include all necessary structural steel, brackets, concrete inserts, etc., which are not a part of the building, or specified, but required to properly support the piping systems.
6. Include necessary temporary supports, pins, etc., for the hydrostatic testing of steam lines and other lines that are spring supported.
7. Install piping and provide necessary supports and anchors to prevent the forces and mounting imposed on equipment from exceeding the limits specified by the equipment manufacturer.
8. Unless shown otherwise, piping shall be parallel to building lines. Hangers on adjacent piping shall be aligned where possible on common size ranges.
9. CONTRACTOR shall note that a maximum rod size of 7/8 inch can be used with Type A concrete inserts. Maximum horizontal pipe hangers and support spacing shall be reduced for 14-inch and larger lines supported from new and existing Unistrut P-3200 type concrete inserts.

B. Adjustment:

1. Prior to putting the piping systems into service, adjust all spring hangers to the correct cold load, adjust all solid hangers to correct position and remove all temporary hangers used in erection and testing.
2. After and during the time the piping systems are being put into service, adjust all spring hangers for the current hot load and align all hanger rods to the vertical position.

END OF SECTION

SECTION 15080 - MECHANICAL INSULATION

PART 1 - GENERAL

1.01 SCOPE

- A. The Work of this Section shall consist of furnishing all labor, materials, tools, equipment, accessories, and services necessary for providing and installing mechanical insulation of all items as shown on Drawings and/or specified herein. All sizing required for preparation of painting shall be performed under this Section.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, including Section 01600, apply to Work of this Section.

1.02 SUBMITTALS

- A. Submit in accordance with DIVISION 1, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. CONTRACTOR shall furnish ENGINEER for approval a list of insulating materials and thickness for items listed on Schedule. The list shall be complete including all types and thicknesses of insulation used for the various services as well as the limits of Work.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
 - 1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to Site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage in accordance with manufacturer's recommendations. Do not install damaged or wet insulation; remove from Site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Cellular glass insulation:
 - a. Pittsburgh Corning

- b. Engineer Approved Equal
2. Flexible elastomeric thermal insulation:
 - a. Armstrong – Armaflex
 - b. Manville – Aerotube
 - c. Rubates
 - d. Engineer Approved Equal

2.02 MATERIALS- CELLULAR GLASS INSULATION

- A. Insulation material shall be cellular glass insulation manufactured in accordance with ASTM C552, “Standard Specification for Cellular Glass Thermal Insulation” or EN14305, “Thermal insulation products for building equipment and industrial applications – factory made cellular glass products (CG) products Specification” by Pittsburgh Corning. The manufacturer’s quality system for manufacturing, inspecting and testing cellular glass insulation shall be certified to meet the requirements of ISO 9001:2008. Cellular glass pie insulation shall be fabricated according to the requirements of ASTM C1639 “Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation”, DIN EN 13167 or AGI Q 137.
- B. Joint sealant shall be provided in accordance with the insulation manufacturer’s recommendations and be similar to one the following.
 1. Butyl sealant used for sealing joints in cellular glass insulation systems, similar to PITTSEAL 444N Sealant as supplied by Pittsburgh Corning or Engineer Approved equivalent.
 2. A high performance, MS Polymer based sealant used for sealing joints in cellular glass insulation systems on chilled water systems, similar to PITTSEAL CW Sealant as supplied by Pittsburgh Corning or Engineer Approved equivalent.
 3. A single component cold bituminous adhesive used to seal longitudinal and circumferential joints of cellular glass insulation in chilled water lines similar to PC 18 adhesive as supplied by Pittsburgh Corning or Engineer Approved equivalent.
- C. Insulation jacketing shall be provided in accordance with the Manufacturer’s recommendations and include the following.
 1. For indoor applications, a non-cellulose multiply laminated fiberglass- reinforced polypropylene, PVC, or vinyl faced/metalized film backed jacket shall be used. The jacket must not contain known mold or mildew nutrients, and exhibit no mold when tested according to ASTM C1338 “Determining Fungi Resistance of Insulation Materials and Facings”.
 2. For outdoor applications, 0.016 in. minimum aluminum jacketing with bands with matching seals shall be used.
- D. Metal bands shall be aluminum with matching seals. Band dimensions shall be a minimum of 0.5 x 0.020 for piping and equipment with O.D. up to 48” and 0.75 x 0.020 for larger O.D.
- E. Tape shall be a minimum or 0.75 wide high tensile strength, fiber reinforced tape.
- F. Weather barrier mastic shall be a flexible, acrylic latex weather barrier coating formulated for use with cellular glass insulation, similar to PITTCOTE 404 coating as supplied by Pittsburgh Corning or Engineer Approved equivalent.
- G. Reinforcing mesh fabric for weather barrier coating shall be synthetic fabric, 6.5 x 6 mesh, similar to PC Fabric 79 as supplied by Pittsburgh Corning or approved equivalent.

- H. Vapor retarder mastic finish/surface filler shall be a vapor and weather barrier asphalt coating especially formulated for use with cellular glass insulation, similar to PITTCOAT 300 finish supplied by Pittsburgh Corning or Engineer Approved equivalent.
- I. Bore coating at pipe supports shall be one of the following:
 - 1. Any commercially available polyurethane varnish.
 - 2. Hydrocal B-11 which is a reactive gypsum product that is mixed with water to form an inorganic, non-combustible bore coating.

2.03 MATERIALS- ELASTOMERIC THERMAL INSULATION

- A. Insulation material shall be flexible tubing elastomeric thermal type with a minimum density of 5.5 pcf. Adhesives shall be recommended by the insulation manufacturer. Indoor and outdoor shall be piping insulation shall be finished by applying two coats of protective insulation coating as recommended by the insulation manufacturer. The protective coating color shall match the existing coatings on the refrigerant piping insulation.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

- A. Installer's Qualifications: Firm with at least 3 years successful installation experience on projects with mechanical insulations similar to that required for this Project.

3.02 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.03 INSTALLATION

- A. The Mechanical Insulation Schedule gives the application, type, temperature, and thickness of insulation required. This Schedule should be used with the following interpretations.
 - 1. Insulation thickness selection not shown on Schedule shall be based on the ASHRAE Standard for the conditions of 80 degrees F ambient air temperature with 80 percent relative humidity indoor, and -20 degrees F ambient air temperature with 90 percent relative humidity outdoor, with operating temperatures as listed on Schedule.
 - 2. Cellular glass insulation thickness shown on Schedule is based on a k-factor of 0.31 at 50 degrees F. Insulation thickness may be increased or decreased in direct proportion to the k-factor of the insulation material furnished.

3.04 HVAC PIPING SYSTEM INSULATION

- A. Sub-Freezing Piping (0 to 39 degrees F (-18 to 4 degrees C):
 - 1. Application Requirements: Insulate the following sub-freezing HVAC piping systems:
 - a. Refrigerant suction and liquid lines between evaporators and compressors.
- B. Cold Piping (40 degrees F (4.4 degrees C) to ambient):
 - 1. Application Requirements: Insulate the following cold HVAC piping systems:
 - a. HVAC chilled water supply and return piping.
 - b. HVAC make-up water piping.

3.05 EQUIPMENT INSULATION

- A. Cold Equipment (Below Ambient Temperature):
 - 1. Application Requirements: Insulate the following cold equipment:
 - a. Cold and chilled water pumps.
 - b. Air separator.
 - c. Miscellaneous cold components.

3.06 INSTALLATION OF PIPING INSULATION – INDOOR (EOC BUILDING)

- A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
- F. Exposed covering shall be cleaned and sized for painting.
- G. Pre-molded sectional covers shall be applied to flanges, fittings, and valves where possible. All other flanges, fittings, and valves shall be field-insulated and jacket applied manually. Insulation shall be the same thickness as that of the pipe insulation.
- H. In general, pipe hangers will be sized to fit the pipe with insulation placed over the pipe hanger assembly. Insulation shall be grooved for hangers. The hanger area shall be completely filled with insulating material and sealed in vapor barrier areas.
- I. Insulation, where terminated at equipment connections, ends of pipe, etc., shall be tapered at a 45-degree angle and sealed.
- J. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.
- K. Butt pipe insulation against pipe hanger insulation inserts. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3-inch-wide vapor barrier tape or band.

3.10 INSTALLATION OF PIPING INSULATION - OUTDOOR (CHILLER/CONDENSER ENCLOSURES)

- A. Application of the insulation shall be as specified above.
- B. Metal jacketing shall be applied with laps positioned to shed water. All laps shall be a minimum of 2 inches. Aluminum jacketing shall be secured using bands and seals of similar materials. Band spacing shall be per jacketing manufacturer's recommendations.

3.11 INSTALLATION OF VAPOR STOPS

- A. In situations where the chilled water system is operational before the insulation system is completely installed, vapor stops must be installed at the end of each open section. Additionally vapor stops must be used at either

side of all penetration, insulation system interruptions, and at any cellular glass insulation to other insulation transition points.

- B. Apply a one inch wide circumferential band of sealant to the inner bore of the cellular glass pipe insulation at each end of each half section to form the vapor stop. This will mate the inside of the pipe covering to the pipe and provide a vapor stop.
- C. Apply cellular glass pipe insulation at the vapor stop to piping with all joints sealed a full depth with specified joint sealant. All joints shall be tightly sealed with no voids.

3.12 APPLICATION TO PIPE SUPPORTS

- A. Install cellular glass insulation at pipe supports in accordance with the manufacturer's written instructions regarding the following.
 - 1. Coating the inner and outer surfaces of the pipe insulation to be used on the support area.
 - 2. Selection of proper support configuration based on hanger spacing and load spreading plate thickness and length.

3.13 INSTALLATION OF EQUIPMENT INSULATION

- A. Install equipment thermal insulation products in accordance with manufacturer's written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Maintain integrity of vapor barrier on equipment insulation as described above for piping and protect it to prevent puncture and other damage.
- D. Apply insulation using staggered joint method for both single- and double-layer construction where feasible. Apply each layer of insulation separately.
- E. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges, and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- F. Cover insulated surfaces with jacketing neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable.
- G. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance, including metal vessel covers, fasteners, flanges, frames, and accessories.
- H. Protect outdoor insulation from weather by installation of jacketing, as recommended by manufacturer.

3.14 REFRIGERANT PIPING SYSTEM INSULATION

- A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

3.15 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Replacement insulation shall be of same thickness as existing insulation. Jacket of replacement insulation shall overlap and seal to the existing insulation.

3.16 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Insulation Installer shall advise CONTRACTOR of required protection for insulation work during remainder of construction period to avoid damage and deterioration.

MECHANICAL INSULATION SCHEDULE

Application	Type	Temp. (°F)	Pipe Size				Remarks		
			Minimum Insulation Thickness Interior		Minimum Insulation Thickness Exterior (Chiller/Cond Enclosure)				
			< 2"	2"-4"	> 4"	< 2"	2"-4"	> 4"	
HVAC									
Chilled Water and make up water piping	Cellular Glass	40-55	1	1-1/2	1-1/2	1	1-1/2	1-1/2	1-1/2
Refrigerant piping	Elastomeric Type	40	3/4	3/4	3/4	3/4	3/4	3/4	3/4

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END OF SECTION

SECTION 15101 VALVES AND APPURTENANCES

PART 1 - GENERAL

- 1.01 SCOPE: The Work of this Section shall consist of furnishing all labor, material, and equipment necessary for the installation of the various valves in piping systems as shown on the Drawings and specified herein.
- 1.02 CONDITIONS OF THE CONTRACT APPLY:
- 1.03 GENERAL:
- A. Like equipment specified herein shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturer's service.
 - B. See Conditions of the Contract and DIVISION 1, General Requirements, which contain information and requirements that apply to the work specified herein and are mandatory for this project.
- 1.04 SUBMITTALS: Submittals shall be as specified in DIVISION 1, General Requirements. In addition, the following specific information shall be provided:
- A. Valve Type Number.
- 1.05 WARRANTY:
- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
 - B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

- 2.01 GENERAL:
- A. All valves shall be complete with all necessary operators, actuators, hand wheels, extension stems, worm and gear operators, operating nuts, wrenches, and other accessories or appurtenances which are required for the proper completion of the work.
 - B. Valves shall be suitable for the intended service. Renewable parts including discs, packing, and seats shall be of types recommended by valve manufacturer for intended service, but not of a lower quality than specified herein.
 - C. Valve and operators shall be suitable for the exposure they are subject to, interior or exterior, as applicable. They shall have all safety features required by OSHA.
 - D. Unless otherwise shown, valves shall be the same size as the adjoining pipe.
 - E. All units shall have the name of the manufacturer and the size of the valve cast on the body or bonnet or shown on a permanently attached plate in raised letters.
 - F. For the purpose of designating the type and grade of valve desired, a manufacturer's name and list or figure number is given in the following specifications. Valves of equal quality by other manufacturers will be considered in accordance with the General Conditions.

2.02 VALVE TYPES: The type of valve to be used for each service and application is shown on the Drawings.

2.03 VALVE OPERATORS:

- A. General: All valves shall be equipped with operators. The valve operator types, as specified herein, describe only the general characteristics of the operator. The operator shall be compatible with the valve that it will be used with and shall be of the same manufacturer, or a product that is recommended by the valve manufacturer.
- B. Manual Operators:
 - 1. General:
 - a. Manual hand wheel operators shall be provided unless otherwise shown or specified. Ferrous hand wheels shall be galvanized and painted the same color as the valve and associated pipeline. Lever operators may be supplied on quarter-turn type valves 8 inches and smaller, if recommended by the manufacturer; however, operator force shall not exceed 40 pounds under any operating conditions, including initial breakaway.
 - b. When the maximum force required to operate a valve under full operating head exceeds 40 pounds, gear reduction operators shall be provided. Gear operators shall be totally enclosed and lubricated.
 - c. On quarter-turn valves, the valve operators shall be of the self-locking type to prevent the disc or ball from creeping and shall be provided with position indicators to show the position of the valve disc or ball. Operators of the worm and gear type shall have self-locking worm gears, one-piece design, of gear bronze material, accurately machine cut. The worm shall be hardened alloy steel, with thread ground and polished. Operators of the geared traveling nut type shall have threaded steel reach rods with an internally threaded bronze or ductile iron nut.
 - 2. Exposed Operators:
 - a. Lever type operators shall have some means of being fixed in any given position to prevent accidental movement; shall be of rugged, noncorrosive construction; and shall be fully compatible with the valve.

2.04 VALVES:

- A. Gate Valves:
 - 1. Gate valves 2 inches and smaller shall be all-bronze with screwed bonnet and ends, single solid wedge gate, and rising stem. Valves shall be rated 125-pound SWP, 200-pound WOG, and shall be Stockham B105; Crane Co. Cat. No. 428; or equal.
- B. Ball Valves (Screwed and Solder ends):
 - 1. Brass or bronze body, screwed, blowout proof stem, Teflon seats and seals. Consolidated Brass "Apollo" Series 80, Crane 930-TF, Jamesbury 351, Jenkins 900T, Lunkenheimer, 780-HST, Powell 4120-T, Smith 140G, Whitey "60"Series.
 - 2. Brass or bronze body, solder ends, blowout proof stem, Teflon seats and seals. Consolidated Brass "Apollo" Series 70, Jenkins 902T, Whitey "60"Series.
- C. Butterfly Valves:
 - 1. Butterfly valves shall be iron body, lug type, bronze disc, replaceable EPT seat, minimum 2-inch neck length to clear insulation. Gear operated for sizes 6 inches and larger. Centerline Series LT, Crane Series 44N-BXZ, Dmeco Series NE, Jenkins Series 232E Powell 3110-BA-1.
- D. Check Valves:

1. Silent check valves shall be wafer style, iron body, bronze trim, center guided, with stainless steel springs. Valves shall be rated 150-pound WOG and shall be Mueller Steam Specialty 91AP, APCO Series 300, or equal.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Boltholes of flanged valves shall straddle the vertical centerline of the pipe run. Prior to installing flanged valves, the flange faces shall be thoroughly cleaned. After cleaning, insert gasket and bolts, and tighten the nuts progressively and uniformly. If flanges leak under pressure, loosen or remove the nuts and bolts, and retest the joints. Joints shall be watertight at pressures before acceptance.
- B. Thoroughly clean threads of screwed joints by wire brushing, swabbing, or other approved methods. Apply approved joint compound to threads prior to making joints. Joints shall be watertight at test pressures before acceptance.

- 3.02 PLACING: Generally, unless otherwise indicated on the Drawings, all valves installed in horizontal runs of pipe having centerline elevations 4 feet-6 inches or less above the finish floor shall be installed with their operating stems vertical. Valves installed in horizontal runs of pipe having centerline elevations between 4 feet-6 inches and higher above the finish floor shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems oriented to facilitate the most practicable operation.

3.03 TESTING:

- A. Valves shall be tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage under test. Repair joints that show signs of leakage prior to final acceptance. If there are any special parts of control systems or operators that might be damaged by the pipeline test, they shall be properly protected. The CONTRACTOR will be held responsible for any damage caused by the testing.
- B. If requested by the DISTRICT, the valve manufacturer shall furnish an affidavit stating the materials options furnished and/or that he has complied with these and other referenced specifications.

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END OF SECTION

SECTION 15121 BACKFLOW PREVENTERS

PART 1 - GENERAL

- 1.01 SCOPE: The Work covered by this Section consists of furnishing and installing backflow prevention devices as shown on the Drawings and as specified herein.
- 1.02 STANDARD REFERENCES: The following standard specifications shall apply to the work of this section:
- A. American Water Works Association (AWWA):
 - 1. C-506 - Standard for Backflow Prevention Devices, Reduced Pressure Principle and Double Check Valve types.
- 1.03 SUBMITTALS:
- A. Submit as specified in DIVISION 1.
 - B. The Contractor shall submit the following:
 - 1. Manufacturer's product data for each type of product included in this section.
- 1.04 QUALITY ASSURANCE: Each backflow prevention device shall be installed by a certified technician as described in PBCWUD's Cross Connection Control Manual.
- 1.05 WARRANTY:
- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
 - B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

- 2.01 ACCEPTABLE MANUFACTURERS: Subject to compliance with requirements, provide products of one of the following:

<u>MANUFACTURER</u>	<u>MODEL NO.</u>	<u>SIZE</u>
Wilkins (Neptune)	575	3/4" to 6"
Hersey (BEECO)	FRP II	3/4" to 2"
Watts	909-QT	3/4" to 2"
Febco	825-Y-RW	3/4" to 2"

- 2.02 BACKFLOW PREVENTERS:
- A. The Contractor shall provide backflow preventers that comply with requirements of governing authorities, for locations indicated.
 - B. The backflow preventers provided shall be of the reduced pressure principle type. Parts and materials shall be as shown on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. The Contractor shall install items included in this section at the locations indicated on the Drawings.
- B. Backflow preventers shall be installed by a certified Backflow Prevention Device Technician in accordance with PBCWUD rules.
- C. The Contractor shall be responsible for all required checkout and testing of the items and/or systems provided and installed under this section. Fittings, fasteners, other items, etc., shall be furnished and installed as required to make complete and workable installations at no additional cost to the District.

END OF SECTION

SECTION 15130 PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following types of HVAC pumps:
 - 1. Base-mounted pump.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, including Section 01600, apply to Work of this Section.

1.02 DESIGN REQUIREMENTS

- A. Pumps shall be selected so operating point is not more than 5 percent under maximum efficiency of impeller. Maximum efficiency of impeller shall be midway plus or minus 1/4 of published pump curve. The ratio of the maximum pump impeller diameter to the selected pump impeller diameter shall be 1.15 or greater. Motors shall be non-overloading at any point on the pump curve.
- B. The pump and motor combination shall be designed for outdoor service in an unprotected environment. The pumps/motors will be subjected to rain and wind.

1.03 SYSTEM RESPONSIBILITY

- A. Pump manufacturer may rely upon information on Pump Schedule pertaining to steady-state operating conditions, however, pump manufacturer shall be responsible to review this Specification Section, Section 01600, relevant pipe Drawings, schematics, and electrical and instrumentation Drawings to ensure that equipment offered is suitable for the purposes intended by the Contract Documents. Refer questions and clarifications to ENGINEER.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 01300, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Shop Drawings showing layout and connections for pumps. Include setting Drawings with templates, and directions for installation of foundation bolts, anchor bolts, and other anchorages.
 - 2. Product data including certified performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.
 - 3. CONTRACTOR shall submit to ENGINEER for approval performance curves on each pump. These curves shall include capacity, head, required NPSH efficiency and horsepower required for operation as shown on Pump Schedule and on Drawings.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730, operation and maintenance manuals for items included under this Section.

1.05 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Hydraulic Institute Compliance: Design, manufacture, and install pumps in accordance with "Hydraulic Institute Standards."
 - 2. National Electrical Code Compliance: Components shall comply with NFPA 70, "National Electrical Code."

3. UL Compliance: Pumps shall be listed and labeled by UL and comply with UL Standard 778, "Motor Operated Water Pumps."
4. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA. All motors shall be NEMA premium rated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Apply factory finish paint to assembled, tested units prior to shipping.
- B. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anti-corrosion compound. Protect flanges, pipe openings, and nozzles.
 1. Store pumps in a dry location.
 2. Retain shipping flange protective covers and protective coatings during storage.
 3. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- C. Comply with manufacturer's rigging instructions for handling, if required.

1.07 WARRANTY

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Base-Mounted Pump:
 - a. Bell & Gossett.
 - b. Aurora.
 - c. Taco.

2.02 BASE-MOUNTED PUMP

- A. Pumps shall be centrifugal end suction type. Pumps shall be motor driven through a flexible coupling, mounted on a common base. Pumps shall be bronze fitted.
- B. Casing: Pump casing shall be cast iron suitable for 175 psi working pressure and have replaceable bronze wearing rings. Supply casings with plugged vent, drain, and gauge tappings.
- C. Impeller: Provide enclosed type, bronze impeller which has been hydraulically and dynamically balanced and keyed to the shaft.
- D. Seal: The pumps shall be furnished with mechanical seals with carbon seal ring and ceramic seat, designed for 225 degrees F continuous service. Provide pump with drain pan and tapping for drain connection.
- E. Shaft and Sleeve: Provide shafts of stainless steel with stainless steel sleeve. The first critical speed of the rotor shall be 5,600 rpm or above.

- F. Pump Bearings: The bearing assembly shall be fitted with oil- or grease-lubricated ball bearings.
- G. Shaft Coupling: Pump shall be coupled to motor through a flexible coupling (1.15 safety factor) in such manner that the pump may be completely serviced without disconnecting piping and without disturbing pump or motor mounts. Coupler shall be covered with a removable metal coupler guard.
- H. Mounting Frame: Pumps are to be mounted on a rigid steel or cast iron sub base suitable for grouting.
- I. Motor: Provide totally enclosed, fan cooled, premium efficiency motors. Motors shall be premium efficiency based on IEEE-112 Method B per NEMA Standard MG1. Motors shall have Class F insulation and be suitable for continuous VFD use for variable torque loads. Motor nameplates shall be marked "For VFD Control". All motors shall be NEMA premium rated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. The following requirements apply to pumps furnished under this Section.
 - 1. Examine areas, equipment foundations, and conditions for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.
 - 2. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation.

3.02 EQUIPMENT BASES

- A. Install frame-mounted pumps on 4-inch-high reinforced pad 4 inches larger on each side than the pump base.

3.03 INSTALLATION

- A. Comply with manufacturer's written installation and alignment instructions.
- B. Install pumps in locations and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.
- D. Support pump base plate on rectangular metal blocks and shims, or on metal wedges having a small taper, at points near the foundation bolts to provide a gap of 3/4 to 1-1/2 inches between the pump base and the foundation for grouting.
- E. Adjust the metal supports or wedges until the pump and driver are level. Check the suction and discharge flanges of the pump to verify that they are level and plumb.
- F. After pumps are level, tighten the foundation bolts evenly but not too firmly.

3.04 CONNECTIONS

- A. Install valves that are same size as the piping connecting the pump.
- B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.
- C. Install a triple duty valve and butterfly valve on the discharge side of pumps.

- D. Install a pump suction diffuser and gate valve on the suction side of base-mounted pumps.
- E. Install flexible connectors on the suction and discharge side of each base-mounted pump. Install flexible connectors between the pump casing and the discharge valves and upstream from the pump suction diffuser.
- F. Install a pressure gauge at the suction and discharge of each pump at the integral pressure gauge tapings provided.
- G. Electrical and Control wiring and connections are specified in Division 16 Sections.

3.05 FIELD QUALITY CONTROL

- A. Check suction line connections for tightness to avoid drawing air into the pump.
- B. A factory-trained representative shall be furnished to check the installation of the water pump, start the pump system, and instruct personnel on its operation.

3.06 COMMISSIONING

- A. Final Checks Before Start-up: Perform the following preventative maintenance operations and checks before start-up:
 - 1. Lubricate oil-lubricated bearings.
 - 2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with manufacturer's recommendations.
 - 3. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
 - 4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
- B. Starting Procedure for pumps with shutoff power not exceeding the safe motor power:
 - 1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.
 - 2. Open the discharge valve slowly.
 - 3. Check the general mechanical operation of the pump and motor.
 - 4. If the pump is to be started against a closed check valve with the discharge valve open, the steps are the same except that the discharge gate valve is opened some time before the motor is started.

END OF SECTION

SECTION 15183 - HYDRONIC PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Piping systems for chilled water cooling and make-up water for this system. Piping materials and equipment specified in this Section include:
 - 1. Materials - pipe and valves.
 - 2. Special duty valves.
 - 3. Hydronic specialties.
- B. Related Documents: Drawing and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 DEFINITIONS

- A. Pipe sizes used in this Specification are nominal pipe size (NPS).

1.03 SYSTEM DESCRIPTION

- A. The hydronic piping systems are the "water-side" of air conditioning system. Hydronic piping systems specified in this Section include:
 - 1. Chilled water piping systems.

1.04 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01300, Submittals covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data, including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions for each hydronic specialty and special duty valve specified.
 - 2. Furnish flow and pressure drop curves or data for diverting fittings, automatic flow control valves, and calibrated plug valves based on manufacturer's testing.
 - 3. Welders' certificates certifying that welders comply meet the quality requirements specified in Quality Assurance below.
 - 4. Certification of compliance with ASTM and ANSI manufacturing requirements for pipe, fittings, and specialties.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730, operation and maintenance manuals for items included under this Section.
- C. Test and Inspection Report: Submit a written report to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 01410.

1.05 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following:
 - 1. ASME B 31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 - 2. Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
 - 3. ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualification," for qualifications for welding processes and operators.

4. Florida Building Code - Mechanical.

1.06 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate the installation of pipe sleeves or cored holes in existing walls for wall penetrations.

1.07 EXTRA STOCK

- A. Maintenance Stock: Furnish a sufficient quantity of chemical for initial system start-up and for preventative maintenance for 1 year from Substantial Completion.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Pump Discharge Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett ITT, Fluid Handling Division.
 - d. Taco, Inc.
 - 2. Pressure Reducing Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett ITT, Fluid Handling Division.
 - d. Taco, Inc.
 - 3. Safety Relief Valves:
 - a. Bell & Gossett ITT, Fluid Handling Division.
 - b. Dunham-Bush.
 - 4. Air Vents
 - a. Armstrong Machine Works.
 - b. Bell & Gossett ITT, Fluid Handling Division.
 - c. Hoffman Specialty ITT, Fluid Handling Division.
 - 5. Diaphragm Compression Tanks:
 - a. Amtrol, Inc.
 - b. Wessels.
 - c. Bell & Gossett ITT, Fluid Handling Division.
 - 6. Air Separators:
 - a. Amtrol, Inc.
 - b. Bell & Gossett ITT, Fluid Handling Division.
 - c. Taco, Inc.
 - 7. Pump Suction Diffusers:
 - a. Amtrol, Inc.
 - b. Bell & Gossett ITT, Fluid Handling Division.
 - c. Taco, Inc.
 - 8. Chemical Feeder (Shot Feeder):
 - a. Burmah Technical Services.
 - b. Culligan USA.
 - c. Vulcan Laboratories, Subsidiary of Clow Corp.
 - d. York-Shipley, Inc.
 - 9. Y-Pattern Strainers:

- a. Armstrong Machine Works.
- b. Hoffman Specialty ITT, Fluid Handling Division.
- c. Spirax Sarco.
- d. Victaulic Co. of America.
- e. Watts Regulator Co.

2.02 MATERIALS - PIPE AND VALVES

- A. Pipe materials shall comply with Section 15251 “piping for Heating and Air Conditioning Systems”.
- B. Pipe construction shall comply with Section 15010 “Piping”.
- C. Pipe supports and penetrations shall comply with section 15020 “Pipe Supports and Penetrations”.
- D. Valves and appurtenances shall comply with Section 15101 “Valves and Appurtenances”.

2.03 SPECIAL DUTY VALVES

- A. Pump Discharge Valves: Features shall include non-slam check valve with spring-loaded weighted disc, calibrated adjustment feature to permit regulation of pump discharge flow and shutoff, 175 psig working pressure, 300 degrees F maximum operating temperature, cast iron body, bronze disc and seat, stainless steel stem and spring, and Teflon packing. Valves shall have flanged or grooved ends to match piping system. Provide straight or angle pattern as indicated.
- B. Pressure-Reducing Valves: Diaphragm operated cast iron or brass body valve with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have the capability for field adjustment.
- C. Safety Relief Valves: 125 psig working pressure and 250 degrees F maximum operating temperature, designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast iron with all wetted internal working parts made of brass and rubber. Select valve to suit actual system pressure and Btu capacity.
- D. Combined Pressure/Temperature Relief Valves: Diaphragm-operated, cast iron or brass body valve with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment. Safety relief valve designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast iron with all wetted internal working parts made of brass and rubber, 125 psig working pressure and 250 degrees F maximum operating temperature. Select valve to suit actual system pressure and Btu capacity. Provide with fast fill feature for filling hydronic system.
- E. Drain Valves: Minimum of 3/4-inch hose bibb with threaded hose connection. Provide with hose cap.

2.04 HYDRONIC SPECIALTIES

- A. Air Vent:
 - 1. Manual: Minimum of 3/8-inch pipe stub with ball valve.
 - 2. Automatic: High capacity air vents with cast iron body and stainless steel, brass, and EPDM internals. Operating pressures up to 150 psig and temperatures up to 250 degrees F. Inlet of 3/4-inch minimum and discharge of 3/8-inch minimum.

- B. Diaphragm Compression Tanks: Tank shall be pre-charged diaphragm type with diaphragm made of heavy-duty butyl rubber. Tank shall be pre-charged to 12 psi and be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. Tank pressure shall be field adjustable.
- C. Air Separator: Welded black steel, ASME constructed and labeled for minimum 125 psig water working pressure and 375 degrees F operating temperature. Perforated stainless steel air collector tube designed to direct released air into compression tank, tangential inlet and outlet connections, screwed connections up to and including 2-inch NPS, flanged connections for 2-1/2-inch NPS and above, threaded blowdown connection sized as indicated for full system flow capacity.
- D. Pump Suction Diffusers: Cast iron body with threaded connections for 2-inch and smaller, flanged connections for 2-1/2-inch and larger, or grooved ends to match piping system; 175 psig working pressure, 300 degrees F maximum operating temperature; and complete with the following features:
 - 1. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
 - 2. Cylinder strainer with 3/16-inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
 - 3. Disposable fine mesh strainer to fit over cylinder strainer.
 - 4. Permanent magnet located in flow stream, removable for cleaning.
 - 5. Adjustable foot support designed to carry weight of suction piping.
 - 6. Blowdown tapping in bottom; gauge tapping in side.
- E. Y-Pattern Strainers: 125 psig working pressure, cast iron body (ASTM A 126, Class B) or ductile iron body (ASTM A 536), grooved coupling ends or flanged ends for 2-1/2-inch and larger and threaded connections for 2-inch and smaller, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.
- F. Chemical Feeder: Bypass type chemical feeders of 1.5-gallon capacity, cast iron construction; 125 psig working pressure; complete with fill funnel and inlet, outlet, and drain valves.
 - 1. Chemicals shall be specially formulated to prevent accumulation of scale and corrosion in piping system and connected equipment, developed based on a water analysis of make-up water.

PART 3 - EXECUTION

3.01 PIPING INSTALLATIONS

- A. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.
- B. Pipe Expansion: The installation of all pipes shall be such as to allow for expansion using offsets, swing joints, expansion joints, etc., as shown or as may be necessary to prevent undue strain on piping.
- C. All piping shall be installed in such a way that it will be free to expand and contract without noise or damage to itself or to the building.

3.02 HANGERS AND SUPPORTS

- A. Pipe supports and penetrations are specified in Section 15020 "Pipe Supports and Penetrations. Conform to the table below for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs. Size clevis to fit over the insulation, and provide insulation shields to allow for expansion and contraction of piping. See insulation specification for insulation shield details.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal runs.
 - 3. Pipe roller complete, MSS Type 44 for multiple horizontal runs supported on a trapeze.
 - 4. Spring hangers to support vertical runs (where required).

- C. Install hangers with the following minimum rod sizes and maximum spacing:

<u>Nominal Pipe Size</u>	<u>Max. Span Feet</u>	<u>Min. Rod Size Inches</u>
1	7	3/8
1-1/2	9	3/8
2	10	3/8
3	12	1/2
3-1/2	13	1/2
4	14	5/8
5	16	5/8
6	17	3/4

- D. Support vertical runs at each floor.

3.03 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
- B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:
1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 2. Align threads at point of assembly.
 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
 - a. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- C. Welded Joints: Comply with the requirement in ASME Code B31.9, "Building Services Piping."
- D. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.04 VALVE APPLICATIONS

- A. General-duty Valve Applications: Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
1. Shutoff Duty: Use butterfly, ball, and gate valves
 2. Throttling Duty: Use globe and butterfly valves
 3. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.
 4. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- B. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
- C. Install check valves on each pump discharge and elsewhere as required to control flow direction.

- D. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.
- E. Install safety relief valves as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves as required to regulate system pressure.

3.05 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in the system, and elsewhere as required for system air venting.
- B. Install in-line air separators in pump suction lines. Run piping to compression tank with 1/4 inch per foot (2 percent) upward slope towards tank. Install drain valve on units 2-inch and larger.
- C. Install pump suction diffusers on pump suction inlet; adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.
- D. Install pump discharge valves in horizontal or vertical position with stem in upward position. Allow clearance above stem for check mechanism removal.
- E. Install shot-type chemical feeders in each hydronic system where indicated in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line off main using globe valves on each side of feeder, and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
- F. Install compression tanks in accordance with the manufacturer's recommendations where shown on the drawings. Install gauge glass and cocks on end of tank. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

3.06 FIELD QUALITY CONTROL

- A. Preparation for Testing: Prepare hydronic piping in accordance with ASME B 31.9, and as follows:
 - 1. Leave joints including welds uninsulated and exposed for examination during the test.
 - 2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
 - 3. Flush system with clear water. Clean strainers.
 - 4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
 - 5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure to protect against damage by expansion of liquid or other source of overpressure during the test.
- B. Test Hydronic Piping as follows:
 - 1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
 - 2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of that liquid.
 - 3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low-pressure filling lines are disconnected.
 - 4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure

at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.

5. After the hydrostatic test pressure has been applied for at least ten minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

3.07 ADJUSTING AND CLEANING

- A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
- B. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- C. Chemical Treatment: Provide the services of a chemical treatment supplier to prepare a water analysis to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.08 COMMISSIONING

- A. Fill system and perform initial chemical treatment.
- B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
- C. Before operating the system perform these steps:
 1. Remove and clean strainers.
 2. Check pump for proper direction of correct improper wiring.
 3. Set automatic fill valves for required system pressure.
 4. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Check operation of automatic bypass valves.
 7. Check and set operating temperatures of chiller to design requirements.
 8. Lubricate motors and bearings.

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END OF SECTION

SECTION 15185 - REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Refrigerant piping used for air conditioning applications, including:
 - 1. Pipes, tubing, fittings, and specialties.
 - 2. Special-duty valves.
 - 3. Refrigerants.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, including Section 01600, apply to Work of this Section.
- C. Products Installed but not Furnished under This Section include: Refrigerant specialties and refrigerant accessories furnished as an integral part of or separately with the condensing units installed under this contract.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01300, Submittals covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Shop Drawings showing layout of refrigerant piping, specialties, and fittings including, but not necessarily limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and proximate to equipment. Refrigerant piping shall be sized in accordance with the manufacturer's recommendations for this application of installing new condensers to support existing Computer Room Air Conditioning (CRAC) units. Manufacturer to provide for sizing of new piping and verification of size of existing piping.
 - 2. Product data for items included under this Section, including:
 - a. Each type valve specified.
 - b. Each type refrigerant piping specialty specified.
 - 3. Brazer's certificates signed by CONTRACTOR certifying that brazers comply with requirements specified under Quality Assurance below.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

- A. Qualify brazing processes and brazing operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- B. Regulatory Requirements: Comply with provisions of the following codes:
 - 1. ANSI B31.5, ASME Code for Pressure Piping - Refrigerant Piping.
 - 2. ANSI/ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.
 - 3. Florida Building Code - Mechanical

1.04 SEQUENCING AND SCHEDULING

- A. Coordinate the installation PVC floor conduit modifications and wall penetrations in the Chiller enclosure.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Refrigerant Valves and Specialties:
 - a. Alco Controls Division, Emerson Electric.
 - b. Danfoss Electronics, Inc.
 - c. EATON Corporation, Control Division.
 - d. Henry Valve Company.
 - e. Parker-Hannifin Corporation, Refrigeration and Air Conditioning Division.
 - f. Sporlan Valve Company.

2.02 PIPE MATERIALS

- A. Materials shall conform to the Specification Section 15251, "Piping for Heating and Air Conditioning Systems".

2.03 VALVES

- A. Complete valve assembly shall be UL listed and designed to conform to ARI 760.
- B. Charging and Purging Valve, 3/8 to 5/8 inch: Forged brass, backed, non-backseating, bottom solder connection, side flare connection, seal caps, 300 degrees F maximum temperature, 500 psi maximum working pressure.

2.04 REFRIGERANT PIPING SPECIALTIES

- A. Complete refrigerant piping specialty assembly shall be UL listed and designed to conform to ARI 760.
- B. Strainers: 500 psig maximum working pressure; forged brass body with monel 80-mesh screen, and screwed cleanout plug, Y-pattern with solder-end connections.
- C. Moisture/Liquid Indicators: 500 psig maximum operation pressure, 200 degrees F maximum operating temperature, forged brass body with replaceable polished optical viewing window, and solder-end connections.
- D. Filter Dryers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder-end connections. Furnish complete with replaceable filter drier core kit including gaskets and standard capacity desiccant sieves to provide micronic filtration.
- E. Suction Line Filter Dryer: 350 psig maximum operation pressure, 225 degrees F maximum operating temperature, steel shell and wrought copper fittings for solder-end connections. Permanent filter element shall be molded felt core surrounded by a desiccant for removal of acids and moisture for refrigerant vapor.
- F. Suction Line Filters: 500 psig maximum operation pressure, steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder-end connections. Furnish complete with replaceable filter core kit, including gaskets.
- G. Flanged Unions: 400 psig maximum working pressure, 330 degrees F maximum operating temperature, 2 brass tail-piece adapters for solder-end connections to copper tubing, flanges for 7/8 inch through 1-5/8-inch unions shall be forged steel, and for 2-1/8-inch through 3-1/8-inch shall be ductile iron, 4 plated steel bolts with silicon bronze nuts and fiber gasket. Flanges and bolts shall have factory applied rust-resistant coating.

2.05 REFRIGERANT

- A. Refrigerant No. 22, in accordance with ASHRAE Standard 34. CONTRACTOR to verify refrigerant type with Liebert Corp for compatibility with existing CRAC units and new condensers.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine rough-in for refrigerant piping systems to verify actual locations of piping connections prior to installation.

3.02 PIPE APPLICATIONS

- A. If other than Type ACR tubing is used, clean and protect inside of tubing as specified in Article "Cleaning" below.

3.03 PIPING INSTALLATION

- A. Install refrigerant piping in accordance with ASHRAE Standard 15, "The Safety Code for Mechanical Refrigeration."
- B. Install piping in as short and direct arrangement as possible to minimize pressure drop.
- C. Install piping for minimum number of joints using as few elbows and other fittings as possible.
- D. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.
- E. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.
- F. Insulate Suction Lines. Liquid lines are not required to be insulated, except where they are installed adjacent and clamped to suction lines, where both liquid and suction lines shall be insulated as a unit.
 - 1. Do not install insulation until system testing has been completed and all leaks have been eliminated.
- G. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.
- H. Install copper tubing in protective covers as shown on the drawings in locations where copper tubing will be exposed to mechanical injury such as walkways in the chiller/condenser enclosure walkways.
- I. Slope Refrigerant Piping as follows:
 - 1. Install horizontal hot gas discharge piping with 1/2 inch per 10 feet downward slope away from the compressor.
 - 2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
 - 3. Install traps and double risers where indicated and where required to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- J. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.
- K. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

- L. Install unions to allow removal of solenoid valves, pressure-regulating valves, expansion valves, and at connections to compressors and evaporators.

3.04 HANGERS AND SUPPORTS

- A. Install refrigerant pipe supports similar to the existing supports. Materials shall be galvanized steel or stainless steel and isolated from the copper piping with suitable copper or non-metallic materials.

3.05 PIPE JOINT CONSTRUCTION

- A. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
 - 1. CAUTION: When solenoid valves are being installed, remove the coil to prevent damage. When sight glasses are being installed, remove the glass. Remove stems, seats and packing of valves, and accessible internal parts of refrigerant specialties before brazing. Do not apply heat near the bulb of the expansion valve.
- B. Fill the pipe and fittings during brazing, with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.

3.06 VALVE INSTALLATIONS

- A. Install refrigerant valves where indicated and in accordance with manufacturer's instructions.
- B. Install globe valves on each side of strainers and dryers, in liquid and suction lines at evaporators, and elsewhere as indicated or required.
- C. Install a full sized, 3-valve bypass around each drier.
- D. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

3.07 EQUIPMENT CONNECTIONS

- A. Install piping adjacent to machine to allow servicing and maintenance.

3.08 FIELD QUALITY CONTROL

- A. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI.
- B. Repair leaking joints using new materials, and retest for leaks.

3.09 CLEANING

- A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:
 - 1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.
 - 2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - 3. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - 4. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

3.10 ADJUSTING AND CLEANING

- A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
- B. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.11 COMMISSIONING

- A. Charge System using the following procedure:
 - 1. Install core in filter dryer after leak test but before evacuation.
 - 2. Evacuate refrigerant system with vacuum pump until temperature of 35 degrees F is indicated on vacuum dehydration indicator.
 - 3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
 - 4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
 - 5. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.
 - 6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.
- B. Train OWNER's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.
- C. Review data in Operating and Maintenance Manuals. Refer to Section 01600.

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END OF SECTION

SECTION 15251 PIPING FOR HEATING AND AIR CONDITIONING SYSTEMS

PART 1 - GENERAL

- 1.01 SCOPE: The Work of this Section shall consist of furnishing all labor, materials, and equipment necessary for installation of piping for heating and air conditioning systems as shown on the Drawings and specified herein.
- 1.02 CONDITIONS OF THE CONTRACT APPLY:
- 1.03 WARRANTY:
 - A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
 - B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

- 2.01 PIPE AND FITTINGS: (See schedule on page 15251-3)

- A. All pipe and fittings shall be of domestic manufacture.

<u>SERVICE</u>	<u>PIPE MATERIAL TYPE</u>
Chilled Water	1 & 5 – See Drawings for limits
Refrigerant Piping	6
Cold Water Make-Up	5
Chemical Feed for Hot & Chilled Water System	1
Miscellaneous Drains (not listed above)	1
Water treatment piping and underground conduit.	7

- 2.02 COPPER PIPE JOINTS:

- A. Joints in copper tubing for water service shall be made with a non-corrosive paste flux and solid string solder composed of 95 percent tin and 5 percent antimony. 50-50 solder will not be permitted.
- B. Joints in copper tubing for refrigerant piping shall be silver brazed with silver solder having a melting point in excess of 1000 degrees Fahrenheit.

- 2.03 PVC JOINTS:

- A. Joints in PVC piping installed in the chiller and condenser enclosures for the water treatment system piping and the PVC conduit for the underground refrigerant piping shall be made with solvent cement. Provide flanged connections to all valves.

PIPE AND FITTINGS SCHEDULE

TYPE	PIPE SIZES	PIPE MATERIAL	STANDARD	FITTING MATERIAL	STANDARD
1	2" and Smaller	Sch. 40 Black Steel, Butt Welded	ASTM A53 TYPE F	150 lb. Black Malleable Iron, Screwed	ASME/ANSI B16.3
1	2-1/2" thru 10" Incl.	Sch. 40 Black Steel, Butt Welded	ASTM A53 TYPE E	Standard Weight Butt Welding Type	ASME/ANSI B16.9, ASTM A234
5	All Sizes	Type "L" Hard-Drawn Copper	ASTM B88-76	Wrought Copper Solder Joint	ASME/ANSI B16.22-73
6	All Sizes	Type "K" Hard-Drawn Copper	ASTM B88-76	Wrought Copper Silver Brazed Joint	ASME/ANSI B16.22-73
7	All Sizes	Sch. 40 PVC	ASTM D1785	Sch. 40 Socket and Flanged	ASTM D1785

2.04 FLANGES AND UNIONS:

- A. Union joints in pipe 2 inches and smaller and flange joints in pipe 2-1/2 inches and larger shall be provided in each pipe line preceding the connection to each piece of equipment. Unions and flanges shall be black or galvanized to match the piping system in which installed.
- B. Flanges shall be faced true and provided with 1/16-inch ring type asbestos gasket conforming to ANSI Standard B16.21-1962. Flanges shall have a raised or flat face to mate with adjacent flanges or valves, fittings and equipment.
 - 1. Flanges in threaded pipe lines shall be 125 lb. cast-iron screwed flanges conforming to Federal Specification WW-F-406C.
 - 2. Flanges in welded pipe lines shall be 150-lb. steel slip-on type welding flanges conforming to ASTM A181-68 and dimensions in accordance with ANSI Standard B16.5-1973.
 - 3. Flange bolts shall be carbon steel, all threaded type, and nuts shall be carbon steel hexagon type. Steel for bolts and nuts shall conform to ASTM A307-74, Grade A for use with steel flanges and Grade B for use with cast-iron flanges.
- C. Unions shall be 150-lb. malleable iron type, screwed, conforming to Federal Specification WW-U-531C.
 - 1. Unions provided between copper and ferrous pipe connections shall be the insulated type to separate dissimilar metal connections in piping systems and prevent galvanic corrosion. Refer to SECTION 15120 Miscellaneous Piping Specialties.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Pipes shall have burrs removed by reaming.
- B. Changes in direction of piping shall be made with fittings.
- C. Changes in pipe sizes in horizontal lines shall be made with eccentric reducing couplings, except reducing tees and reducing elbows will be allowed for connections for pressure gauges and gauge cocks, for thermometers and test wells, and for pipe mounted insertion-type temperature control devices. In chilled water lines eccentric reducing couplings shall be installed with the flat side on top to maintain the top of the pipe line flush.. Reducing tees, reducing elbows and concentric reducing couplings will be allowed for changing pipe sizes in vertical risers and for making connections to

equipment from vertical risers except in pump suction lines eccentric reducing couplings only will be allowed.

3.02 QUALIFICATIONS OF WELDERS:

- A. All Welders employed for the work shall be qualified under the requirements of American National Standards for Institute Specification B31.1.0, Section 127.5.
- B. Evidence of welders' qualifications shall be submitted to the DISTRICT before any welds are made.

3.03 PIPE JOINTS:

- A. Screw Joints for Steel Pipe: After cutting and before threading, pipe shall be reamed and shall have burrs removed. Screw joints shall be made with tapped threads. Screw joints shall be made with graphite and oil applied to male threads only. Caulking of threaded joints to stop or prevent leaks will not be permitted.
- B. Welded joints shall be fusion-welded. Changes in direction of piping shall be made with welding fittings only. Mitering of notching pipe to form elbows and tees will not be permitted. Branch takeoffs at 90 degrees from mains shall be made with welded tee fittings, except where main size is larger than 2 inches. Factory fabricated forged steel shaped fittings may be used in lieu of welding tees if the main is two pipe sizes or more larger than the branch takeoff; shaped fittings shall be weldolets for branch sizes 2-1/2 inches and larger and threadolets for branch sizes 2 inches and smaller; branch takeoffs at 45 degrees to mains shall be made with factory fabricated latrolets.
 - 1. Defective Welding: Defective welds shall be removed and replaced at no additional cost to the DISTRICT. Repairing of defective welds by adding new material over the defects or by peening will not be permitted.
- C. Copper tubing shall be cut square and burrs shall be removed. Both inside and outside of tubing shall be cleaned with emery cloth before joining.

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END OF SECTION

SECTION 15670 - CONDENSING UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Air-cooled condensing units.
- B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, including Section 01600, apply to Work of this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01300, Submittals covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submit manufacturer's technical product data/Shop Drawings, including rated capacities of selected model clearly indicated, weights (shipping, installed, and operating), dimensions, required clearances, and methods of assembly of components, furnished specialties and accessories; and installation and start-up instructions.
 - 2. Wiring Diagrams: Submit ladder-type wiring diagrams for power and control wiring required for final installation of condensing units and controls. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Capacity ratings for condensing units 135,000 Btuh or greater shall be in accordance with (ARI) Standard 360, "Standard for Commercial and Industrial Unitary Air Conditioning Equipment." Refrigeration system of condensing units shall be constructed in accordance with ASHRAE Standard ASHRAE 15, "Safety Code for Mechanical Refrigeration."
 - 2. Condensing units shall be listed by UL and have UL label affixed.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Handle condensing units and components carefully to prevent damage. Follow manufacturer's written instructions for rigging. Replace damaged condensing units or components.
- B. Store condensing units and components in clean dry place off the ground. Protect from weather, water, and physical damage.

1.05 WARRANTY

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than five years from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, the new condensing units shall be the product of the Liebert Company and be matched to the new Computer Room Air Conditioning Units (CRAC) specified in Section 15731 to provide air conditioning performance at the CRAC Units as specified. No substitution is permitted.

2.02 AIR-COOLED CONDENSING UNITS

- A. Factory assembled and tested air-cooled condensing units consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls. Capacities and electrical characteristics are scheduled on Drawings. Capacities listed are nominal capacities and the manufacturer shall make the final selection of the condensing units and capacities to support the capacities of the new CRAC units served considering the installation, location of condensing units and configuration of refrigerant piping system. The refrigerant shall be R-407C.
- B. Unit Casings: Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to controls, condenser fans, motors, and drives.
- C. Controls: Operating and safety controls shall include condenser fan motors with thermal and overload cutouts. Control transformer, if required, shall be 115 volts. Provide magnetic contactors for condenser fan motors. Additional features include:
 - 1. A locking disconnect switch, factory mounted and wired, for single external electrical power connection.
 - 2. An indoor unit interlock circuit shall enable condenser operation whenever indoor unit compressors are active.
 - 3. Only supply wiring and indoor unit interlock wiring are required at condenser installation.
- D. Condenser coil: Condenser coil shall be constructed of copper tubes in a staggered tube pattern. Tubes shall be expanded in continuous, corrugated aluminum fins. The fins shall have full depth fin collars completely covering the copper tubers which shall be connected to heavy wall Type L headers. Inlet coil connector tubes shall pass through relieved holes in the tube sheet for maximum resistance to piping strain and vibration. The hot gas and liquid lines shall be spun shut and shall include factory installed Schrader valve. Coils shall be factory leak tested at a minimum of 300 psig, dehydrated, then filled and sealed with a nitrogen holding charge for shipment. Field relief of the Schrader valve shall indicate a leak free system. The condenser coil shall have a factory dipped phenolic (Heresite) corrosion resistant coil coating applied. Coating shall be in accordance with the condenser manufacturer's recommendations and applied by fully submerging the condenser coil in the coating material in accordance with the coating material manufacturer's recommendations to ensure all surfaces receive the coating. The number of coats applied shall be in accordance with the coating manufacturer's recommendations and procedures. The finished coated coil shall meet the performance requirements of the unit and fin spacing and coil size shall be selected to accommodate the use of the selected coating. The coating shall be applied during the or after manufacturer of the coil, but prior to delivery the jobsite. Jobsite application of the corrosion coating is unacceptable.
- E. Condenser Fans and Motors: Propeller type condenser fans for vertical air discharge direct drive. Additional features include:
 - 1. Fan motors shall be continuous air over design and shall be equipped with rain shield and permanently sealed bearings. Motors shall be rigidly mounted on die-formed galvanized steel supports.
 - 2. Separate motor for each condenser fan.
 - 3. Fans shall be factory balanced and run before shipment.
 - 4. Fan guards shall be heavy gauge, close meshed steel wire with a corrosion resistant PVC finish that shall be rated to pass a 675 hour salt spray test.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify mounting pads installations are completed to the proper point to allow installation of units. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install condensing units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support:
 - 1. Install ground-mounted units on 4-inch-thick reinforced concrete pad, 4 inches larger on each side than condensing unit. Concrete is specified in Division 3. Coordinate installation of anchoring devices.
- C. Air-Cooled Condensing Units: Connect refrigerant piping to unit; maintain required access to unit.
 - 1. Install furnished field-mounted accessories.
 - 2. Refrigerant piping sizes and configuration shall be selected/verified by the condensing unit manufacturer.

3.03 FIELD QUALITY CONTROL

- A. Testing: Charge systems with refrigerant and oil, and test for leaks. Repair leaks and replace lost refrigerant and oil.

3.04 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start condensers under provisions of Section 01640 Start Up/Check Out/Manufacturer's Field Services for Contractor Furnished Equipment.
- B. Supply service of factory-trained representative for a period of four (2) days per unit to supervise testing, dehydration and charging of systems, start-up, and instruction on operation and maintenance to Owner. Coordinate services of factory representative with installation of the Computer Room Air Conditioning Units specified in Section 15731.
- C. Supply initial charge of refrigerant and oil.

3.05 DEMONSTRATION

- A. Provide services of manufacturer's authorized service representative to provide start-up service and to instruct OWNER's personnel in operation and maintenance of condensing units.
- B. Start-up condensing units in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- C. Train OWNER's personnel on start-up and shutdown procedures, troubleshooting procedures, servicing, and preventative maintenance schedule and procedures. Review with OWNER's personnel the data contained in the operating and maintenance manuals.

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END OF SECTION

SECTION 15682 AIR-COOLED WATER CHILLERS

PART 1- GENERAL

1.01 SUMMARY:

- A. This section includes: Extent of air-cooled water chillers. Work required by this Section as indicated on Drawings and by requirements of this Section.
- B. Types of air-cooled water chillers specified in this Section include the following:
 - 1. Outdoor high efficiency unit located in chiller enclosure (CH-2)
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.
 - 1. Interlock wiring, specified as factory installed, is Work of this Section.
 - 2. Starters & disconnects switch.
- D. Refer to Division 16 for the following Work; not Work of this Section:
 - 1. Power supply wiring from power source to power connection on units.
 - 2. Interlock wiring between electrically operated units and between equipment and field-installed control devices.

1.02 SUBMITTALS:

- A. Shop Drawings: Submit in accordance with Section 01300, Submittals covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories, and installation and start-up instructions.
 - 2. Submit manufacturer's assembly-type Shop Drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
 - 3. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to the air-cooled chillers. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of air-cooled chillers and controls. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air-cooled water chillers of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Conform to ANSI/ARI 590 code for testing and rating of reciprocating water chillers.
 - 2. Conform to ANSI/UL 465 code for construction of reciprocating water chillers and provide UL label.

3. Conform to ANSI/ASME SEC 8 Boiler and Pressure Vessel Code for construction and testing of reciprocating water chiller.
4. Conform to ANSI/ASHRAE 15 code for construction and operation of reciprocating water chiller.
5. Provide certification of inspection for conforming authority having jurisdiction approval.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. Handle air-cooled water chillers and components carefully to prevent damage, breaking, denting, and scoring. Do not install damaged packaged heating and cooling units or components; replace with new.
- B. Store units and components in clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with manufacturer's rigging and installation instructions for unloading air-cooled water chillers and moving units to final location for installation.

1.05 TRAINING:

- A. Provide services of manufacturers' technical representative to instruct Owner's personnel in operation and maintenance of the air cooled water chillers.
- B. Schedule training with the Engineer, provide at least 7-day notice to the Engineer of training date.
- C. All training shall be in accordance with Section -01664 – Training.
- D. Provide (2) days of training instructions in operation and maintenance of the air cooled water chiller equipments and associated controls. Each day shall consist of four (4) hours of classrooms training and four hours (4) of in field training.

1.06 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship for parts and labor, for no less than five years from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

1.07 MAINTENANCE:

- A. The manufacture shall furnish service and maintenance of complete assembly including material and labor for one (1) year from substantial completion. During the one (1) year period, the following items shall be included.
 1. Quarterly operational inspections including “logging out” chiller to confirm control and sensor operation.
 2. Condenser coil cleaning.
 3. Oil analysis on both circuits.
 4. Quarterly inspection reports which will be reviewed with the Owner.

PART 2 -PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with specified performance requirements and physical size envelope, the air cooled chiller shall be the product of the Trane Company and of the Model Number shown on the Drawings. No substitution is permitted.

2.02 AIR COOLED CHILLER:

A. General

1. Provide factory assembled and tested outdoor air-cooled liquid chillers consisting of compressors, condenser, evaporator, refrigeration accessories, control panel and all components required for complete operation. Construction rating shall be in accordance with ANSI/ARI 590. See schedules on drawings for equipment capacities.
2. Units shall be leak and pressure tested at 390 psig high side, 250 psig low side, then evacuated and charged. All Air-Cooled Chillers shall be factory testes prior to shipment. Packaged units shall ship with a full operating charge of oil and refrigerant. Unit panels, structural elements and control boxes shall be constructed of galvanized steel and mounted on a welded structural steel base. Unit panels and control boxes shall be finished with a baked on powder paint, and the structural base with air dry paint. All paint shall meet the requirements of outdoor equipment of the US Navy and other federal government agencies.
3. All motors shall be NEMA premium rated.

B. Evaporator

1. Provide a tube-in-shell heat exchanger design with internally and externally finned copper tubes roller expanded into the tube sheet. The evaporator shall be designed, tested and stamped in accordance with ASME for refrigerant side working pressure of 200 psig. The evaporator shall be designed for a water side working pressure of 150 psig. Water connections shall be grooved pipe. Each shell shall include a vent, a drain and fittings for temperature control sensors and be insulated with 3/4-inch equal insulation (K=0.26). Evaporator heaters with thermostat shall be provided to help protect the evaporator from freezing at ambient temperatures down to -20°F). Factory installed flow switch shall be installed on a pipe stub in evaporator inlet.

C. Condenser and Fans

1. Air-cooled condenser coils shall have copper or aluminum fins mechanically bonded to internally finned seamless copper tubing. The condenser fins shall have a corrosion resistant coating applied. Coating shall be applied by fully submerging condenser in coating (dip method) to ensure all surfaces receive the coating. Coating shall be applied during or after manufacturer, but before delivery to the jobsite. Jobsite application of corrosion coating is unacceptable. The condenser coil shall have an integral sub-cooling circuit. Condensers shall be factory proof and leak tested at 506 psig. Direct vertical discharge condenser fans shall be balanced. Totally enclosed air over motors shall be provided to completely seal the motor windings to prevent exposure to ambient conditions. Three-phase condenser fan motors with permanently lubricated ball bearings and internal thermal overload protection shall be provided. Standard units shall start and operate between 25 to 115°F (-4 to 46°C) ambient.

D. Compressor and Lube Oil System

1. The compressor shall be rotary screw, semi-hermetic, direct drive, 3600 rpm, 60 Hz, with capacity control slide valve, a load/unload valve, rolling element bearings, differential refrigerant pressure oil pump and oil heater. The motor shall be a suction gas cooled, hermetically sealed, two-pole squirrel cage induction motor. Oil separator and filtration devices shall be provided separate from the compressor. Check valves in the compressor discharge and lube oil system and a solenoid valve in the lube system shall be provided.

E. Refrigeration Circuits

1. Each unit shall have two (2) refrigerant circuits, with one (1) or two (2) rotary screw compressors per circuit. Each refrigerant circuit shall include a compressor suction and

discharge service valve, liquid line shutoff valve, removable core filter, liquid line sight glass with moisture indicator, charging port and an electronic expansion valve. Fully modulating compressors and electronic expansion valves shall provide variable capacity modulation over the entire operating range.

F. Unit Controls

1. Controls shall be housed in an outdoor rated weather tight enclosure with removable plates to allow for connection of power wiring and remote interlocks. All controls, including sensors, shall be factory mounted and tested prior to shipment. Microcomputer controls shall provide all control functions including startup and shut down, leaving chilled water temperature control, evaporator flow proving, compressor and electronic expansion valve modulation, fan sequencing, anti-recycle logic, automatic lead/lag compressor starting and load limiting. The unit control module, utilizing Adaptive Control™ microprocessor, automatically shall take action to avoid unit shut down due to abnormal operating conditions associated with low refrigerant pressure, high condensing pressure and motor current overload. Should the abnormal operating condition continue until a protective limit is violated, the unit shall be shut down. Unit protective functions shall include loss of chilled water flow, evaporator freezing, loss of refrigerant, low refrigerant pressure, high refrigerant pressure, reverse rotation, compressor starting and running over current, phase low, phase imbalance, phase reversal, and loss of oil flow. A digital display shall indicate chilled water setpoint and leaving chilled water temperature. Current limit setpoint, evaporator and condenser refrigerant pressures, and electrical information shall be provided. Displays shall be visible on the unit without opening any panel doors. Power connections shall include main three phase power to the compressors, condenser fans and control power transformer. Provide a BACnet communications interface.
2. The unit shall be provided with all the hardware required to communicate the following control points to the existing Siemens EMCS.
 - a. Chiller start/stop
 - b. Chiller status (on/off)
 - c. Chilled water temperature set point.
 - d. Entering chilled water temperature
 - e. Leaving chilled water temperature.
 - f. Evaporator refrigerant pressure (each circuit).
 - g. Evaporator refrigerant temperature (each circuit).
 - h. Condenser refrigerant pressure (each circuit).
 - i. Condenser refrigerant temperature (each circuit).
 - j. All available fault codes and/or alarms.
 - k. Energy consumption.

G. Starters

1. Starters shall be housed in a weather tight enclosure with removable cover plate to allow for customer connection of power wiring. Across-the-line starters shall be provided. Helical rotary screw compressors shall be full speed in one second when started across-the-line and have equivalent inrush with similar size reciprocating compressor with part wind starters.

H. Chilled Water Reset

1. Provide the control logic and factory installed sensors to reset leaving chilled water temperature. The setpoint shall be reset based on ambient temperature.

I. Flow Control

1. The factory installed flow switch shall be provided with the control logic and relays to turn the chilled water flow on and off as the chiller requires for operation and protection.
- J. Electrical
1. Provide non-fused molded case disconnect switch (UL approved) to disconnect the chiller from main power pre-wired from the factory with terminal block power connections. The external operator handle shall be lockable.
- K. Miscellaneous Accessories
1. Provide neoprene isolators to help eliminate vibrator transmission.

PART 3 -EXECUTION

3.01 INSPECTION:

- A. Examine areas and conditions under which packaged heating and cooling units are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF AIR-COOLED WATER CHILLERS:

- A. Install in accordance with manufacturer's instructions.
- B. Align chiller package on steel foundations on the roofs as shown on the drawings.
- C. Install units with vibration isolation.
- D. Connect to electrical service. Refer to Electrical.
- E. Connect to chilled water piping, refer to Section 15183. On inlet, provide thermometer well for temperature controller, thermometer well for temperature limit controller, flow switch, flexible pipe connector, and shut-off valve. On outlet, provide flexible pipe connector, shut-off and balancing valves.
- F. Arrange piping fore easy dismantling to permit tube cleaning.

3.03 MANUFACTURER'S FIELD SERVICES:

- A. Prepare and start systems under provisions of Section 01465.
- B. Supply service of factory-trained representative for a period of two (2) days to supervise testing, dehydration and charging of machine, start-up, and instruction on operation and maintenance to Owner.
- C. Supply initial charge of refrigerant and oil.

3.04 DEMONSTRATION:

- A. Provide systems demonstration.
- B. Demonstrate system operation and verify specified performance.

END OF SECTION

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SECTION 15731 COMPUTER ROOM AIR CONDITIONING UNITS

PART 1 - GENERAL

- 1.01 SCOPE: Section includes requirements for computer room air conditioning systems (computer room air conditioning units –CRAC units). The systems 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 of the room.

The provisions of Part 1, General Documents, and DIVISION 1, General Requirements, apply to this section. These general provisions for mechanical work shall apply to all sections of DIVISION 15

- 1.02 DESIGN REQUIREMENTS: The precision cooling system shall be a Liebert, self-contained, factory-assembled unit with Downflow air delivery. The system shall have a total cooling capacity of 202,500 BTU/H, (kW) with a sensible cooling capacity of 176,800 BTU/H (kW) Chilled Water & Air-Cooled Operation based on an entering air temperature of 75 *F (*C) dry bulb and 62.5 *F (*C) wet bulb. The unit is to be supplied with 460 volt 3 ph 60 Hz electrical service. 65,000 amps rms Short Circuit Current Rating.

1.03 SUBMITTALS:

- A. Shop Drawings: Submit in accordance with Section 01300, Submittals covering the items included under this Section. Submit manufacturer's data for approval before any work is commenced. Shop Drawing submittals shall include:

1. Submit manufacturer's technical product data/Shop Drawings, including rated capacities of selected model clearly indicated, weights (shipping, installed, and operating), dimensions, required clearances, and methods of assembly of components, furnished specialties and accessories; and installation and start-up instructions. Include Single-Line Diagrams; Dimensional, Electrical and Capacity Data; Piping and Electrical Connection Drawings.
2. Wiring Diagrams: Submit ladder-type wiring diagrams for power and control wiring required for final installation of computer room air conditioning units and controls. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01730, operation and maintenance manuals for items included under this Section.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. Handle computer room air conditioning units and components carefully to prevent damage. Follow manufacturer's written instructions for rigging. Replace damaged condensing units or components.
- B. Store computer room air conditioning units and components in clean dry place off the ground. Protect from weather, water, and physical damage.

1.05 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than five years from the date of

Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.

- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 – PRODUCTS

2.01 MANUFACTURERS: Subject to compliance with specified requirements, the Computer Room Air Conditioning Units (CRAC) shall be the product of the Liebert Company and be matched by the manufacturer to the new condensing units specified in Section 15670 to provide complete operating systems. No substitution is permitted.

2.02 COMPUTER ROOM AIR CONDITIONING UNITS (CRAC-1 AND CRAC-2):

- 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.
- B. Downflow Air Supply: The supply air shall exit from the bottom of the unit, with the air scrolled towards the front of the unit.
- C. Downflow Air Return: The return air shall enter the unit from the top.
- D. Exterior Panels: The exterior panels shall be insulated with a minimum 1" (25mm), 1.5 lb. (0.68 kg) density fiber insulation. The main front panel shall have captive 1/4 turn fasteners. The main unit color shall be Light Gray Z-0430.
- E. Filters, Downflow Unit: The filter chamber shall be located within the cabinet, and filters shall be removable from the top of the unit. Filters shall be arranged in a V-bank configuration to minimize air pressure drop.
- F. Filters, 4": Filters shall be deep pleated 4" filters with a MERV 8 rating.

2.03 BLOWER SECTION: The fan section shall be designed for 10,000 CFM at an external static pressure of 0.2 in. wg. (49.8 Pa). The fans shall be the centrifugal type, double width double inlet and shall be statically and dynamically balanced as a completed assembly to a maximum vibration level of two mils in any plane. The shaft shall be heavy duty steel with self-aligning pillow block ball bearings with a minimum L3 life of 200,000 hours. The fans shall be located to draw air over the A-Frame coil to ensure even air distribution and maximum coil performance. A static regain duct shall be factory-installed to the bottom of the blower.

- A. Motor: The fan motor shall be 7.5 hp (5.6 kW) at 1750 RPM @60Hz, mounted to a spring-tensioning base. The motor shall be removable from the front of the cabinet.
 - 1. Premium Efficiency Motor: The fan motor shall be Open Drip-Proof, Premium efficiency and shall meet NEMA and EPACT minimum efficiency standards.
- B. 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.

- 2.04 HUMIDIFIER: A humidifier shall be factory-installed inside the unit. Bypass air slots shall be included to enable moisture to be absorbed into the air stream. The humidifier capacity shall be 22.0 lb/hr (kg/hr). The humidifier shall be removable from the front of the cabinet.
- A. Infrared Humidifier: The humidifier shall be of the infrared type consisting of high intensity quartz lamps mounted above and out of the water supply. The humidifier pan shall be stainless steel and arranged to be removable without disconnecting high voltage electrical connections. The complete humidifier section shall be pre-piped, ready for field connection to water supply. The humidifier shall be equipped with an automatic water supply system and shall have an adjustable water-overfeed to prevent mineral precipitation. A high-water detector shall shut down the humidifier to prevent overflowing.
- 2.05 REHEAT: The precision cooling unit shall include a factory-installed reheat to control temperature during dehumidification.
- A. Three -Stage Electric Reheat: The electric reheat coils shall be low watt density, 304/304 stainless steel fin tubular construction, protected by thermal safety switches, shall be 51,200BTU/ H, 15.0 kW, controlled in three stages. The reheat elements shall be removable from the front of the cabinet.
- 2.06 DUAL REFRIGERATION SYSTEM: Each unit shall include two (2) independent refrigeration circuits and shall include hot gas mufflers (semi-hermetic compressors units only), 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.
- A. Dual Scroll Compressors: The compressor shall be scroll-type. The compressor shall be suction gas cooled motor, vibration isolators, thermal overloads, automatic reset high pressure switch with control lockout after three failures, pump down low pressure transducer, suction line strainer, rotalock service valves, a maximum operating speed of 3500 RPM.
- B. Evaporator Coil: The evaporator coil shall be A-frame design with offset orientation and have 24.7 sq. ft. (m²) face area, three rows deep. It shall be constructed of rifled copper tubes and aluminum fins and have a maximum face velocity of 384.6 ft. per minute (m/s) at 9,600 CFM. A stainless steel condensate drain pan shall be provided.
- C. 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. Refrigerant shall be field supplied and field charged on air-cooled systems.
- 2.07 ICOM MICROPROCESSOR CONTROL WITH LARGE GRAPHIC DISPLAY: The iCOM unit control shall be factory set-up 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:
- A. Compressor Short Cycle Control - Prevents compressor short-cycling and needless compressor wear.
- B. System Auto Restart - The auto restart feature will automatically restart the system after a power failure. Time delay is programmable.
- C. 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.

- D. 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.
- E. The iCOM control shall be compatible with all Liebert remote monitoring and control devices. Provide a BACnet communications interface.
- F. The iCOM 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, esthetically pleasing housing. The display & 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 percent 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.
- G. The User Menus Shall be Defined as Follows:
1. Active Alarms: Unit memory shall hold the 200 most recent alarms with time and date stamp for each alarm.
 2. Event Log: Unit memory shall hold the 400 most recent events with id number, time and date stamp for each event.
 3. Graphic Data View: Eight graphic records shall be available: return air temperature, return air humidity, supply air temperature, outdoor temperature and four custom graphs.
 4. 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.
 5. Total Run Hours: Menu shall display accumulative component operating hours for major components including compressors, Econ-O-Coil (FC), fan motor, humidifier and reheat.
 6. 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.
 7. Display Setup: Customer shall pre-select the desired grouping of display languages at the time of the order from the following choices:

Group 1: English, French, Italian, Spanish, German
Group 2: English, Russian, Greek
Group 3: English, Japanese, Chinese, Arabic

8. Service Contacts: Menu shall allow display of local service contact name and phone number. The Service Menus Shall be Defined as Follows:

Setpoints: Menu shall allow set points within the following ranges:

Temperature Set point 65-85°F (18-29°C)*
Temperature Sensitivity +1-10°F (0.6-5.6°C)
Humidity Set point 20-80% RH*
Humidity Sensitivity 1-30% RH
High Temperature Alarm 35-90°F (2-32°C)
Low Temperature Alarm 35-90°F (2-32°C)
High Humidity Alarm 15-85% RH
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.

Standby Settings/Lead-Lag: Menu shall allow planned rotation or emergency rotation of operating and standby units.

Timers/Sleep Mode: Menu shall allow various customer settings for turning on/off unit.

9. Alarm Setup: Menu shall allow customer settings for alarm notification (audible/local/remote). The following alarms shall be available:

High Temperature
Low Temperature
High Humidity
Low Humidity
Short Cycle
Compressor Overload (Optional)
Main Fan Overload (Optional)
Humidifier Problem
High Head Pressure
Change Filter
Loss of Air Flow
Low Suction Pressure
Loss of Power
Custom Alarm (#1 to #4)

10. Custom alarms are four customer accessible alarm inputs to be indicated on the front panel. Custom alarms can be identified with prepared (programmed) alarm labels for the following frequently used inputs:

Water Under Floor
Smoke Detected
Loss of Water Flow
Standby Unit On

11. User customized text can be entered for two of the four custom alarms. Each alarm (unit and custom) can be separately enabled or disabled, selected activate the common alarm and programmed for a time delay of 0 to 255 seconds.

12. Audible Alarm: The audible alarm shall annunciate any alarm that is enabled by the operator.

13. Common Alarm: A programmable common alarm shall be provided to interface user selected alarms with a remote alarm device.
 14. Remote Monitoring: All alarms shall be communicated to the Liebert monitoring system with the following information: Date and time of occurrence, unit number and present temperature and humidity.
 15. Sensor Calibration: Menu shall allow unit sensors to be calibrated with external sensors.
 16. Maintenance/Wellness Settings: Menu shall allow reporting of potential component problems before they occur.
 17. Options Setup: Menu shall provide operation settings for the installed components. System/Network Setup: Menu shall allow Unit to Unit (U2U) communication and setup for teamwork modes of operation (up to 32 units).
 18. Teamwork Modes of Operation - Saves energy by preventing operation of units in opposite modes multiple units.
 19. Auxiliary Boards: Menu shall allow setup of optional expansion boards.
 20. Diagnostics/Service Mode: The iCOM 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.
 21. 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.
- H. iCOM Microprocessor Control With Large Graphic Display: The iCOM unit control with large graphic display shall include all of the features as the iCOM 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 and Online Manual.
1. The iCOM 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, esthetically pleasing housing.
 2. 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.
 3. Spare Parts List: Menu shall include a list of critical spare parts, their quantity and respective part numbers.
 4. Setup Assistant: Menu shall include an online manual "assistant" for guidance during initial setup and routine maintenance.

5. Unit Diary: Menu shall include a free field area within the unit memory where unit history may be stored for reference.
- 2.08 DUAL COOLING SOURCE: The dual cooling source system shall consist of an air cooled compressorized system with the addition of a chilled water coil, a modulating control valve and a comparative temperature sensor. The system shall be able to function either as a modulating chilled water system or as a compressorized system, or a combination of both. The primary mode of cooling shall be chilled water. Switchover between the two cooling modes shall be performed automatically by the microprocessor control.
- A. Dual Cooling Source Control Valve: The water circuit shall include a three-way modulating valve. The microprocessor positions the valve in response to room conditions. Cooling capacity will be controlled by bypassing chilled water around the coil. The modulating valve travel for dehumidification shall be proportional.
- 2.09 NON-LOCKING DISCONNECT SWITCH: The manual disconnect switch shall be mounted in the high voltage section of the electrical panel. The switch shall be accessible with the door closed.
- A. Smoke Sensor: The smoke sensor shall sample the return air, shutdown the unit upon detection, and send visual and audible alarm. Dry contacts shall also be provided. This 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.
- 2.10 AIR-COOLED CONDENSER: Provide Liebert manufactured outdoor air cooled condensers in accordance with Section 15670 Condensing Units.
- 2.11 LIQUID-TECT SENSORS: Provide One (quantity) solid state water sensors under the raised floor.
- 2.12 FLOOR STAND: The floor stand shall be constructed of a welded tubular steel frame. The floor stand shall have adjustable legs with vibration isolation pads. The floor stand shall be 12" inches (mm) high.
- A. Floor Stand Turning Vane: A turning vane shall be supplied with the floor stand.

PART 3 – EXECUTION

3.01 INSTALLATION:

- A. General: Install computer room 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.
- B. The CRAC units shall be replaced on weekends, one unit at a time. The north stair shall be used for access and installation of the CRAC units. After getting the CRAC units inside the building in the EOC operations room, the CONTRACTOR shall allow the room temperature to stabilize prior to entering the Data Center. Following installation and start-up of the first CRAC Unit, the CONTRACTOR shall allow the new CRAC unit and Data Center temperature and humidity to stabilize for a minimum of one week prior to replacing the second unit. Refer to Section 01010 Summary of Work for further details on sequencing the Work
- C. 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. Connect the new Liebert unit controllers to the existing Liebert nVSA network switch to communicate to existing unit.

- D. 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.
 - E. Field Quality Control: Startup computer room air conditioning units in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements. These specifications describe requirements for a computer room precision cooling 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.
 - F. Coordinate installation of the CRAC units with the installation of the air cooled condensing units and the refrigerant piping modifications and installation.
 - G. Charge systems with refrigerant and oil, and test for leaks. Repair leaks and replace lost refrigerant and oil.
- 3.02 MANUFACTURER'S FIELD SERVICES: Prepare and start computer room air conditioning units under provisions of Section 01640 Start-up/Checkout/ Manufacturer's Field Services for CONTRACTOR Furnished Equipment.
- A. Supply service of factory trained representative for a period of four (4) days per unit to supervise installation testing, dehydration and charging of systems, start-up, and instruction on operation and maintenance to the OWNER. Factory representative shall be available to support weekend work as noted herein.
 - B. Supply initial charge of refrigerant and oil.
- 3.03 DEMONSTRATION: Provide services of manufacturer's authorized service representative to provide start-up service and to instruct OWNER's personnel in operation and maintenance of computer room air conditioning units.
- A. Train OWNER's personnel on start-up and shutdown procedures, troubleshooting procedures, servicing, and preventative maintenance schedule and procedures. Review with OWNER's personnel the data contained in the operating and maintenance manuals.

SECTION 15900 ENERGY MANAGEMENT AND CONTROL SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The Energy Management and Control System (EMCS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.
- B. The proposed DDC system shall be a direct extension of the existing South Florida Water Management District ("SFWMD") Headquarters Campus energy management system - Siemens Industry, Inc., Building Technologies Division APOGEE System. The DDC system shall communicate to the existing SFWMD energy management system Server - APOGEE Insight.
- C. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
- D. EMCS manufacturer shall be responsible for all EMCS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.

1.02 WORK BY OTHERS

- A. Mechanical contractor installs all wells, valves, taps, dampers, flow stations, etc. furnished by EMCS manufacturer.
- B. Electrical Contractor provides:
 - 1. 120V power to all EMCS and/or temperature control panels
 - 2. Wiring of all power feeds through all disconnect starters to electrical motor
 - 3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by EMCS manufacturer
 - 4. Wiring of any electrical sub-metering devices furnished by EMCS manufacturer.
- C. Products furnished but not installed under this section
 - 1. Section 15183 - Hydronic Piping:
 - a. Control Valves
 - b. Temperature Sensor Wells and Sockets
 - c. Taps for Flow Meters and Pressure Transmitters
 - 2. Section 15185 - Refrigerant Piping:
 - a. Pressure and Temperature Sensor Wells and Sockets
- D. Products installed but not furnished under this section
 - 1. Section 15682 – Air Cooled Water Chillers:
 - a. Pressure Transmitters
 - b. Temperature Transmitters

- c. Power Transmitters
- d. Refrigerant Leak Detectors

1.03 RELATED WORK

- A. Division 01000 - General and Special Conditions
- B. Division 15000 - Mechanical
- C. Division 16000 - Electrical

1.04 QUALITY ASSURANCE

- A. The EMCS system shall be designed and installed, commissioned and serviced by the local Siemens Industry, Inc., Building Technologies Division factory owned office. Distributors or licensed installing contractors are not acceptable.

The manufacturer shall provide an experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the B.M.S.

The Bidder shall be regularly engaged in the manufacturing, installation and maintenance of BMS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of B.M.S. systems similar in size and complexity to this project.

- B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- C. All EMCS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX. and be so listed at the time of bid. All floor level controllers shall comply, at a minimum, with UL Standard UL 916 category PAZX; Standard UL 864, categories UDTZ, and QVAX. and be so listed at the time of Bid.
- D. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- E. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.
- F. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network.

Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.05 SUBMITTALS

- A. Submit five (5) complete sets of documentation in the following phased delivery schedule:
 - 1. Valve and damper schedules
 - 2. Equipment data cut sheets

3. System schematics, including:
 - a. sequence of operations
 - b. point names
 - c. point addresses
 - d. interface wiring diagrams
 - e. panel layouts.
 - f. system riser diagrams
 4. Auto-CAD compatible as-built drawings
- B. Prior to final completion, submit operation and maintenance manuals, consisting of the following:
1. Index sheet, listing contents in alphabetical order
 2. Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams
 3. Description of sequence of operations
 4. As-Built interconnection wiring diagrams
 5. Operator's Manual
 6. Trunk cable schematic showing remote electronic panel locations, and all trunk data
 7. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.)
 8. Conduit routing diagrams

1.06 WARRANTY

- A. Provide all services, materials and equipment necessary for the successful operation of the entire EMCS system for a period of one year after beneficial use.
- B. The adjustment, required testing, and repair of the system includes all computer equipment, transmission equipment and all sensors and control devices.
- C. The on-line support services shall allow the local EMCS subcontractor to dial out over telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.
- D. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the EMCS manufacturer shall dispatch the appropriate personnel to the job site to resolve the problem within 3 hours of the time that the problem is reported.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Siemens Industry, Inc., Building Technologies Division APOGEE System. No substitutions are permitted.

2.02 NETWORKING COMMUNICATIONS

- A. The design of the EMCS shall network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of three levels, a district-wide (Management Level Network) Ethernet network based on TCP/IP protocol, high performance peer-to-peer building level network(s) and DDC Controller floor level local area networks with access being totally transparent to the user when accessing data or developing control programs.
- B. The design of EMCS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.
- C. System shall have the capability to be an OPC Server for dynamic communication with OPC Clients over an Ethernet network. At a minimum, the following must be supported:
 - 1. Data Access 1.0 (96), 1.0A (97) and 2.0 (11/98)
 - 2. Alarms & Events 1.0 (1/99)
- D. Peer-to-Peer Building Level Network:
 - 1. All operator devices either network resident or connected via dial-up modems shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.
 - 2. The peer-to-peer network shall support a minimum of 100 DDC controllers and PC workstations
 - 3. Each PC workstation shall support a minimum of 4 peer-to-peer networks hardwired or dial up, or up to 32 peer-to-peer networks using Ethernet.
 - 4. The system shall support integration of third party systems (fire alarm, security, lighting, PCL, chiller, boiler) via panel mounted open protocol processor. This processor shall exchange data between the two systems for interprocess control. All exchange points shall have full system functionality as specified herein for hardwired points.
 - 5. Field panels must be capable of integration with open standards including Modbus, BACnet, and Lonworks as well as with third party devices via existing vendor protocols.
 - 6. Telecommunication Capability:
 - a. Auto-dial/auto-answer communications shall be provided to allow DDC Controllers to communicate with remote operator stations and/or remote terminals via telephone lines, as indicated in the sequence of operations.
 - b. Auto-dial DDC Controllers shall automatically place calls to workstations to report alarms or other significant events. The auto-dial program shall include provisions for handling busy signals, "no answers" and incomplete data transfers.
 - c. Operators at dial-up workstations shall be able to perform all control functions, all report functions and all database generation and modification functions as described for workstations connected via the network. Routines to automatically answer calls from remote DDC or HVAC Mechanical Equipment Controllers shall be inherent in the Controller. The use of additional firmware or software is not acceptable. The fact that communications are taking place with remote DDC or HVAC & Mechanical Equipment Controllers over telephone lines shall be completely transparent to an operator.

- d. Multiple modems shall be supported by DDC or HVAC & Mechanical Equipment Controllers on the Peer-to-Peer Network to ensure continuous communication to workstation.

E. Management Level Network

1. All PC and Laptop Workstations shall simultaneously direct connect to the Ethernet and Building Level Network without the use of an interposing device
2. Operator Workstations shall be capable of simultaneous direct connection and communication with BACnet, OPC, and Apogee networks without the use of interposing devices.
3. The Management Level Network shall not impose a maximum constraint on the number of operator workstations.
4. When appropriate, any controller residing on the peer-to-peer building level networks shall connect to Ethernet network without the use of a PC or a gateway with a hard drive.
5. Any PC on the Ethernet Management Level Network shall have transparent communication with controllers on the building level networks connected via Ethernet, as well as, directly connected building level networks. Any PC shall be able to interrogate any controller on the building level network.
6. Any break in Ethernet communication from the PC to the controllers on the building level networks shall result in an alarm notification at the PC.
7. The Management Level Network shall reside on industry standard Ethernet utilizing standard TCP/IP, IEEE 802.3
8. Access to the system database shall be available from any client workstation on the Management Level Network.

2.03 DDC CONTROLLER FLOOR LEVEL NETWORK:

- A. This level communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through DDC Controllers for transmission of global data.

2.04 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLERS

- A. The DDC & HVAC Mechanical Equipment Controllers shall reside on the Building Level Network.
- B. DDC & HVAC Mechanical Equipment Controllers shall use the same programming language and tools. DDC & HVAC Mechanical Equipment Controllers which require different programming language or tools on a network are not acceptable.
- C. DDC & HVAC Mechanical Equipment Controllers which do not meet the functions specified in Section 2.4.1 and Section 2.5 for DDC Controllers or Section 2.4.2 and Section 2.5 for HVAC Mechanical Equipment Controllers are not acceptable.

2.04.01 DDC CONTROLLER

- A. DDC Controllers shall be a 16-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point I/O schedule. Each controller shall support a minimum of three (3) Floor Level Application Specific Controller Device Networks.

- B. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:
1. Control processes
 2. Energy management applications
 3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 4. Historical/trend data for points specified
 5. Maintenance support applications
 6. Custom processes
 7. Operator I/O
 8. Dial-up communications
 9. Manual override monitoring
- C. Each DDC Controller shall support firmware upgrades without the need to replace hardware.
- D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
- E. DDC Controllers shall provide a minimum two RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.
- F. As indicated in the point I/O schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
1. Switches shall be mounted either within the DDC Controllers key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.
 2. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.
- G. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.
- H. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- I. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
- RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
 - Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
 - Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
 - Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
- Isolation shall be provided at all peer-to-peer panel's AC input terminals to suppress induced voltage transients consistent with:

- IEEE Standard 587-1980
 - UL 864 Supply Line Transients
 - Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)
- J. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 60 days.
1. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
 2. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.
- K. Provide a separate DDC Controller for each AHU or other HVAC system as indicated in Section 3.02. It is intended that each unique system be provided with its own point resident DDC Controller.

2.04.2 HVAC MECHANICAL EQUIPMENT CONTROLLERS

- A. HVAC Mechanical Equipment Controllers shall be a 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.
- B. Each HVAC Mechanical Controller shall have sufficient memory to support its own operating system and databases, including:
1. Control processes
 2. Energy management applications
 3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 4. Historical/trend data for points specified
 5. Maintenance support applications
 6. Custom processes
 7. Operator I/O
 8. Dial-up communications
- C. Each HVAC Mechanical Equipment Controller shall support firmware upgrades without the need to replace hardware.
- D. HVAC Mechanical Equipment Controllers shall provide a RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.
- E. HVAC Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
- F. Each HVAC Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- G. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

- RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
- Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
- Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
- Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
Isolation shall be provided at all peer-to-peer panel's AC input terminals to suppress induced voltage transients consistent with:
 - IEEE Standard 587-1980
 - UL 864 Supply Line Transients
 - Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

- H. In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC Mechanical Equipment Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
1. Upon restoration of normal power, the HVAC Mechanical Equipment Controller shall automatically resume full operation without manual intervention.
 2. Should HVAC Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

2.05 DDC & HVAC MECHANICAL EQUIPMENT CONTROLLER RESIDENT SOFTWARE FEATURES

A. General:

1. The software programs specified in this Section shall be provided as an integral part of DDC and HVAC Mechanical Equipment Controllers and shall not be dependent upon any higher level computer for execution.
2. All points shall be identified by up to 30 character point name and 16 character point descriptor. The same names shall be used at the PC workstation.
3. All digital points shall have user defined two-state status indication (descriptors with minimum of eight (8) characters allowed per state (i.e. summer/winter)).

B. Control Software Description:

1. The DDC and HVAC Mechanical Equipment Controllers shall have the ability to perform the following pre-tested control algorithms:
 - a. Two-position control
 - b. Proportional control
 - c. Proportional plus integral control
 - d. Proportional, integral, plus derivative control
 - e. Automatic tuning of control loops

C. DDC and HVAC Mechanical Equipment Controllers shall provide the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.

1. Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down

HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.

- a. The SSTO program shall operate in both the heating and cooling seasons.
 - 1) It shall be possible to apply the SSTO program to individual fan systems.
 - 2) The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
 - b. The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.
2. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
- a. It shall be possible to individually command a point or group of points.
 - b. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.
 - c. The operator shall be able to define the following information:
 - 1) Time, day
 - 2) Commands such as on, off, auto, and so forth.
 - 3) Time delays between successive commands.
 - 4) There shall be provisions for manual overriding of each schedule by an appropriate operator.
 - d. It shall be possible to schedule events up to one year in advance.
 - 1) Scheduling shall be calendar based.
 - 2) Holidays shall allow for different schedules.
3. Enthalpy switchover (economizer) .The Energy Management Control Software (EMCS) will control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover set point the EMCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.
4. Temperature-compensated duty cycling.
- a. The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.
 - b. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.
5. Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
6. Night setback control: The system shall provide the ability to automatically adjust setpoints for night control.

7. The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
 - a. PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
 - b. PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
 - c. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.
 - d. Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.
- D. DDC and HVAC Mechanical Equipment Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
 1. A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database shall support 30 character, English language point names, structured for searching and logs.
 2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
 3. DDC and HVAC Mechanical Equipment Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.
 4. DDC and HVAC Mechanical Equipment Controller shall be capable of comment lines for sequence of operation explanation.
- E. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
 1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
 2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
 3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hour's destinations) or based on priority.

4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
 5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.
- F. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.
1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC and HVAC Mechanical Equipment Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples. All trend data shall be available for transfer to a Workstation without manual intervention.
 2. DDC and HVAC Mechanical Equipment Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
 - a. Loop tuning shall be capable of being initiated either locally at the DDC and HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.
- G. DDC and HVAC Mechanical Equipment Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.
- H. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to access any data from or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers shall send alarm reports to multiple workstation without dependence upon a central or intermediate processing device. The peer to peer network shall also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.
- I. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

2.06 FLOOR LEVEL NETWORK APPLICATION SPECIFIC CONTROLLERS (ASC)

- A. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs) through Floor Level LAN Device Networks.
- B. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Provide the following types of ASCs as a minimum:
 1. Central System Controllers

2. Terminal Equipment Controllers

C. Central System Controllers:

1. Provide for control of central HVAC systems and equipment including, but not limited to, the following:
 - a. Rooftop units
 - b. Packaged air handling units
 - c. Built-up air handling systems
 - d. Chilled and condenser water systems
 - e. Steam and hot water systems
2. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Provide a hand/off/automatic switch for each digital output for manual override capability. Switches shall be mounted either within the controller's key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides. In addition, each switch position shall be supervised in order to inform the system that automatic control has been overridden.
3. Each controller shall support its own real-time operating system. Provide a time clock with battery backup to allow for stand-alone operation in the event communication with its DDC Controller is lost and to insure protection during power outages.
4. All programs shall be field-customized to meet the user's exact control strategy requirements. Central System controllers utilizing pre-packaged or canned programs shall not be acceptable. As an alternative, provide DDC Controllers for all central equipment in order to meet custom control strategy requirements.
5. Programming of central system controllers shall utilize the same language and code as used by DDC Controllers to maximize system flexibility and ease of use. Should the system controller utilize a different control language, provide a DDC Controller to meet the specified functionality.
6. Each controller shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs.

D. Terminal Equipment Controllers:

1. Provide for control of each piece of equipment, including, but not limited to, the following:
 - a. Variable Air Volume (VAV) boxes
 - b. Constant Air Volume (CAV) boxes
 - c. Dual Duct Terminal Boxes
 - d. Unit Conditioners
 - e. Heat Pumps
 - f. Unit Ventilators
 - g. Room Pressurization
2. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 psi pneumatic, 0-10v, allowing for interface to a variety of modulating actuators.
3. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the FLN, BLN or MLN is not acceptable

E. Digital Energy Monitors:

1. DDC system shall have capability for three phase digital watt-meters with pre-wired CTs. All watt-meter electronics shall be housed within the CTs. CTs shall include sizes capable of mounting directly on a power bus. Diagnostics visible to the installing electrician (without a operator tool) shall indicate: proper operation, mis-wiring or low power-factor, device malfunction, and over-load condition. The meters shall include the following:
 - a. The device shall be UL Listed, and shall comply with ANSI C12.1 accuracy specification. The minimum CT/meter combined accuracy shall be no greater than 1% of reading over the range of 5% to 100% of rated load. The meter shall not require calibration.
 - b. The wattmeter shall directly connect to power from 208 through 480 with no potential transformer. In-line fuses for each voltage tap phase shall be included.
 - c. The wattmeter CTs shall be split-core and at minimum be sized to accommodate loads ranging from 100 to 2400 Amps. The CTs shall be volt-signal type, and shall not require shorting blocks.
 - d. The wattmeter shall reside directly on the Floor Level Network along with other FLN devices. Data transferred shall include.
 - kW & kWh
 - Consumption
 - Demand
 - Power Factor
 - Current
 - Voltage
 - Apparent Power
 - Reactive Power

2.07 DYNAMIC COLOR GRAPHIC DISPLAYS

- A. Create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including the new 156 ton chilled water system and floor level terminal units. Displays shall be provided by the EMCS contractor as indicated on the drawings to optimize system performance, analysis and speed alarm recognition.
- B. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands. Graphics software shall permit the importing of AutoCAD or scanned pictures for use in the system.
- C. Dynamic temperature values, energy values, flow values, pressure values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.
 1. Sizable analog bars shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.
 2. Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.
 3. Equipment state can be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or setpoint.
 4. State text for digital points can be defined up to eight characters.

- D. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.
- E. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
- F. Off the shelf graphic software, Micrografx Designer or Coral Draw software shall be provided to allow the user to add, modify or delete system graphic displays.
- G. A clipart library of HVAC and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams and laboratory symbols. The user shall have the ability to add custom symbols to the clipart library.
- H. A dynamic display of the site specific architecture showing status of controllers, PC workstations and networks shall be provided.

2.08 LOCAL USER DISPLAY

Where specified in the sequence of operation or points list, the controllers on the peer to peer building level network shall have a display and keypad for local interface. A keypad shall be provided for interrogating and commanding points in the controller.

- A. The display shall use the same security password and access rights for points in the display as is used in the associated controller.
- B. The LCD display shall be a minimum of a 2 line 40 character display.
- C. The LCD display shall include the full point name, value (numeric, digital or state text), point priority and alarm status on one screen.
- D. The LCD shall dynamically update the value, priority, and alarm status for the point being displayed.
- E. The display shall be mounted either on the door of the enclosure or remote from the controller

2.09 FIELD DEVICES

- A. Provide instrumentation as required to make a fully functional system for monitoring, control or optimization functions.
- B. Insertion Magnetic Flow Meters (Onicon Series F-3500 with Onicon System 10 BTU transmitter)

Power Supply	24 VAC from new Apogee EMCS panel
Accuracy	± 1% of Actual Reading over a flow range of 2 to 20 feet/sec.
Maximum Operating Pressure	400 PSI
Output Signals	One 4-20mA plus Modbus RS-485 half-duplex communications
Input Signals	Two temperature transmitters, 4-20mA (loop-powered from the System 10 BTU transmitter)

C. Pressure to Current Transmitters

Range	3 to 50 psig
Output Signal	4 – 20 mA, loop powered
Accuracy	± 1% of full scale

D. Temperature Transmitters

Range	32-200 ^o F
Output Signal	4 – 20 mA, loop powered
Accuracy	± 1% of full scale

PART 3 - EXECUTION

3.01 PROJECT MANAGEMENT

- A. Provide a designated project manager who will be responsible for the following:
1. Construct and maintain project schedule
 2. On-site coordination with all applicable trades, subcontractors, and other integration vendors
 3. Authorized to accept and execute orders or instructions from owner/architect
 4. Attend project meetings as necessary to avoid conflicts and delays
 5. Make necessary field decisions relating to this scope of work
 6. Coordination/Single point of contact

3.02 SEQUENCE OF OPERATION

- A. Refer to mechanical drawings.

3.03 POINT SCHEDULE

- A. The contractor shall collaborate with the owner directly to determine the owner's preference for naming conventions, etc. before entering the data in to the system.

3.04 START-UP AND COMMISSIONING

- A. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the manufacturer. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power.
- B. Provide any recommendation for system modification in writing to owner. Do not make any system modification, including operating parameters and control settings, without prior approval of owner.
- C. After manufacturer has completed system start-up and commissioning. Joint commissioning of integrated system segments shall be completed.

3.05 ELECTRICAL WIRING AND MATERIALS

- A. Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories. All wiring in mechanical rooms and exposed areas shall be installed in conduit. Plenum rated cable is acceptable above ceilings where local building codes allow.
- B. Provide wiring between thermostats, aquastats and unit heater motors, all control and alarm wiring for all control and alarm devices for all Sections of Specifications.
- C. Provide status function conduit and wiring for equipment covered under this Section.
- D. Provide conduit and wiring between the B.M.S. panels and the temperature, humidity, or pressure sensing elements, including low voltage control wiring in conduit.
- E. Provide conduit and control wiring for devices specified in this Section.
- F. Provide conduit and signal wiring between motor starters in motor control centers and high and/or low temperature relay contacts and remote relays in B.M.S. panels located in the vicinity of motor control centers.
- G. Provide conduit and wiring between the PC workstation, electrical panels, metering instrumentation, indicating devices, miscellaneous alarm points, remotely operated contractors, and B.M.S. panels, as shown on the drawings or as specified.
- H. All wiring to be compliant to local building code and the NEC.
- I. Provide electrical wall box and conduit sleeve for all wall mounted devices.

3.06 PERFORMANCE

- A. Unless stated otherwise, control temperatures within plus or minus 2°F, humidity within plus or minus 3% of the set point, and static pressure within 10% of set point.

3.07 COMMISSIONING, TESTING AND ACCEPTANCE

- A. Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets which shall be submitted prior to acceptance testing. Commissioning work which requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed. Notify the operating personal in writing of the testing schedule so that authorized personnel from the owner and construction manager are present throughout the commissioning procedure.
 - 1. Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications and approved shop drawings. Test, calibrate and bring on line each control sensor and device. Commissioning to include, but not be limited to:
 - a. Sensor accuracy at 10, 50 and 90% of range.
 - b. Sensor range.
 - c. Verify analog limit and binary alarm reporting.
 - d. Point value reporting.
 - e. Binary alarm and switch settings.
 - f. Actuator ranges.
 - g. Fail safe operation on loss of control signal, electric power, network communications.

- B. After control devices have been commissioned (i.e. calibrated, tested and signed off), each BMS program shall be put on line and commissioned. The contractor shall, in the presence of the owner and construction manager, demonstrate each programmed sequence of operation and compare the results in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracy's. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and retested.
- C. After all BMS programs have been commissioned, the contractor shall verify the overall system performance as specified. Tests shall include, but not be limited to:
1. Data communication, both normal and failure modes.
 2. Fully loaded system response time.
 3. Impact of component failures on system performance and system operation.
 4. Time/Date changes.
 5. End of month/ end of year operation.
 6. Season changeover.
 7. Global application programs and point sharing.
 8. System backup and reloading.
 9. System status displays.
 10. Diagnostic functions.
 11. Power failure routines.
 12. Battery backup.
 13. Smoke Control, stair pressurization, stair, vents, in concert with Fire Alarm System testing.
 14. Testing of all electrical and HVAC systems with other division of work.
- D. Submit for approval, a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracy's and the system performance does not degrade over time.
- E. Using the commissioning test data sheets, the contractor shall demonstrate each point. The contractor shall also demonstrate all system functions. The contractor shall demonstrate all points and system functions until all devices and functions meet specification.
- F. The contractor shall supply all instruments for testing.
1. All test instruments shall be submitted for approval.

Test Instrument Accuracy:

Temperature:	1/4F or 1/2% full scale, whichever is less.
Pressure:	High Pressure (psi): ½ psi or 1/2% full scale, whichever is less.
Low Pressure: (in w.c.)	1/2% of full scale
Humidity:	2% RH
Electrical:	1/4% full scale
- G. After the above tests are complete and the system is demonstrated to be functioning as specified, a thirty day performance test period shall begin. If the system performs as specified throughout the test period, requiring only routine maintenance, the system shall be accepted. If the system fails during the test, and cannot be fully corrected within eight hours, the owner may request that performance tests be repeated.

3.08 TRAINING

- A. The manufacturer shall provide factory trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The manufacturer shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 4:30 PM weekdays.

- B. Provide four (4) hours of training for Owner's designated operating personnel. Training shall include:
 - 1. Explanation of drawings, operations and maintenance manuals
 - 2. Walk-through of the job to locate control components
 - 3. Operator workstation and peripherals
 - 4. DDC controller and ASC operation/function
 - 5. Operator control functions including graphic generation and field panel programming
 - 6. Explanation of adjustment, calibration and replacement procedures
 - 7. Student binder with training modules

END OF SECTION

SECTION 15950 TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.01 SCOPE

- A. Section Includes: Requirements and procedures for total mechanical systems testing, adjusting, and balancing. Requirements include:
 - 1. Measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications.
 - 2. Recording and reporting the results.
- B. Work includes complete testing, adjusting and balancing of the new chilled water system including new pumps, new chiller and all existing air handling units and computer room air conditioning (CRAC) units which use chilled water as shown on the Chilled Water Flow Diagram. The complete piping system shall be balanced including the new and existing chilled water piping which forms the chilled water system as shown on the drawings.
- C. Test, adjust, and balance the following mechanical systems:
 - 1. Hydronic systems.
- D. This Section does not include:
 - 1. Specifications for materials for patching mechanical systems.
 - 2. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
 - 3. Requirements and procedures for piping and ductwork systems leakage tests.
 - 4. Testing and balancing of air handling systems.
- E. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, apply to Work of this Section.

1.02 DEFINITIONS

- A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
 - 1. The balance of water distribution.
 - 2. Adjustment of total system to provide design quantities.
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate at the terminal equipment.

- D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.
- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- F. Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- G. Terminal: The point where the controlled fluid enters or leaves the distribution system. There are supply inlets on water terminals, and return outlets on water terminals.
- H. Main: Pipe containing the system's major or entire fluid flow.
- I. Sub main: Pipe containing part of the systems' capacity and serving two or more branch mains.
- J. Branch main: Pipe serving two or more terminals.
- K. Branch: Pipe serving a single terminal.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01300, Submittals covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Agency Data: Proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified in Quality Assurance Article.
 - 2. Engineer and Technicians Data: Proof that the Test and Balance Engineer assigned to supervise the procedures and the technicians proposed to perform the procedures meet the qualifications specified below.
 - 3. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this Project.
- B. Certified Reports:
 - 1. Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards, are an accurate representation of how the systems have been installed, are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures, and are an accurate record of all final quantities measured to establish normal operating values of the systems. Follow the procedures and format specified below:
 - a. Reports: Upon completion of testing, adjusting, and balancing procedures, prepare a testing and balancing report. Reports must be complete, factual, accurate, and legible. Organize and format reports as specified below. Submit four complete sets of reports to ENGINEER for evaluation and approval.
 - b. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced,

vinyl, 3-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:

- 1) General Information and Summary.
- 2) Hydronic Systems.

c. Report Contents: Provide the following minimum information, forms, and data:

- 1) General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, CONTRACTOR, OWNER, ENGINEER, and Project. Include addresses and contact names and telephone numbers. Also include a certification sheet containing the seal and name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.
- 2) The remainder of the report shall contain the appropriate forms containing, as a minimum, the information indicated on the standard report forms prepared by the AABC and NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form. Diagrams are not required for air systems containing one or two terminals.

C. Calibration Reports:

1. Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of 6 months prior to starting Project.

1.04 QUALITY ASSURANCE

A. Agency Qualifications:

1. Employ the services of an independent testing, adjusting, and balancing agency to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
2. An independent testing, adjusting, and balancing agency certified by Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB), in those testing and balancing disciplines required for this Project and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by AABC or NEBB as a Test and Balance Engineer.

B. Codes and Standards:

1. AABC: "National Standards for Total System Balance."
2. ASHRAE: ASHRAE Handbook, Current Edition, Testing, Adjusting, and Balancing.

C. Pre-balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the representatives of installers of the mechanical systems. The objective

of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.05 PROJECT CONDITIONS

- A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PRELIMINARY PROCEDURES FOR HYDRONIC SYSTEM BALANCING

- A. Before operating the system perform these steps:
1. Open valves to full open position.
 2. Remove and clean all strainers.
 3. Examine hydronic systems and determine if water has been treated and cleaned.
 4. Check pump rotation.
 5. Clean and set automatic fill valves for required system pressure.
 6. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
 7. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
 8. Set temperature controls so all coils are calling for full flow.
 9. Check operation of automatic bypass valves (where applicable).
 10. Lubricate all motors and bearings.

3.02 MEASUREMENTS

- A. Provide all required instrumentation to obtain proper measurements calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the referenced standards.

- C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured. Apply instrument as recommended by the manufacturer.
- D. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- E. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until two consecutive identical values are obtained.
- F. Take all reading with the eye at the level of the indicated value to prevent parallax.
- G. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- H. Take measurements in the system where best suited to the task.

3.03 PERFORMING TESTING, ADJUSTING, AND BALANCING

- A. Perform testing and balancing procedures on each system identified in accordance with the detailed procedures outlined in the referenced standards.
- B. Mark equipment settings, valve indicators, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- C. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.04 RECORD AND REPORT DATA

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

3.05 BALANCING TOLERANCES

- A. Adjust hydronic systems to plus or minus five (5) percent of design conditions indicated.

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END OF SECTION 15950

SECTION 16050 BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE:

- A. Summary of Work: The CONTRACTOR shall furnish all labor, equipment and material for installation of the electrical hardware as described herein and as shown on the Drawings.
- B. The provisions of this Section apply to all sections in DIVISION 16, except as indicated otherwise.
- C. Concrete, excavation, backfill, and steel reinforcement required for encasement, installation, or construction of the WORK of the various sections of DIVISION 16 is included as a part of the WORK under the respective sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light pole bases.
- D. For work at existing sites the CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required by the Drawings. Costs for this WORK shall be included in the CONTRACTOR'S original bid amount.

1.02 REFERENCES: 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.

- A. NEC (NFPA 70) National Electrical Code
- B. NETA International Electrical Testing Association - Acceptance Testing Specifications
- C. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum)
- D. Local Building Codes and Standards

1.03 DEFINITIONS: N/A

1.04 SUBMITTALS:

- A. The CONTRACTOR shall furnish submittals as applicable to this Project and in accordance with SECTION 01300 - Contractor Submittals.
- B. The CONTRACTOR shall provide the following for shop drawing submittals:
 - 1. Complete material lists stating manufacturer and brand name of each item or class of material
 - 2. Front, side, rear elevations, and top views with dimensional data
 - 3. Location of conduit entrances and access plates
 - 4. Component data
 - 5. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers
 - 6. Method of anchoring, seismic requirements, weight
 - 7. Types of materials and finish
 - 8. Nameplates
 - 9. Temperature limitations, as applicable
 - 10. Voltage requirement, phase, and current, as applicable
 - 11. Front and rear access requirements

12. Test reports
 13. Grounding requirements
 14. Catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material. Mark-out any model or part numbers of material on catalog data sheets that do not specifically apply to the project. Catalog data sheets shall be stamped to indicate the project name, applicable Section and paragraph, model number, and options.
- C. Shop Drawings shall be custom prepared. Drawings or data indicating "optional" or "as required" equipment are not acceptable. Options not proposed shall be crossed out or deleted from Shop Drawings.
 - D. Materials and Equipment Schedules: The CONTRACTOR shall deliver to the DISTRICT within 30 days of the commencement date in the Notice to Proceed, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
 - E. Owner's Manuals: Complete information in accordance with Section 01300.
 - F. Record Drawings: The CONTRACTOR shall show invert and top elevations and routing of all conduits in duct banks and concealed below-grade electrical installations. Buried electrical conduits shall be located by showing the horizontal distance to two fixed structures at the start of the conduit installation, the end of the conduit installation, and for every conduit change of direction. In addition, circuit schematic drawings and wiring drawings shall show all field changes. Layout drawings shall show all equipment location changes. Record drawings shall be prepared, be available to the DISTRICT, and be submitted according to Section 01300.
 - G. Where test reports are indicated, proof of design test reports for mass-produced equipment shall be submitted with the Shop Drawings, and factory performance test reports for custom-manufactured equipment shall be submitted and be approved prior to shipment. Field test reports shall be submitted for review prior to Substantial Completion.
- 1.05 QUALIFICATIONS: All electrical work shall be performed by personnel employed by an Electrical Contractor licensed in the State of Florida. Actual work shall be performed by Master and or Journeyman electricians or personnel under direct on-site supervision of a Master and or a Journeyman electrician. If the work is performed under the direct on-site supervision of a Journeyman electrician, he or she shall be certified in the county in which the work is performed or meet the reciprocity standards of Florida State Statue 489 part II. The credentials of the Electrical Contractor, Master and/or Journeyman electricians shall be supplied to the DISTRICT upon request.
- 1.06 RESPONSIBILITIES:
- A. Permits shall be obtained and inspection fees shall be paid according to General Conditions.
 - B. The CONTRACTOR shall be responsible for factory and field tests required by specifications in DIVISON 16 and by the DISTRICT and other authorities having jurisdiction. The CONTRACTOR shall furnish necessary testing equipment and pay costs of tests, including all replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of faulty installation.
- 1.07 TESTING: N/A
- 1.08 INSPECTION COORDINATION:

- A. The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The Contractor shall provide 48 hours notice of its intention to begin new WORK activities.

1.09 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. The CONTRACTOR shall provide equipment and materials that shall be new, shall be listed by UL, or by an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction, and shall bear the UL label or other certification where these requirements apply. Equipment and materials shall be the products of experienced and reputable manufacturers in the industry. Similar items in the WORK shall be products of the same manufacturer. Equipment and materials shall be of heavy duty industrial grade.
- B. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.
- C. On devices indicated to display dates, the year shall be displayed as 4 digits.

2.02 SIGNAGE:

- A. Electrical Equipment
 - 1. Each piece of electrical equipment shall be legibly marked to indicate its purpose unless the DISTRICT determines that its purpose is indicated by the location and arrangement.
- B. Warning Signs
 - 1. Over 50 Volts nominal, or more - Entrances to rooms and other guarded locations that contain live parts shall be marked with conspicuous signs prohibiting unqualified persons to enter.
 - 2. All buildings, rooms or enclosures containing exposed live parts or exposed conductors operating at 600 volts nominal, or more, shall be lockable. Permanent and conspicuous warning signs shall be provided reading as follows: DANGER - HIGH VOLTAGE - KEEP OUT.
 - 3. Outside branch circuits and feeders - for 600 volts nominal, or less - Warning signs shall be posted in plain view where unauthorized persons might come in contact with live parts.
- C. Isolating Switches - Isolating switches not interlocked with an approved circuit interrupting device shall be provided with a sign warning against opening them under load.

2.03 AREA DESIGNATIONS:

- A. General:
 - 1. Raceway system enclosures shall comply as mentioned herein and in SECTION 16110.
 - 2. Electric WORK specifically indicated in sections within any of the Specifications shall comply with those requirements.

AREA	NEMA ENCLOSURE CLASSIFICATION						Notes
	1	3R	4X	7	9	12	
Air Condition Space	√						
Non A/C Space Interior						√	Or as directed by project drawings
Outdoor Application			√				Or as directed by project drawings

B. Materials Requirements

1. NEMA 4X enclosures shall be 316 stainless steel.
2. NEMA 7 enclosures shall be cast aluminum where used with aluminum conduit; cast iron when used with galvanized steel conduit.
3. NEMA 1, 3R, and 12 enclosures shall be steel coated with ANSI 61 grey paint. NEMA 4X, 7, and 9 enclosures shall not be painted.

2.04 MOUNTING HARDWARE:

A. Miscellaneous Hardware

1. Threaded rods for trapeze supports shall be continuous threaded, 3/8-inch diameter minimum. Utilize hot dipped galvanized steel for dry indoor non process areas and 316 stainless steel for “wet,” “damp,” or “corrosive” areas.
2. Strut for mounting of conduits and equipment shall be 316 stainless steel or hot dipped galvanized as specified on project drawings. Where contact with concrete or dissimilar metals may cause galvanic corrosion, suitable non-metallic insulators shall be utilized to prevent such corrosion.
3. Wall-mounted panels that weigh more than 500 pounds shall be provided and mounted with steel support pedestals. Transformers hung from 4-inch stud walls and weighing more than 300 pounds shall have auxiliary floor supports.

B. Bolts and Anchors

1. Standard Service (Non-Corrosive Application): Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolt material, anchor bolts and cap screws shall be in accordance with the following.
 - a. Structural connections: ASTM A307, Grade A or B, hot-dip galvanized
 - b. Anchor Bolts: ASTM A307, Grade A or B, or ASTM A36, hot-dip galvanized
 - c. High strength bolts where indicated: ASTM A325
2. Corrosive Service: All bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated below.
 - a. All buried locations
 - b. All submerged locations
 - c. All locations subject to seasonal or occasional flooding
 - d. Inside hydraulic structures below the top of the structure
 - e. Inside buried vaults, manholes, and structures which do not drain through a gravity sewer or to a sump with a pump
 - f. All chemical handling areas

- g. Inside trenches, containment walls, and curbed areas
 - h. Locations indicated by the Contract Documents or designated by the DISTRICT to be provided with stainless steel bolts.
 - 3. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, class 2, conforming to ASTM A193 for bolts and to ASTM A194 for nuts. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.
 - a. Anti-seizure lubricant shall be classified as acceptable for potable water use by the NSF.
 - b. Anti-seizure lubricant shall be odorless, non-toxic, weather-proof, teflon based, with operating temperatures up to 475 deg F.
 - 4. Indoors Finished Areas Service:
 - a. Expanding-Type Anchors: Expanding-type anchors if indicated or permitted, shall be 18-8 stainless steel split expansion ring with threaded stud bolt body and integral cone expander, nut and washer. Plated carbon steel, hot-dipped galvanized carbon steel, type 304 stainless steel or type 316 stainless steel anchor bodies, as identified in the drawings or other notations.

2.05 ELECTRICAL IDENTIFICATION:

- A. Nameplates: Nameplates shall be fabricated from white-letter, black-face laminated plastic engraving stock. Each shall be fastened securely, using fasteners of brass, cadmium plated steel, or stainless steel, screwed into inserts or tapped holes, as required. Engraved characters shall be block style with no characters smaller than 1/4-inch high.
- B. Conductor and Equipment Identification: Conductor and equipment identification devices shall be either imprinted plastic-coated cloth marking devices or shall be heat-shrink plastic tubing, imprinted split-sleeve markers cemented in place.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Incidentals: The CONTRACTOR shall provide all materials and incidentals required for a complete and operable system, even if not required explicitly by the Specifications or the Drawings. Typical incidentals are terminal lugs not furnished with vendor supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor furnished equipment to connect with other equipment indicated in the Contract Documents.
- B. Field Control of Location and Arrangement: The CONTRACTOR shall determine the exact locations in the field based on the physical size and arrangement of equipment, finished elevations, and other obstructions. The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Locations on the Drawings, however, shall be followed as closely as possible.
 - 1. Where conduit development drawings or "home runs" are shown, the CONTRACTOR shall route the conduits in accordance with the indicated installation requirements. Routings shall be exposed or encased as indicated, except that conduit in finished areas shall be concealed unless specifically indicated otherwise. Conduits encased in a slab shall be sized for conduit OD to not exceed one-third of the slab thickness and be laid out and spaced to not impede concrete flow.
 - 2. Conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear.

3. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide all lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated. Wiring shall be #12 AWG minimum, and conduits shall be 3/4-inch minimum (exposed) and 1-inch minimum (encased). Where circuits are combined in the same raceway, the CONTRACTOR shall derate conductor ampacities in accordance with NEC requirements.
- C. Workmanship: Materials and equipment shall be installed in strict accordance with printed recommendations of the manufacturer. Installation shall be accomplished by workers skilled in the work. Installation shall be coordinated in the field with other trades to avoid interference.
- D. Protection of Equipment and Materials: The CONTRACTOR shall fully protect materials and equipment against damage from any cause. Materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. Moving parts shall be kept clean and dry. The CONTRACTOR shall replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections as part of the WORK.
- E. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 FR 1926, as applicable), state building standards, and applicable local codes and regulations.

3.02 CORE DRILLING:

- A. The CONTRACTOR shall perform core drilling required for installation of raceways through concrete walls and floors. Locations of floor penetrations, as may be required, shall be based on field conditions. Verify all core drilling locations based on equipment actually furnished as well as exact field placement. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the DISTRICT prior to any core drilling activities.

3.03 CONCRETE HOUSEKEEPING PADS:

- A. Concrete housekeeping pads shall be provided for indoor floor standing electrical equipment. Housekeeping pads for equipment, including future units, shall be 4 inches nominal above surrounding finished floor or grade and 4 inches larger in both dimensions than the equipment, unless otherwise indicated.
- B. Concrete housekeeping curbs shall be provided for all conduit stub-ups in indoor locations that are not concealed by equipment enclosures. Such curbing shall be 4 inches nominal above finished floor or grade.

3.04 EQUIPMENT IDENTIFICATION:

- A. General: Equipment and devices shall be identified as follows:
 1. Nameplates shall be provided for all panelboards, control and instrumentation panels, starters, switches, and pushbutton stations. In addition to nameplates, control devices shall be equipped with standard collar-type legend plates.
 2. Control devices within enclosures shall be identified as indicated. Identification shall be similar to the subparagraph above.
 3. Toggle switches which control loads out of sight of switch and all multi-switch locations of more than 2 switches shall have inscribed finish plates clearly indicating the load.
 4. Where shown on the drawings, name tags shall be inscribed with the equipment name and tag number.
 5. The CONTRACTOR shall furnish typewritten circuit directories for panelboards; circuit directory shall accurately reflect the devices/equipment connected to each circuit breaker.

3.05 CLEANING:

- A. The CONTRACTOR shall thoroughly clean the electrical WORK before final acceptance. Exposed parts shall be thoroughly clean of cement, plaster, and other materials. Oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Touch-up paint shall be applied to scratches on panels and cabinets. Electrical cabinets or enclosures shall be vacuum-cleaned.

END OF SECTION

SECTION 16110 RACEWAYS, BOXES, FITTINGS, AND SUPPORTS

PART 1 - GENERAL

1.01 SCOPE OF WORK:

A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.

1.02 REFERENCES: 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.

- A. NEC (NFPA 70) National Electrical Code
- B. NETA International Electrical Testing Association - Acceptance Testing Specifications
- C. NEMA 250 - Enclosure for Electrical Equipment (1,000 Volts Maximum)
- D. Local Building Codes and Standards
- E. ASTM A47 - Standard Specification for Ferric Malleable Iron Castings
- F. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High - Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- G. ASTM A635 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Commercial Steel, Drawing Steel, Structural, High - Strength Low Alloy, High - Strength Low Alloy with Improved Formability, Hot-Rolled, General Requirements for D2000 Standard Classification System for Rubber Products in Automotive Applications
- H. ASTM D2564 - Solvent Cements for Poly Vinyl Chloride Plastic Piping Systems
- I. UL 508 - Industrial Control Equipment
- J. UL 514A – Standard for Safety Metallic Outlet Boxes
- K. UL 514B – Standard for Safety Conduit, Tubing and Cable Fittings
- L. UL 886 - Standard for Safety for Outlet Boxes and Fittings for use in Hazardous (Classified) Locations
- M. UL 1059 – Standard for Safety Terminal Blocks
- N. UL 6 - Standard for Safety Electrical Rigid Metal Conduit - Steel
- O. UL 360 - Standard for Liquid Tight Flexible Steel Conduit
- P. ANSI C80.1 – Standard for Electrical Rigid Steel Conduit - Zinc Coated
- Q. UL 5B - Strut-Type Channel Raceways and Fittings
- R. UL 651 – Standard for Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings.

1.03 DEFINITIONS: N/A

1.04 SUBMITTALS:

Furnish submittals in accordance with SECTION 16050 - Basic Materials and Methods.

A. Shop Drawings

1. Complete catalog cuts of all raceways, fittings, boxes, supports, and mounting hardware, marked to show proposed materials and finishes.
2. Complete catalog cuts of all pullboxes, manholes, and handholes, marked where applicable to show proposed materials and finishes
3. Dimensioned layout drawings of all cable tray routings, including elevations.
4. Dimensioned layout drawings of all conduit racks and trapeze type hangers including elevations.

1.05 QUALIFICATIONS: N/A

1.06 RESPONSIBILITIES:

- A. Unless otherwise hereinafter specified, or shown on the Drawings, all boxes shall be metal.
- B. Combination expansion-deflection fittings shall be used where exposed or embedded conduits cross structure expansion joints.
- C. All conduit, fittings and accessories shall be UL listed and labeled.
- D. Furnish sizes of conduit, fittings and accessories as indicated, specified or as required by Electrical Codes and Standards.

1.07 TESTING: N/A

1.08 INSPECTION COORDINATION:

- A. The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The CONTRACTOR shall provide 48 hours advance notice of its intention to begin new WORK activities.

1.09 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS, and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of SECTION 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of SECTION 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Rigid Galvanized Steel (RGS) Conduit:
 1. Rigid steel conduit shall be mild steel, hot-dip galvanized inside and out.
 2. Rigid steel conduit shall be manufactured in accordance with ANSI C80.1 - Rigid Steel Conduit, Zinc Coated, and UL-6.
 3. Each conduit length shall be threaded on both ends with threads protected.
- B. Rigid Non-Metallic Conduit:
 1. Rigid non-metallic conduit shall be Schedule 40 PVC or Schedule 80 PVC, sunlight resistant.

2. Rigid non-metallic conduit shall be manufactured in accordance with NEMA TC-2 - Electrical Plastic Tubing and Conduit, and UL-651 - Standard for Rigid Non-metallic Conduit.
- C. Electrical Metallic Tubing (EMT):
1. Electrical metallic tubing shall be hot-dipped galvanized steel. EMT conduit shall only be allowed in office or control room areas which are considered air conditioned interior space.
- D. Liquidtight Flexible Conduit:
1. Liquidtight flexible conduit shall be constructed of a flexible galvanized metal core with a sunlight resistant thermoplastic outer jacket. Utilize liquid tight flexible conduit with spiral enclosed copper bonding conductors for conduit sizes 1 1/4 inches and smaller.
 2. Liquidtight flexible conduit shall be manufactured in accordance with UL-360 - Steel Conduits, Liquid-Tight Flexible.
 3. Fittings used with flexible conduit shall be of the screw-in type as manufactured by O-Z/Gedney, Appleton or Crouse-Hinds.
- E. Flexible Couplings:
1. Flexible couplings shall be of heavy-duty construction, water tight, and have electrical conductivity equal to rigid conduit. 3/4" - 2" shall have an inner brass core with insulating liner, outer bronze braid. 2 1/2"-4" shall have inner stainless steel core with insulating liner, outer stainless steel braid. Couplings shall be in compliance with UL Standard 886 and conform to ASTM A47, Grade 32510.
- F. Boxes and Fittings:
1. Terminal boxes, junction boxes, pull boxes, etc. shall be sheet steel unless otherwise shown on the Drawings. Boxes shall be galvanized and have continuously welded seams. Welds shall be ground smooth and galvanized. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14-gauge metal and covers shall not be less than 12-gauge metal. Covers shall be gasketed and fastened with stainless steel screws.
 2. Cast iron boxes and fittings shall be galvanized with cast galvanized covers and corrosion proof screws. Cast and malleable iron fittings for use with metallic conduit shall be the threaded type with five full threads.
 3. In outdoor areas, conduit shall be terminated in raintight hubs. In other than outdoor areas, sealed locknuts and bushings shall be used.
 4. Conduit, fittings, and boxes in hazardous locations shall be suitable for the Class and Division indicated.
 5. Floor boxes shall be of the round or rectangular cast metal type. Boxes shall be watertight and cover frames shall be adjustable. Box covers shall finish flush with finished floor surface. Boxes shall be located as directed by the DISTRICT and/or as indicated on the Drawings. Necessary gaskets, sealing compound, plugs, or devices shall be provided for the complete installation.
 6. Steel elbows and couplings shall be hot-dipped galvanized. Joints shall be taped.
 7. Electrical metallic tubing fittings shall be of the rain-tight, concrete-tight, compression type.
- G. Outlet Boxes:
1. Construction: Outlet boxes shall be Zinc-coated or cadmium-plated sheet steel boxes of a class to satisfy the condition at each outlet except where unilet or conduit bodies are required. They shall be knockout type with knockouts removed only where necessary to accommodate the conduit entering. Square cornered, straight-sided gang boxes, 4-inch octagon concrete rings

and 4 inch octagon hung ceiling boxes with bars, may be folded type. All other boxes shall be one-piece, deep-drawn.

2. Size: All boxes shall be of sufficient size to accommodate the required number and sizes of conduits, wires and splices in accordance with NEC requirements, but not smaller than size shown or specified. Special purpose boxes shall be sized for the device or application indicated.
 3. Fixture Studs: 3/8 inch malleable-iron fixture studs shall be used in outlet boxes for ceiling lighting fixtures and interior-bracket lighting fixtures, other than lamp receptacles and drop cords.
 4. Exposed: Screw-joint type boxes, with gasketed weatherproof covers shall be used in locations exposed to the weather.
 5. Tile Boxes: Boxes rectangular in shape with square corners and straight sides shall be used for receptacles and switches mounted in furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls. Install without plaster rings.
 6. Wall-mounted Switch, Receptacle, and Signal Boxes: Shall be, unless otherwise noted or specified, not less than 4 inches square by 2 inches deep for two devices, and multigang boxes for more than two devices. Boxes for switches and receptacles on unfinished walls may be screw-joint type with covers to fit the devices.
 7. Wall-mounted Telephone Outlet Boxes: Shall be 4 inches square by 2 inches deep, unless otherwise noted on the Drawings.
 8. Light Fixture Boxes: Shall be 4 inch diameter by 2 inch deep, minimum, for ceiling and interior bracket fixtures with concealed conduits. Plaster covers for bracket fixtures shall have 3-inch diameter openings. Screw-joint boxes with canopy seat shall be used for ceiling and interior bracket fixtures with exposed conduits.
 9. Grounding Terminal: Provide a grounding terminal in each box containing a green equipment ground conductor, or serving motors, lighting fixtures, or receptacles. Grounding terminal shall be green-colored, washer-in-head, machine screw or grounding bushing.
- H. Pullboxes:
1. Pullboxes shall be minimum NEC size requirements unless larger box is noted, as specified for outlet boxes with blank cover for pullboxes with internal volume not more than 150 cubic inches, and as specified for cabinets for pullboxes with internal volume over 150 cubic inches, except covers to have some thickness as box with corrosion resistant screw or bolt attachment.
- I. PVC Fittings:
1. Fittings for use with rigid non-metallic conduit shall be PVC, solvent welded type.
 2. Provide watertight field-applied coat of all weather PVC solvent cement compound with viscosity and wet film thickness recommended as required for installation of non-metallic conduit and fittings. The cement compound shall be furnished by the conduit manufacturer. PVC solvent cement shall meet the requirements of ASTM D2564, "Solvent Cements for Poly Vinyl Chloride Plastic Piping Systems".
- J. Stainless Steel Boxes:
1. Stainless steel boxes shall be used with RGS conduit and where indicated.
 2. Stainless steel boxes shall be NEMA 4X, Type 316 as indicated in specification SECTION 16050.
 3. Stainless steel shall be minimum 14-gauge thickness, with a brushed finish.
 4. Doors shall have full length stainless steel piano hinges. Non-hinged boxes are not acceptable.

K. Terminal Cabinets:

1. Interiors shall be so designed that control relays and terminal blocks can be replaced or added without disturbing adjacent units. Each cabinet shall be furnished with a minimum of 30% spare terminals.
2. All interiors shall be completely factory assembled with control relays, terminal blocks, insulating barriers, etc. All 120 volt AC and DC terminal blocks shall be isolated from each other by insulating barriers or separate enclosures.
3. All wiring within the cabinets shall be grouped together in harnesses and secured to the structure.
4. For terminal block specification refer to SECTION 16120.
5. Boxes shall be made from 14 gauge galvanized steel and shall be of sufficient size to provide a minimum of 4 inches of wiring space on all sides and between adjacent terminal blocks. A minimum two-inch spare shall be provided between control relays. A minimum of four mounting studs shall be provided on each cabinet. Cabinets shall be furnished without knockouts. Holes for raceways shall be drilled on the job.
6. A single hinged door shall cover the front of each terminal cabinet. Doors shall have a neoprene gasket, vault type handle, three-point catch and lock. Two keys will be supplied for each lock. All locks shall be keyed alike.
7. All exterior and interior steel surfaces of the cabinets shall be properly cleaned and finished with gray over a rust-inhibiting phosphatized coating conforming to ANSI A55.1. The finish paint shall be of a type to which field applied paint will adhere.
8. Cabinets shall be painted 14 gauge or 16 gauge steel with 14 gauge steel doors, seams continuously welded and ground smooth, no holes or knockouts, with latch kit hardware. Cabinets shall conform to UL 508, File No. E61997, Type 12 and Type 13, NEMA/EEMAC Type 12 and Type 13.

L. Conduit Mounting Hardware:

1. Conduit supports shall be one hole galvanized malleable iron pipe straps with galvanized clamp backs and nesting backs where required.
2. Ceiling hangers shall be adjustable galvanized carbon steel pipe hangers. Straps or hangers of plumbers perforated tape shall not be acceptable. Hanger rods shall be 3/8 inch minimum galvanized all-thread rod and shall meet or exceed ASTM A193B7. Trapeze, rod type hangers shall not be loaded in excess of 500 pounds per rod. Where loading exceeds this value, rigid frames shall be provided.
3. Racks shall be constructed from framing channel. Channels and all associated hardware shall be steel, hot dipped galvanized after fabrication of the channel. Field cuts shall be painted with zinc rich paint. Channels attached directly to building surfaces shall be 14-gauge minimum material 1 5/8 inch wide by 13/16 inch depth. All other channels shall be 12-gauge minimum 1 5/8 inch wide by 1 5/8 inch minimum depth. Racks shall be designed to limit deflection to 1/200 of span length. All exposed ends of framing channel shall be covered with manufacturer's standard plastic inserts.

2.02 CABLE TRAYS:

- A. Cable tray systems shall be composed of straight sections, curved sections, fittings, and accessories as defined in the latest NEMA Standards publication VE-1 - Ventilated Cable Tray.
1. The cable tray and fittings shall be hot-dip galvanized after fabrication, aluminum or stainless steel.

2. Cable tray shall be ladder type with 6, 9, 12, or 24-inch spacing with ventilated trough or solid trough. Tray sizes shall have 3, 4, 5 or 6-inch minimum usable load depth as indicated on project drawings.
3. Loading capacities shall meet NEMA weight classification with a safety factor of 1.5.

2.03 MANHOLES AND HANDHOLES:

- A. Manholes and pullboxes shall be precast, light duty, heavy duty or extra heavy duty of square, rectangular, or round configurations with loading capacities as shown on the drawings.
 1. Traffic covers shall be traffic type, H-20 loading, except as indicated otherwise. Manhole and pullbox covers shall be identified as "Electric" by raised letters cast into the covers. Manhole frames and covers shall be heavy duty, frost-tight, water-tight neoprene gasketed frame, solid lids and inner lids.
 2. Manholes shall have frost-proof and water-tight grey iron frames and covers with solid lids and inner lids with 28-inch clear openings. Covers and lids shall be bolted to cast-in-place steel frames with corrosion resistant hardware. Covers shall be cast-iron and shall have pick-holes.
- B. Manholes and pullboxes shall be equipped with pulling-in irons opposite and below each ductway entrance.
- C. PVC ductbank conduits shall be provided with end bells. Brackets and 60-inch concrete inserts shall be provided in manholes as required for racking wiring through manholes.

2.04 DUCT BANKS:

- A. Underground ducts shall be Schedule 40 PVC, unless otherwise noted.
- B. Ducts shall be arranged as shown on the drawings and encased in concrete. Variations from the standard duct bank configurations will be considered by the DISTRICT on a case by case basis if needed to clear obstacles or provide adequate cover. Concrete shall have 3,000 psi compressive strength conforming to SECTION 03300.
- C. Ductbanks shall contain a No. 4/0 bare stranded copper ground wire. The ground wire shall be continuous through the ductbank and terminate at power distribution equipment and grounding grid.
- D. Identification Tape: Continuous lengths of underground warning tapes shall be installed 12-inches above and parallel to all ductbanks. Tape shall be 6-inches wide polyethylene with foil backing film imprinted "CAUTION - ELECTRIC UTILITIES BELOW."

PART 3 - EXECUTION

3.01 PREPARATION:

- A. The CONTRACTOR shall provide suitable protection for conduit risers against damage during construction.
- B. The CONTRACTOR shall cap ends of all conduits before concrete is poured.
- C. The CONTRACTOR shall install pull cord and cap all conduits after cleaning where conduits are to be left empty by this Contract.
- D. The CONTRACTOR shall carefully ream ends of all conduit lengths after cutting to eliminate sharp burrs.
- E. The CONTRACTOR shall clean out all conduits before pulling wire.
- F. The CONTRACTOR shall clean out all conduits immediately after concrete work is finished.

3.02 INSTALLATION:

- A. No conduit smaller than 3/4-inch electrical trade size shall be used, nor shall any have more than three 90° bends in any one run. Pull boxes shall be provided as required per references listed in section 1.02.
- B. No wire shall be pulled until the conduit system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the conduit system has been completed in every detail.
- C. The ends of all conduits shall be tightly plugged to exclude dust and moisture while under construction.
- D. Conduit supports shall be spaced at intervals of 8 feet or less, as required to obtain rigid construction.
- E. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on trapeze type hangers with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-inch diameter.
- F. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, concrete inserts of the spot type shall be provided.
- G. All conduits on exposed work shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. All conduits shall be run perfectly straight and true.
- H. No unbroken run shall exceed 300 feet in length. This length shall be reduced by 75-feet for each 90° elbow.
- I. Conduits terminating in pressed steel boxes shall have double lock nuts and insulated bushings.
- J. Conduits terminating in gasketed enclosures shall be terminated with conduit hubs.
- K. Conduit wall seals shall be used for all conduits penetrating walls below grade or other locations shown on the Drawings.
- L. Liquid-tight, flexible metal conduit shall be used for all motor terminations and other equipment where vibration is present.
- M. Conduit stubouts for future construction shall be provided with threaded PVC end caps at each end.
- N. All wiring shall be run in raceway unless indicated otherwise.
- O. Raceways shall be installed between equipment as indicated. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be accomplished with tools designed for this purpose. Factory elbows shall be utilized wherever possible.
- P. Where raceway routings are indicated on plan views, follow those routings to the extent possible.
- Q. Where raceways are indicated but routing is not shown, such as home runs or on conduit developments and schedules, raceway routings shall be the CONTRACTOR'S choice and in strict accordance with the NEC and customary installation practice. Raceway shall be encased, exposed, concealed, or under floor as indicated, except that conduit in finished areas shall be concealed unless specifically indicated otherwise.
- R. Underground raceways shall be installed between manholes, handholes, and pullboxes as indicated. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be fabricated with tools designed for this

purpose. Factory elbows shall be utilized wherever possible. Continuous lengths of underground warning tapes shall be installed 12-inches above and parallel to all underground conduits. Tape shall be 6-inches wide polyethylene with foil backing film imprinted "CAUTION – ELECTRIC UTILITIES BELOW."

- S. Routing shall be adjusted to avoid obstruction. Coordinate between trades prior to installation of raceways. Lack of such coordination shall not be justification for extra compensation, and removal and re-installation to resolve conflicts shall be by the CONTRACTOR as part of the WORK.
- T. Exposed raceways shall be installed parallel or perpendicular to structural beams.
- U. Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.
- V. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, suitable insulating means shall be provided to prevent such corrosion.
- W. Holes:
 - 1. The CONTRACTOR shall provide the required insert materials and holes for all openings in new work completely bonded, curbed, flashed and finished off in an approved manner, whether in concrete, steel grating, metal panels or roofs. Resulting seal shall prevent smoke and gas penetration and adhere to Lloyds Register Standards Certificate Numbers SVG/F93/468, SVG/F93/469 and SVG/F93/470 and applicable UL Standards. Insert materials shall be of one of the following type:
 - a. Non-shrinking grout applied to continuously fill annular space between pipe and wall opening. The resulting seal shall serve as an isolator of fire, weather and gaseous conditions.
 - b. Fire rated, Ozone and Ultra-Violet radiation resistant, two-part silicone room temperature vulcanizing (RTV) foam.
 - 2. The CONTRACTOR shall core-drill all holes required in existing building work using a dustless method.
 - 3. The CONTRACTOR shall place grout or foam as specified, in the following locations:
 - a. All holes in concrete wall, floor and roof slabs after installation of conduit.
 - b. Wall entrances where conduit enters the building or vaults from exterior underground.
 - 4. The CONTRACTOR shall install fire and smoke stop fittings at all conduit penetration of fire rated walls, ceilings, and floors.

3.03 CONDUIT:

- A. Exposed conduit shall be Rigid Galvanized Steel, unless indicated otherwise:
 - 1. In areas with chlorine or hydrofluosilicic acid, Schedule 40 PVC shall be utilized.
 - 2. In lime or ferric chloride areas, rigid aluminum conduit shall be utilized
 - 3. In Class I, Div. I or Div. II hazardous locations, rigid aluminum conduit shall be utilized.
- B. Where conduit emerges from concrete encasement, use a PVC Schedule 40 elbow with a PVC terminal adapter and stainless steel threaded coupling. Install the top of the stainless steel coupling flush with top of concrete. Insert a PVC plug into the open end of the coupling to prevent debris from entering the conduit during construction. Use a PVC conduit nipple atop the elbow for height adjustment. Conduit shall emerge from the concrete perpendicular to the surface whenever possible.
- C. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4-inch for concrete not exposed to weather or in contact with the ground.

- D. Conduits passing through a slab, wall, or beam shall not impair significantly the strength of the construction.
- E. Conduits embedded within a slab, wall, or beam (other than those merely passing through) shall satisfy the following:
 - 1. Conduits with their fittings embedded within a column shall not displace more than 4 percent of the gross area of cross section.
 - 2. Conduits shall not be larger in outside dimension than one third the overall thickness of slab, wall, or beam in which embedded.
 - 3. Conduits shall not be spaced closer than 3 outside diameters on centers.
- F. Conduit shall be placed so that cutting, bending, or displacing reinforcement from its proper location will not be required.
- G. Threads shall be coated with a conductive lubricant before assembly.
- H. Joints shall be tight, thoroughly grounded, secure, and free of obstructions in the pipe. Conduit shall be adequately reamed to prevent damage to wires and cables during installation. Strap wrenches and vises shall be used to install conduit to prevent wrench marks on conduit. Conduit with wrench marks shall be replaced.
- I. Wherever possible, conduit runs shall slope to drain at one or both ends of run. Wherever conduit enters substructures below grade, the conduit shall be sloped to drain water away from the structure.
- J. Installation of rigid steel conduit through a core-drilled hole in an exterior wall below grade shall utilize a modular sealing device.
- K. Each conduit shall be identified at each end with a permanent non-corrosive metal marker. Designation shall be pressure stamped into the tag. The conduit identification shall be designated circuit number as shown.

3.04 SUPPORTS:

- A. The CONTRACTOR shall construct metal framing strut systems with sufficient rigidity to hold all mounted equipment and material in permanent and neat alignment. All channels, fittings and hardware of the strut assemblies shall be as per contract drawings and specifications and shall not exceed load requirements in UL classification 5B and applicable NEC, NEMA and ASTM standards. Utilize galvanized material for interior non-corrosive and air conditioned spaces and stainless steel, for outdoor or corrosive environments.
- B. Design supports to provide 1/4-inch space between equipment housings and walls or columns upon which they are mounted.
- C. After Power Tool Cleaning, paint all welds, field cuts and damaged areas with one manufacturer type of primer and paint. Utilize organic zinc-rich primer at 3 mils dry film thickness.
- D. All screws, nuts, bolts, pipe clamps and other anchoring materials for struts and framing shall be stainless steel.
- E. All outdoor supports shall be constructed to meet wind load requirements of the site as set forth in structural specifications or/and contract drawings.

3.05 OUTLET BOXES:

- A. Installation: Unless otherwise specified or shown on the drawings, outlet boxes shall be flush mounted, and the front edges of the boxes or plaster covers shall be flush with the finished wall or ceiling line; or, if installed in walls and ceilings of incombustible construction, not more than 1/4 inch

back of same. Mount boxes with the long axes of devices vertical, unless otherwise specified. A multiple of box extensions and/or covers will not be permitted. Install in a rigid and satisfactory manner with suitable metal bar hangers, box cleats, adjustable box hangers, etc. Use wood screws on wood, expansion shields on masonry and machine screws on steelwork.

- B. Mounting Heights: The mounting height of a wall-mounted outlet box shall be construed to mean the height from the finished floor to the horizontal center line of the cover plate. On exposed tile, block, or brick constructions, mount outlet boxes at the nearest bed joint to the mounting height indicated. Verify heights with the DISTRICT.
- C. Wall-mounted Switch, Receptacle and Signal Outlets: On columns, pilasters, etc., mount so the centers of the columns are clear for future installation of partitions. Install outlet boxes near doors or windows close to the trim. Install according to architectural drawings, unless other locations are approved by the DISTRICT.
- D. Back-to-Back: Outlets shown on the drawings "back-to-back" are to be installed with a minimum of 6 inches lateral separation between outlets. "Through-the-wall" type boxes are not permitted.

3.06 FIXTURE CONNECTIONS:

- A. Recessed or surface light fixtures in lay-in or accessible ceilings shall be connected with minimum 1/2 inch flexible metallic conduit, 4 to 6 feet long, with grounding provisions.

3.07 DUCTBANKS:

- A. Ductbanks shall be installed in accordance with the criteria below:
 - 1. Duct shall be assembled using high impact non-metallic spacers and saddles to provide conduits with vertical and horizontal separation. Plastic spacers shall be set every 5 feet. The duct array shall be anchored every 5 feet to prevent movement during placement of concrete.
 - 2. Duct shall be laid on a grade line of at least 3-inches per 100-feet, sloping towards pullboxes or manholes. Duct shall be installed and pullbox and manhole depths adjusted so that the top of the concrete envelope is a minimum of 18-inches below grade and a minimum of 24-inches below roadways.
 - 3. Changes in direction of the duct envelope by more than 10° horizontally or vertically shall be accomplished using bends with a minimum radius 24 times the duct diameter.
 - 4. Duct couplings shall be staggered a minimum of 6-inches.
 - 5. The bottom of trench shall be of select backfill or sand.
- B. Each bore of the completed ductbank shall be cleaned by drawing through it a standard flexible mandrel one foot long and 1/4-inch smaller than the nominal size of the duct. After passing of the mandrel, a wire brush and swab shall be drawn through. Spare raceways that are not indicated to contain conductors shall have a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway.
- C. Duct entrances shall be grouted smooth; ducts shall be terminated with flush end bells. Sections of pre-fabricated manholes and pullboxes shall be assembled with waterproof mastic and shall be set on a 12-inch bed of gravel as recommended by the manufacturer or as required by field conditions.
- D. Ductbank penetration through walls of manholes, pullboxes, and building walls below grade shall be watertight.
- E. Concrete encased ductbank shall terminate at building foundations. When duct enters the building with a concrete slab on grade foundation, duct shall not be encased, but shall transition to rigid steel conduits at the edge of the slab.

3.08 BURIED CONDUITS; YARD AREAS:

- A. The CONTRACTOR shall place PVC Schedule 40 conduit where indicated on project drawings.
- B. Make all joints watertight per requirements of section 2.01.J.2.
- C. Bury conduits a minimum of 24 inches below finish grade unless indicated otherwise.
- D. Slope conduit away from conduit risers where possible.
- E. Maintain 6-inch separation from underground piping.
- F. Use long radius bends at all risers unless indicated otherwise.
- G. After trench bottom has been excavated to elevation, lay conduit. Backfilling shall be as specified in DIVISION 2.
- H. Provide watertight seal around wires where conduit terminates in pull box.
- I. Empty service entrance conduits shall be PVC Schedule 40, or as otherwise required by serving utility.

END OF SECTION

SECTION 16120 WIRES AND CABLE

PART 1 - GENERAL

1.01 SCOPE:

- A. This SECTION includes furnishing and installing (including terminations) of all electrical wire, cable, and accessories.

1.02 REFERENCES: The latest edition of the following codes or standards shall apply to the design and fabrication of the products and equipment to be supplied by this SECTION.

- A. NEC (NFPA 70) National Electrical Code
- B. UL 83 - Thermoplastic Insulated Wires and Cables
- C. NETA International Electrical Testing Association - Acceptance Testing Specifications

1.03 DEFINITIONS: N/A

1.04 SUBMITTALS:

- A. The CONTRACTOR shall submit Shop Drawings in accordance with CONTRACTOR Submittals and SECTION 16050 – Basic Materials and Methods.

1.05 QUALIFICATIONS: N/A

1.06 RESPONSIBILITIES: N/A

1.07 TESTING:

- A. Cable Assembly and Testing: Cable assembly and testing shall comply with applicable requirements of NETA ATS Section 7.3.2. Factory test results shall be submitted in accordance with SECTION 01300 prior to shipment of cable. The following field tests shall be the minimum requirements:
 - 1. Power cable rated at 600 VAC shall be tested for insulation resistance between phases and from each phase to a ground using a megohmmeter.
 - 2. Field testing shall be done after cables are installed in the raceways.
 - 3. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the DISTRICT for review and acceptance.
 - 4. Cables failing the tests shall be replaced with a new cable.
- B. Continuity Test: Control and instrumentation cables shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cables in service.

1.08 INSPECTION COORDINATION:

- A. The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The CONTRACTOR shall provide 48 hours advance notice of its intention to begin new WORK activities.

1.09 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS, and PRODUCTS specified in this SECTION against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of SECTION 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of SECTION 00700 - General Terms and Conditions.

PART 2 - MATERIALS

2.01 GENERAL:

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

2.02 LOW VOLTAGE WIRE AND CABLE:

- A. Power and Lighting Wire
 - 1. Wire rated for 600 volts in duct or conduit for all power and lighting circuits shall be Class B Type THHN or THWN, polyvinyl chloride rated at 90°C in dry locations, 75°C in wet locations, meeting the requirements of UL 83.
 - 2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
 - 3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
- B. Control Wire
 - 1. Control wire in duct or conduit shall be the same type as power and lighting wire indicated above.
 - 2. Interconnecting control wiring installed in conduit to or between field devices (field wiring) shall be sized in accordance with NEC Article 310.15, Table 310.16 and shall not be smaller than No.14 AWG (minimum), unless otherwise indicated on project drawings
 - 3. Internal wiring installed within a control panel and cabinets shall be sized in accordance with NFPA 79, Table 12.5.1; and shall not be smaller than No. 18 AWG, unless otherwise indicated on project drawings.
 - 4. Internal control wires within control panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations.
- C. Instrumentation Cable
 - 1. Instrumentation cable shall be rated at 600 volts.

2. Individual conductors shall be No. 16 AWG stranded, tinned copper. Insulation shall be color coded polyethylene: black-red for two-conductor cable and black-red-white for three-conductor cable.
3. Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 16 AWG stranded tinned copper drain wire, and a PVC outer jacket with a nominal thickness of 0.048-inches.

2.03 CONNECTORS:

A. General Requirements:

1. Cable connectors shall be designed and sized for specific cable being connected.
2. Solderless, pressure-type connectors shall be constructed of non-corrodible tin-plated copper.
3. All connectors shall have a current-carrying capacity equal to or greater than the cable being connected.
4. Application tooling for compression type connectors shall contain die or piston stops to prevent over-crimping and cycling or pressure relief to prevent under-crimping. Dies of all application tooling shall provide wire size coding for quality control verification. All tooling shall be manufactured by the connector manufacturer.
5. General purpose insulating tape shall be high temperature (105°C) tape, with a dielectric strength of 1,150 V/mil of polyvinyl material.

B. Mechanical Pressure Connectors:

1. Connectors shall be threaded split bolt type of high strength copper alloy.
2. Pressure type, twist-on connectors will not be acceptable.
3. Barrel shall have funnel entry, and vinyl insulation.

C. Power Lugs (10 AWG and Smaller) 600V and Below:

1. Pre-insulated ring tongue type
2. Manufactured from high-strength copper alloy

D. Power Lugs (Sizes 8-4 AWG) 600V and Below:

1. Non-insulated ring-tongue type
2. Ring tongue sized to match terminal stud size
3. Brazed barrel seam
4. Sight hole to verify proper cable insertion
5. Application tooling designed to crimp the wire barrel (conductor grip) with a one-step crimp

E. Control, Instrument and Specialty Cable Connectors:

1. Tin-plated copper
2. Vinyl or nylon pre-insulated ring-tongue type (Spade lugs will not be permitted.)
3. Sized to match terminal stud size
4. Have insulation grip sleeve to firmly hold to cable insulation
5. Insulation grip sleeve shall be funneled to facilitate wire insertion and prevent turned-back strands.

6. Application tooling designed to crimp the wire barrel (conductor grip) and the insulation grip sleeve with a one-step crimp.

2.04 TERMINAL BLOCKS:

- A. For Mounting in Terminal Boxes:
 1. Designed and sized for the cables being terminated
 2. Phenolic block rated 600 volts
 3. Binding screw-type terminals for power cables and straight-strap stud terminals for control and instrument cables
 4. Rated current carrying capacity equal to or greater than the cable being terminated
 5. Marking strip
- B. For Mounting in Cabinets, Panels, Control Boards, etc.:
 1. Designed and sized for the cables being terminated
 2. Terminal blocks shall be tubular screw type with pressure plates and shall be rated 600 V AC/DC, 10 A rated minimum.

2.05 CABLE IDENTIFICATION SLEEVES:

- A. Refer to SECTION 16050 for appropriate conductor identification material.

PART 3 - EXECUTION

3.01 GENERAL:

- A. The CONTRACTOR shall provide and terminate all power, control, and instrumentation conductors except where indicated.

3.02 INSTALLATION:

- A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.
- B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.
- C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.
- D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.
- E. Single conductor cable in cable trays shall be No. 1/0 or larger and shall be of a type listed and marked for use in cable trays. Tray cable smaller than 1/0 shall be multi-conductor, with outer jacket.

3.03 SPLICES AND TERMINATIONS:

- A. General
 1. Wire taps and splices shall be properly taped and insulated according to their respective classes.
 2. In general, there shall be no cable splices in underground manholes or pullboxes. If splices are necessary, the cables shall be brought aboveground and terminated in a NEMA 4X, stainless steel terminal or splice cabinet that is stand mounted on a concrete pad. Splices in underground manholes and pullboxes may be made only with the approval of the DISTRICT and shall utilize

outdoor mechanical or compression type splice connectors meeting UL486D and UL50 requirements.

3. Stranded conductors shall be terminated directly on equipment box lugs making sure that all conductor strands are confined within lug. Use compression lugs where equipment box lugs have not been provided.
4. Surplus control and instrumentation wire shall be properly taped and terminated as spares.

B. Control Wire and Cable

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.
2. In junction boxes, motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips.

C. Instrumentation Wire and Cable

1. Shielded instrumentation cables shall be grounded at one end only, preferably the receiving end on a 4-20 mA system.
2. Two and three conductor shielded cables installed in conduit runs which exceed available standard cable lengths may be spliced in pullboxes. Such cable runs shall have only one splice per conductor. Splices, where approved by the DISTRICT, shall be made on terminal blocks.

D. Power Wire and Cable

1. All 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable boxes or conduit bodies at locations determined by the CONTRACTOR.
2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of two layers of varnished cambric tape overtaped with a minimum of two layers of high temperature tape.

3.04 CABLE IDENTIFICATION:

- A. General: Wires and cables shall be identified for proper control of circuits and equipment and to reduce maintenance effort.
- B. Identification Numbers: The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to all conductors having common terminals and shall be shown on "as built" drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control Conductor" shall be defined as any conductor used for alarm, control, annunciation, or signal purposes.
 1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.
 2. All 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The 480/277-volt system conductors shall be color coded as follows: Phase A - Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switched conductors shall be yellow. Insulated ground wire shall be green. Color coding and phasing shall be consistent throughout the Site, but bus bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs.

3. All 4-wire, delta-connected secondary where the midpoint of one phase winding is grounded, the phase conductor having the higher voltage to ground shall be identified by an outer finish that is orange in color. Color coding tape shall be used where colored insulation is not available. Such identification shall be placed at each point where a connection is made if the ground conductor is also present. The B phase shall be that phase having the higher voltage to ground on 3-phase, 4 wire delta-connected system.
4. Fire alarm cable jackets shall be red. General purpose DC control cable jackets shall be blue.
5. Spare conductors shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.
6. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

END OF SECTION

SECTION 16140 WIRING DEVICES

PART 1 - GENERAL

1.01 SCOPE:

The Work of this Section shall consist of furnishing all labor, materials, and equipment necessary for installation of wiring devices and plates as shown on the Drawings and specified herein.

1.02 REFERENCES: 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.

- A. NEC (NFPA 70) National Electrical Code
- B. NETA International Electrical Testing Association - Acceptance Testing Specifications
- C. NEMA 250 - Enclosure for Electrical Equipment (1,000 Volts Maximum)
- D. Local Building Codes and Standards
- E. UL 1449 Standard for Transient Voltage Surge Suppressors
- F. UL 498 Standard for Safety Attachment Plugs and Receptacles

1.03 DEFINITIONS: N/A

1.04 SUBMITTALS:

- A. Furnish submittals in accordance with Contractor Submittals.
- B. Shop Drawings
 - 1. Complete catalog cuts of switches, receptacles, enclosures, covers, and appurtenances, marked to clearly identify proposed materials
 - 2. Documentation showing that proposed materials comply with the requirements of NEC and U.L.

1.05 QUALIFICATIONS:

- 1. Submit documentation of the manufacturer's qualifications.

1.06 RESPONSIBILITIES:

- A. The Requirements of SECTION 16050 Basic Materials and Methods apply to this section.
- 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.

1.07 TESTING:

- A. Provide checkout, field, and functional testing of wiring devices in accordance with SECTION 16050.
- B. Test each receptacle for polarity and ground integrity with a standard receptacle tester.
- C. Test GFCI receptacle for correct tripping operation with suitable tester.

1.08 INSPECTIONS COORDINATION:

The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The Contractor shall provide 48 hours notice of its intention to begin new WORK activities.

1.09 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 PLUG CAPS & CORDS:

Provide and install a matching plug cap and properly-sized cord for equipment items noted on the drawings as by Electrical Contractor. No plug caps are required for duplex receptacle.

2.02 DEVICE PLATES:

- A. General: 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. Plates shall be of commercial grade nylon.
- B. Provide nameplates or equivalent markings on switch enclosures to indicate ON and OFF positions of each switch. ON and OFF for 3-way or 4-way switches is not acceptable. Receptacles slated for special purposes shall have nameplates clearly indicating their intended use. Conform to requirements of SECTION 16050.
- C. Special Purpose: Plates for special purpose outlets shall be of a design suitable for the particular application and as called for in the project drawings.

PART 3 - EXECUTION

3.01 GENERAL: Perform work in accordance with the National Electrical Code.

3.02 CONNECTION:

- A. Rigidly attach wiring devices in accordance with National Electrical Code, and as indicated, avoiding interference with other equipment.
- B. Securely fasten nameplates using screws, bolts, or rivets centered under or on the device, unless otherwise indicated.

3.03 GROUNDING:

- A. Ground all devices, including switches and receptacles, in accordance with NEC, ART 250, and SECTION 16450 Grounding.
- 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 positive ground connections to outlet box and grounding system. Maintain ground to each receptacle by spring-loaded grounding contact to

mounting screw or by grounding jumper, each making positive connection to outlet box and grounding system at all times.

END OF SECTION

SECTION 16440 DISCONNECT SAFETY SWITCH

PART 1 - GENERAL

1.01 SCOPE:

- A. The Work of this Section shall consist of furnishing all labor, materials, and equipment necessary for installation of safety switches, service entrance fusible and non fusible switches, and stand alone service entrance main circuit breakers as shown on the Drawings and as specified herein.
- B. Safety switches without the neutral assembly shall not be allowed as service entrance equipment but can be utilized as local load disconnects.

1.02 REFERENCES: 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.

- A. NEC (NFPA 70) National Electrical Code
- B. NETA International Electrical Testing Association - Acceptance Testing Specifications
- C. NEMA 250 - Enclosure for Electrical Equipment (1,000 Volts Maximum)
- D. Local Building Codes and Standards
- E. UL 489 - Molded-Case Circuit Breakers, Molded - Case Switches and Circuit-Breaker Enclosures
- F. UL 98 - Standard for Safety for Enclosed and Dead-Front Switches

1.03 DEFINITIONS: N/A

1.04 SUBMITTALS:

- A. Furnish shop drawings in accordance with Contractor Submittals and SECTION 16050 Basic Materials and Methods.
- B. Include catalog cuts of all switches and circuit breakers.
- C. Include fuse and circuit breaker protection coordination curves.

1.05 QUALIFICATIONS: N/A

1.06 RESPONSIBILITIES:

- A. If required by project documents, the CONTRACTOR shall perform a system protection coordination study to properly set the protection devices.

1.07 TESTING:

- A. Test devices as called for in SECTION 16950 Field Testing.

1.08 INSPECTION COORDINATION:

- A. The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The Contractor shall provide 48 hours notice of its intention to begin new WORK activities.

1.09 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 DISCONNECTING MEANS:

- A. Separately Enclosed Motor Snap Switches/Safety Switches: Motor snap switches and/or heavy duty safety switches may be used for motor disconnect means, controller, and motor overcurrent protection when applicable. These devices shall be horsepower rated and may contain motor running overcurrent protection. The enclosures shall meet the classification set forth in Section 16050.

2.02 FUSES:

- A. General: All fuses shall be dual element, time delay type, based on heavy service unless otherwise noted or required for installation.

2.03 SPARE FUSES:

- A. Furnish one complete spare set of each size of fuses installed. The CONTRACTOR shall deliver to the District Site in original boxes and store them in the fuse cabinet furnished under this Contract.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Disconnect Devices shall be installed in accordance with SECTION 16050 and in accordance with the manufacturer recommendations.
- B. Disconnect Devices shall be protected at the Site from loss, damage, and the effects of weather. Services Entrance Devices shall be stored in an indoor, dry location. Heating shall be provided in areas subject to corrosion and humidity.
- C. Disconnect Device interiors and exteriors shall be cleaned, and coatings shall be touched up to match original finish upon completion of the WORK.
- D. Conduit, conductors, and terminations shall be installed in accordance with SECTIONS 16050, 16110 and 16120.

END OF SECTION

SECTION 16450 GROUNDING

PART 1 - GENERAL

1.01 SCOPE:

- A. The CONTRACTOR shall provide the electrical grounding system, complete and operable, in accordance with the Contract Documents. Including but not limited to the building grounding grid, the grounding rod system and ground riser extension to electrical equipment.
- B. The requirements of SECTION 16050 - Basic Materials and Methods, General apply to this SECTION.

1.02 REFERENCES: 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.

- A. NEC Article 250 - Grounding
- B. UL 467 - Standard for Safety Grounding and Bonding Equipment
- C. IEEE 837 - Standard for Qualifying Permanent Connections Used in Substation Grounding
- D. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- E. AWWA C210 - Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
- F. NETA (International Acceptance Testing Specifications)

1.03 DEFINITIONS:

- A. Low Voltage Grounded System (600V or less): A low voltage grounded system is a system where the local power supply is a transformer with the transformer secondary grounded.
 - 1. The first disconnecting means on the load side of this transformer shall provide the point where the neutral conductor is grounded.
 - 2. The neutral shall be connected to the Equipment Grounding Circuit Conductor only at one point which is within the enclosure of the disconnecting means.
 - 3. The Grounding Electrode Conductor or the Equipment Grounding Circuit Conductor shall not be used as the neutral.

1.04 SUBMITTALS:

- A. Furnish submittals in accordance with CONTRACTOR Submittals and SECTION 16050.
- B. Product Data: Manufacturer's product information for connections, clamps, grounding rods and grounding system components, showing compliance with the requirements of this SECTION.
- C. "As-built" Drawings: Provide the DISTRICT with "as-built" drawings of actual grounding system installation. The "as-built" drawings of the grounding system shall be signed and sealed by a State of Florida licensed Professional Engineer.

1.05 QUALIFICATIONS: N/A

1.06 RESPONSIBILITIES:

- A. The CONTRACTOR shall not conceal or cover any ground connections until the DISTRICT has established that every grounding connection conforms to the Contract Documents and has given the CONTRACTOR written confirmation.

1.07 TESTING:

- A. Measure and test the ground impedance in accordance with IEEE Standard 81 after installation but before connecting the electrode to the remaining grounding system. Verify all ground potentials on plan drawings and submit to the DISTRICT for final approval.
- B. Test the grounding system per NETA ATS section 7.13 and called for in SECTION 16950 - Field Testing.
- C. **INSPECTIONS COORDINATION:** The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The CONTRACTOR shall provide 48 hours advance notice of its intention to begin new WORK activities.

1.08 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS, and PRODUCTS specified in this SECTION against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than one year from the date of Substantial Completion, and as described in Article 13 of SECTION 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of SECTION 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. Components of the grounding electrode system shall be manufactured in accordance with ANSI/UL 467 - Standard for Safety Grounding and Bonding Equipment, and shall conform to the applicable requirements of National Electrical Code Article 250 and local codes.

2.02 GROUNDING ELECTRODE SYSTEM: (USE AS REQUIRED FOR THIS PROJECT)

- A. Grounding loop conductors shall be bare annealed copper conductors suitable for direct burial. Conductors shall be #2/0 AWG unless indicated otherwise.
- B. Ground Rods
 - 1. Unless indicated otherwise, the ground rod shall be a minimum of 3/4-inch in diameter, 20-feet long with pointed end to facilitate driving, and have a uniform covering of electrolytic copper metallically bonded to a rigid steel core. The copper to steel bond shall be corrosion resistant. The rod length shall be clearly stamped near the top of the rod.
 - 2. Conform to ANSI/UL 467.
 - 3. Sectional type joined by threaded copper alloy couplings.
- C. Buried cable-to-cable and cable-to-ground rod connections shall be made using exothermic welds or compression connectors suitable for direct burial.
- D. Exposed grounding connectors shall be of the compression type (connector to cable), made of high copper alloy, and be manufactured specifically for the particular grounding application.
- E. Grounding clamps shall be used to bond each separately derived system to the grounding electrode conductors.
- F. Equipment Grounding Circuit Conductors
 - 1. These conductors shall be the same type and insulation as the load circuit conductors. The minimum size shall be in accordance with the NEC-Article 250, unless indicated otherwise.
 - 2. Present in all raceways. The conduit system is not an allowable equipment ground.
 - 3. Cable to equipment ground lugs shall be compression type, bolted to the equipment with silicon bronze bolts and lock washers.

2.03 COATINGS:

- A. Coal Tar:
 - 1. All underground grounding connections shall be coated with coal tar as specified herein.
 - 2. Coating shall be of Polyamide Epoxy-Coal Tar with high build corrosion resistance. Resulting coat shall conform to the performance requirements of AWWA C 210.

PART 3 - EXECUTION:

3.01 WIRE, CABLE AND RACEWAY GROUNDING: (USE AS REQUIRED FOR THIS PROJECT)

- A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material as well as in each raceway with parallel feeder run.
- B. Size shall be as given on the conduit schedule and in accordance with the NEC-Article 250.
- C. Provide the duct bank ground system indicated, including, trenching, splices, ground rods, and connections to equipment and structures.
- D. Grounding Wires and Cables:
 - 1. Install using as few joints as possible.
 - 2. Protect against abrasion by several wrappings of rubber tape at all points where cable leaves concrete in exposed areas.
 - 3. Suitably protect cable against damage during construction.
 - 4. Replace or suitably repair cable if damaged by anyone before final acceptance.

3.02 GROUNDING BOXES, MOTORS AND ELECTRICAL EQUIPMENT: (USE AS REQUIRED FOR THIS PROJECT)

- A. Provide a separate grounding conductor for each motor and connect at motor box. Do not use bolts securing motor box to frame or cover for grounding connectors.
- B. Provide a grounding type bushing for secondary feeder and branch circuit conduits which originate from the secondary section of each MCC section, switchboard, or panelboard.
- C. Individually bond these raceways to the ground bus in the secondary section.
- D. Provide solid copper green insulated wire as grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.
- E. Interconnect the secondary switchgear neutral bus to the ground bus in the secondary switchgear compartment only at service entrance point or after a transformer.

3.03 GROUNDING SYSTEMS: (USE AS REQUIRED FOR THIS PROJECT)

- A. Embedded Ground Connectors
 - 1. The connection shall be made in accordance with the manufacturer's instructions.
 - 2. Lay in bottom of trench or in other excavations at least 18 inches below finished grade.
 - 3. Maintain clearance of at least 12 inches from all underground metal piping or structures, except where connections thereto are specifically indicated.
 - 4. Duct Bank Ground: A grounding conductor shall be embedded in every duct bank as indicated.
- B. Ground Ring
 - 1. Furnish trenching and materials necessary to install the ground ring as indicated.
 - 2. Bonding conductor shall be in direct contact with the earth and be of the size indicated.
 - 3. Minimum burial depth **30**-inches or as indicated on the Drawings, whichever is greater.
 - 4. Re-compact disturbed soils to original density in 6-inch layers.
- C. Ground Rods

1. Ground rods forming an individual ground array shall be equal in length.
2. The CONTRACTOR shall install rods as indicated by driving and not by drilling or jetting.
3. The CONTRACTOR shall drive rods into unexcavated portion of the earth where possible.
4. In excavated areas, the CONTRACTOR shall drive grounding rods after compaction and backfill is completed.
5. The CONTRACTOR shall drive to a depth such that top of rods will be approximately **30** inches below final grade, or subgrade, and connect main grid ground cable thereto.

3.04 SHIELD GROUNDING:

- A. Shielded instrumentation cable shall have its shield grounded at one end only unless Shop Drawings indicate the shield will be grounded at both ends.
- B. The grounding point shall be at the control panel or otherwise at the receiving end of the signal carried by the cable.
- C. Termination of shield drain wire shall be on its own terminal screw.
- D. All terminal screws shall be jumpered together using manufactured terminal block jumpers.
- E. Connection to the ground bus shall be via a green No. 12 conductor to the main ground bus for the panel.

END OF SECTION

SECTION 16455 VARIABLE FREQUENCY DRIVE UNITS

PART 1 - GENERAL

1.01 SCOPE:

- A. The Work of this Section shall consist of furnishing all labor, material, and equipment as necessary for the installation of variable frequency drive (VFD) equipment as shown on the Drawings and specified herein. The equipment covered by this specification covers stand-alone VFDs with all associated controls and shall be suitable to operate Chilled Water Pumps.

1.02 REFERENCES: 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.

- A. NEC (NFPA 70) National Electrical Code
- B. NETA International Electrical Testing Association - Acceptance Testing Specifications
- C. NEMA 250 - Enclosure for Electrical Equipment (1,000 Volts Maximum)
- D. Local Building Codes and Standards
- E. NEMA ICS 3.1 - Safety standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems
- F. UL 508 - Industrial Control Equipment

1.03 DEFINITIONS: N/A

1.04 SUBMITTALS:

- A. General: Submittals shall be in accordance with SECTION 01300 - Contractor Submittals. The Contractor shall provide shop drawing submittals in conformance with SECTION 16050, except that Shop Drawing information for the drives shall be submitted as part of the information for the driven equipment.
- B. Shop Drawings: Shop drawings shall include the following information:
 - 1. Equipment information
 - a. Name of drive manufacturer
 - b. Type and model
 - c. Assembly drawing and nomenclature
 - d. Maximum heat dissipation capacity in KW
 - 2. Conduit entrance provisions
 - 3. Circuit breaker type, frames and settings
 - 4. Information related to relays, timers, pilot devices, control transformer VA and fuse sizes. Include catalog cuts.
 - 5. System schematic ladder diagram and interconnection diagrams. The schematic ladder diagram shall include all remote devices. The ladder diagram shall incorporate the control logic on the corresponding elementary schematic on the Contract Drawings. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the CONTRACTOR stamped "REJECTED".

6. Factory test data certifying compliance of similar equipment from the same manufacturer with requirements of this Section
- C. The Technical Manual shall contain the following documentation:
1. Manufacturer's warranty
 2. Harmonic analysis report
 3. Field test report
 4. Programming procedure and program settings
- D. The CONTRACTOR shall provide Maintenance Data to include the following:
1. Variable frequency drive installation instructions and User Manual
 2. Installation / Operation instructions for major components such as circuit breakers, contactors, isolation transformers, etc.
 3. Drive Parameter Listing
 4. Field Service report from drive start-up service
 5. Listing and pricing of recommended spare parts
 6. Name and phone number for a local distributor for the spare parts

1.05 QUALIFICATIONS:

- A. Acceptable VFD manufacturers must have an authorized service provider within two-hour drive from the project location. The service provider must be able to respond to a warranty-related problem within two (2) hours.

1.06 RESPONSIBILITIES:

- A. CONTRACTOR shall be responsible for coordinating the shipping of equipment with the manufacturer.
- B. CONTRACTOR shall connect internal space heaters (if specified) with temporary power.

1.07 TESTING:

- A. Testing shall be per manufacturer's standard.
- B. A copy of the test reports shall be provided as part of the Closeout Documentation.

1.08 INSPECTION COORDINATION:

- A. The CONTRACTOR shall provide access to the WORK for the DISTRICT as requested for inspection. The Contractor shall provide 48 hours notice of its intention to begin new WORK activities.

1.09 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with a minimum three (3) year warranty for parts and labor starting from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for one year from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 PRODUCT REQUIREMENTS:

A. General Requirements:

1. Drive shall accept an input voltage of 480VAC, three-phase plus or minus 10 percent.
2. The displacement power factor shall range between 1.0 and 0.95, lagging, over the entire speed range
3. Minimum efficiency shall be >95% at full load and speed.
4. The drive shall be designed to operate on an AC line which may contain line notching and up to 10 percent harmonic distortion.
5. A 2-1/2% (minimum) Line Reactor, integral to the drive enclosure shall be provided for each drive for protection from normal line transients.
6. Output line filter.
7. Programmable current limiting from 0.1 amperes to 150 percent of drive rated amperes shall be active for all drive states (accelerating, constant speed and decelerating).
8. All set up, operation and adjustment settings shall be made through a digital interface.
 - a. All adjustments shall be stored in nonvolatile Electrically Erasable Programmable Read Only Memory (EEPROM).
 - b. Potentiometer adjustments shall not be required.
9. Storage ambient temperature range shall be -25C to 70 C (-13 to 158 F).
10. Separate terminal blocks shall be provided for control and power wiring.
11. Operating ambient temperature range shall be - 10C to 40 C (14 to 104 F) without derating.
12. Relative humidity range shall be 0 percent to 90 percent non-condensing. The output frequency range shall be adjustable from 47 to 63 Hz. The drive unit's inverter section shall produce a pulse width modulated (PWM) waveform using the latest generation IGBTs.
13. The drive unit's inverter section shall produce a pulse width modulated (PWM) using the latest generation IGBTs.

B. Performance Requirements:

1. Drive unit shall have the ability to be operated with the motor disconnected.
2. Controlled shutdown when properly fused, with no component failure in the event of an output phase to phase or phase to ground short circuit shall be available. Annunciation of the fault condition shall be provided.
3. Drive shall be suitable for use on either variable torque load as specified. VFD's variable torque loading, the drive shall have 110 percent overload capability for up to one minute. VFD's for constant torque loading, the drive shall have 150 percent overload capability for up to one minute.
4. Multiple programmable stop modes including - Ramp, Ramp-to Hold and S-Curve shall be available, as specified.
5. The drive unit shall provide up to ten automatic fault reset and restarts following a fault condition before locking out and requiring manual restart.
 - a. Ground fault and shorted output faults shall not apply to the automatic mode.
 - b. Adjustable time between restarts shall be available.

6. Multiple acceleration and deceleration rates shall be available.
 7. Drive unit shall have the ability to skip up to three (3) frequencies, which may produce mechanical resonance, by providing set points to lock out continuous operation at those frequencies.
 - a. The set points shall have a bandwidth adjustable from 0Hz to 60Hz.
- C. Drive Unit Component Requirements:
1. Utilize diode of fully gated bridge on the input.
 2. Utilize DC bus inductor.
 3. Utilize switching logic power supply operating from the DC bus.
 4. Incorporate phase to phase and phase to Metal Oxide Varistor (MOV) protection.
 5. Microprocessor based inverter logic shall be isolated from power circuits.
 6. Inverter section shall not require commutation capacitors.
 7. Employ interface common for all horsepower ratings. Interface shall include a LCD digital display, programming keypad and operator key options.
 8. Main Control Board shall be common for all ratings.
 9. Control connection shall be common for all ratings.
 10. Separate terminal blocks shall be provided for control and power wiring.
 11. Provide drive input fuses to provide branch circuit protection for the drive. The drive input fuses shall be selected by the manufacturer and mounted in the fused disconnect.
 12. Provide a door interlocked drive input motor circuit protector disconnect.
 13. Provide a harmonic trap filter mounted within the drive system enclosure. Separately mounted units are not acceptable. The harmonic trap filter shall incorporate a 5 percent input line reactor.
 14. Provide a drive input line reactor mounted within the drive system enclosure. The reactor shall meet the following specifications.
 - a. Iron core construction with an impedance of two and one-half (2-1/2) percent (minimum).
 - b. Copper wound winding.
 - c. Insulation class H with a 115 degree rise.
 - d. Unit shall be rated for system voltage and frequency.
 15. All VFD/s must be provided with a 3- contactor bypass option.
 16. Provide a drive output contactor between the drive output and the motor. The contactor shall close on power up and open after a drive fault or loss of power.
 17. Provide a means to manually switch a single motor from drive control to bypass (across the line operation).
 18. Provide a Class 20 Motor Thermal Overload Relay. The relay is to utilize eutectic alloy heater elements.
 19. Provide a control power transformer mounted and wired inside of the drive system enclosure. Transformer shall be rated for drive power plus 250 VA for customer use.
 20. Provide a common mode choke at the drive output to help, in conjunction with the proper grounding techniques, reduce or eliminate interference with sensitive electronic equipment or communication devices installed in the same system.

21. Provide relays for Drive Alarm, Drive Fault and Drive Run. Provide two additional relays to be wired per custom requirements.
22. Provide an enclosure space heater (fin strip type) to help prevent condensation inside the enclosure during periods of inactivity. The space heater is to be energized whenever the drive power is removed.
23. Provide Hand - Off - Auto selector switch for start - stop control. Pilot lights shall be provided for indication of the "Hand" and "Auto" modes and shall be suitable for the environment it is exposed to.
24. Provide start-stop pushbuttons. The pushbuttons are to be mounted on the drive system enclosure door and be suitable for the environment it is exposed to.
25. Pilot lights for indication of Control Power On, Drive Fault and Run shall be provided and mounted on the drive system enclosure door.
26. Provide a digital, non-resettable, door mounted elapsed motor run time meter. The meter shall be electrically interlocked with the drive run relay and bypass contactor.
27. Provide a door mounted Human Interface Module with integral display, operating keys and programming keys.
28. For large motors with winding and/or bearing RTDs, provide a door mounted RTD sensing module for over-temperature and under temperature protection. Each unit shall monitor up to six (6) motor and two (2) bearing mounted RTDs and shall have three (3) output relays for alarm, trip, and fault. Relay contacts shall be rated 5A-250VAC.
29. VDF's must be provided from the factory with the ability to communicate directly with the building EMCS panel using RD-485 with Modbus RTU communication protocol.

D. Materials of Construction:

1. Enclosure must be weatherproof meeting the tests as outlined by NEMA 3 or NEMA 4 type enclosures.
 - a. Free standing enclosures shall be provided with cooling mechanisms deemed appropriate for the environmental conditions.
2. Paint shall be manufacturer's standard.

E. Acceptable Manufacturers:

1. Yaskawa
2. Rockwell
3. Eaton

2.02 SPECIAL REQUIREMENTS:

- A. Spare Parts: The CONTRACTOR shall furnish the spare parts listed below, suitably packaged and labeled with the corresponding equipment number.
- B. During the term of this Contract, the CONTRACTOR shall notify the DISTRICT in writing about any manufacturer's modification of spare part numbers, interchangeabilities, or model changes. If the DISTRICT determines that the modified parts no longer apply to the equipment provided, the CONTRACTOR shall furnish other applicable parts at no increase to the DISTRICT.
- C. The following spare parts shall be furnished:
 1. Provide one (1) set of (3) of each size power fuse utilized.
 2. Provide spares equal to 10 percent of the installed quantity for primary and secondary control power fuses.

3. Provide one (1) spare control relay for each unique relay utilized on the project.
 4. (1) PCB Main Control Board for each unique PCB Main Control Board utilized on the project.
 5. (1) Communication Adapter Boards for each unique Communication Adapter Board utilized on the project.
- D. Harmonic Analysis:
1. The CONTRACTOR shall perform a harmonic study of the facilities included in this Contract.
 2. The following assumptions will be utilized:
 - a. The distribution system is a “general” system as classified by IEEE 519 under low voltage systems.
 - b. Assume 90 percent of total plant operating load is motor load and 10 percent is resistive.
 - c. Assume a 70 percent diversity factor (70 percent of total plant operating).
 - d. Assume the maximum of VFDs, as limited by rated process flows, and similar facility restrictions, are operating.
 - e. Results shall be submitted prior to VFD shipment. Excessive harmonic distortion shall be specifically denoted and corrective measures shall be submitted for action to the DISTRICT.

PART 3 - EXECUTION

3.01 SERVICES OF MANUFACTURER:

- A. General: An authorized service representative of the manufacturer shall be present at the site for 3 work days to furnish the services listed below. For the purpose of this paragraph, a work day is defined as an 8-hour period excluding travel time.
- B. Inspection, Startup, Field Adjustment: The authorized service representative shall supervise the following, as a minimum, and certify the equipment and controls have been properly installed, aligned, and readied for operation.
 1. Pre-Power Check
 - a. Megger Motor Resistances: Phase to Phase and Phase to Ground.
 - b. Verify system grounding per manufacturer’s specifications.
 - c. Verify power and signal grounds.
 - d. Check connections.
 - e. Check environment.
 2. Drive Power-up and Commissioning
 - a. Measure Incoming Power Phase-to-Phase and Phase-to-Ground.
 - b. Measure DC Bus Voltage.
 - c. Measure AC Current Unloaded and Loaded.
 - d. Measure Output Voltage Phase-to-Phase and Phase-to-Ground.
 - e. Verify input reference signal.
 3. Record all measurements.
 4. Tune drive for optimal system operation.
 5. Provide Drive Parameter Listing.

- C. Instruction of DISTRICT Personnel: The authorized representative shall instruct DISTRICT personnel in the operation and maintenance of the equipment, including step by step troubleshooting with test equipment. Instruction shall be specific to the VFD models provided. Training shall be scheduled a minimum of 3 weeks in advance of the first session. Training shall include individual two-hour sessions for 4 shifts of plant personnel. Proposed training materials shall be submitted for review, and comments shall be incorporated. Training materials shall remain with the trainees. The DISTRICT may videotape the training for later use with DISTRICT personnel.

3.02 DELIVERY, STORAGE AND HANDLING:

- A. Contractor shall coordinate the shipping of equipment with the manufacturer.
- B. Contractor shall store the equipment in a clean and dry space.
- C. The contractor shall protect the units from dirt, water, construction debris and traffic.
- D. During storage the contractor shall connect internal space heaters (if specified) with temporary power

3.03 INSTALLATION:

- A. Conduit stub-ups for interconnected cables and remote cables shall be located and terminated in accordance with the drive manufacturer's recommendation.
- B. The CONTRACTOR shall perform all programming of drive parameters required for proper operation of the VFDs included in this project. Submit records of programming data in the equipment Technical Manual.

3.04 FIELD TESTING:

- A. Testing, checkout, and startup of the VFD equipment in the field shall be performed under the technical direction of the manufacturer's service engineer. Under no circumstances shall any portion of the drive system be energized without authorization from the manufacturer's representative.
- B. The CONTRACTOR shall test the completed installation for actual harmonic distortion at the point of common coupling.
 - 1. Harmonic analysis shall be performed in accordance with IEEE 519-Harmonic Control and Reactive Compensation of Static Power Converters at unit full load using a harmonic analyzer by an appropriate harmonic analyzer vendor.
- C. Tests shall prove that the harmonic voltage distortion at the 480 volt distribution bus of the panelboard, motor control center, or switchgear serving the VFD is limited to a magnitude of 5 percent of the fundamental with the isolation transformer or input line reactor in the circuit as indicated and with the maximum number of drives, as permitted by the process, in operation. The report shall include the following:
 - 1. Expected harmonic voltage (THD) through the 35th harmonic, calculated with isolation transformers
 - 2. Actual RMS value and measured percentage of the THD in the field.

END OF SECTION

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SECTION 16950 FIELD TESTING

PART 1 - GENERAL

1.01 SCOPE:

- A. This Section specifies the work necessary to test, commission, and demonstrate that the electrical work satisfies the criteria of these specifications and functions as required by the Contract Documents.
- B. The work of this Section includes furnishing the labor, equipment, and power required to support the testing specified in other divisions of these Specifications. This scope may require the CONTRACTOR to activate circuits, shutdown circuits, and run equipment, make electrical measurements, replace blown fuses, install temporary jumpers, etc.
- C. The requirements of SECTION 16050 Basic Materials and Methods, apply to the WORK of this Section.

1.02 REFERENCES: 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.

- A. (ASTM) American Society for Testing and Materials
- B. (ICEA) Insulated Cable Engineers Association
- C. NEC (NFPA 70) National Electrical Code
- D. (NEMA) National Electrical Manufacturers Association
- E. (NETA) International Electrical Testing Association - Acceptance Testing Specifications

1.03 DEFINITIONS: N/A

1.04 SUBMITTALS:

- A. Prior to scheduling the field acceptance tests, the Contractor shall submit the following items for the station control panel and engine control panels,.
 - 1. A detailed automation systems (Instrumentation, PLC's, HMI and Televent SCADA) test plan and schedule.
 - 2. Instrument data sheets
 - 3. Completed instrument calibration sheets
 - 4. All related control system setpoints
 - 5. Database tags
 - 6. PLC programs and HMI screens
 - 7. Instrument calibration procedures
- B. Five (5) bound copies of the certified test reports shall be submitted by the independent testing firm to the CONTRACTOR upon completion of the project. The final report shall be signed and shall include the following information:
 - 1. Summary of the project
 - 2. Description of equipment tested
 - 3. Visual Inspection report
 - 4. Description of tests
 - 5. Test data
 - 6. Analysis and recommendations
 - 7. Appendix including appropriate test forms
 - 8. Identification of test equipment used and calibration dates

1.05 QUALIFICATIONS: (NOT USED)

1.06 RESPONSIBILITIES:

- A. The CONTRACTOR shall notify and coordinate the scheduling of Testing when equipment becomes available for acceptance tests.
- B. The CONTRACTOR shall provide the Independent Testing SUBCONTRACTOR with a complete set of approved electrical drawings, coordination study (if applicable), settings of all adjustable devices (if applicable), manufacturer's instruction manuals and any other information necessary for an accurate evaluation of the equipment and systems prior to performance of any tests.
- C. All testing shall include coordination with EMCS subcontractor, to test proper operation/communication to and from EMCS. 1.07 B. Add CONTRACTOR shall coordinate with EMCS subcontractor to ensure any adjustments required for proper EMCS operation is completed prior to testing.
- D. The CONTRACTOR shall provide a suitable source of electrical power as specified by the Independent Testing Firm at each test site point of need.
- E. The CONTRACTOR shall report to the DISTRICT any system, equipment, material, or workmanship which is found deficient on the basis of acceptance tests.
- F. The CONTRACTOR shall correct deficiencies identified by tests and make ready for retest.
- G. The CONTRACTOR shall hire and pay for the services of the Independent Testing Firm to retest any equipment found to be deficient at initial testing until specified requirements are met.

1.07 TESTING:

- A. The following test requirements supplement test and acceptance criteria that may be stated elsewhere.
 - 1. Meters shall be tested as per NETA ATS Section 7.11.
 - 2. Instrument transformers shall be tested as per NETA ATS Section 7.10.
 - 3. Demonstrate mechanical and/or electrical interlocking by attempting to subvert the intended sequence.
 - 4. Surge arrestors rated less than 600V shall be tested as per NETA ATS Section 7.19.1
 - 5. Batteries shall be tested as per NETA ATS Section 7.18.1.
 - 6. Battery chargers shall be tested as per NETA ATS Section 7.18.2.
 - 7. Uninterruptible Power Systems shall be tested as per NETA ATS Section 7.22.2
 - 8. Cable Testing: Low voltage 600-volt maximum cable shall be tested for insulation resistance.
 - 9. Testing shall be done after the equipment is terminated. Inspection and test procedures, as outlined in NETA ATS Section 7.3.2 - Cables, shall be followed. Test results, stating equipment used and time of test shall be submitted for review 30 days prior to plant operation and any system testing. Equipment which may be damaged during this test shall be disconnected. Perform tests with all other equipment connected to the circuit. In order to be acceptable, the cable must withstand the test high voltage without breakdown, have steady or decreasing leakage current during the high potential test, and have satisfactory comparable megger readings in each megger test.
 - 10. Metal Enclosed Busways shall be tested as per NETA ATS Section 7.4

11. A functional test and check of all electrical components is required prior to performing subsystem testing and commissioning. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Inspection and test procedures outlined in NETA ATS Section 8.1 - System Functional Tests - shall be used. Functional testing shall comprise:
 - a. Switches rated less than 600V shall be tested in accordance with NETA ATS Section 7.5.1.1. Switches shall be toggled, back and or side contacts tested for correct wiring, any special features verified.
 12. Complete ground testing of all grounding electrodes per requirements below prior to operating the equipment. Inspection and test procedures outlined in NETA ATS section 7.13 - Grounding Systems - shall be used.
- B. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the DISTRICT and after process control devices have been adjusted as accurately as possible. It is intended that the CONTRACTOR will adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.
- C. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.
- D. Motor operated valves shall be tested after having been phased and tested for correct motor rotation and after travel and torque limit switches have been adjusted by a representative of the valve manufacturer. Tests shall verify status indication, proper valve travel, and correct command control from local and remote devices.
- E. Provide ground resistance tests on the main grounding electrode or system in the presence of the DISTRICT and submit results. Utilize the fall-of-potential method or alternative, in accordance with IEEE Standard 81.
- F. Subsystems shall be defined as individual and groups of pumps, chemical feeders, air conditioning units, ventilation fans, air compressors, etc.
- G. General: Carry out tests indicated herein for individual items of materials and equipment in other Sections.

1.08 INSPECTION COORDINATION:

- A. The CONTRACTOR shall provide access to the work for the DISTRICT as requested for inspection. The CONTRACTOR shall provide 48 hour notice of its intention to begin new work activities

1.09 WARRANTY:

- A. The MANUFACTURER shall warrant the EQUIPMENT, MATERIALS and PRODUCTS specified in this section against defective materials and workmanship with the MANUFACTURER'S standard warranty, but for no less than five years from the date of Substantial Completion, and as described in Article 13 of Section 00700 - General Terms and Conditions.
- B. The CONTRACTOR shall warrant the WORK against defects for five years from the date of Substantial Completion and as described in Article 13 of Section 00700 - General Terms and Conditions.

PART 2 - PRODUCTS

2.01 PRODUCT REQUIREMENTS:

A. The CONTRACTOR shall provide all testing equipment required which includes but are not limited to following:

1. Wet- and dry-bulb thermometer
2. 1000V meggers
3. Battery-powered portable telephone sets and portable radios
4. Digital High Precision Multimeter
5. Commercial model three-point ground test set
6. Miscellaneous cable, test lights, buzzers, bells, switches, receptacles, plugs, and other equipment as required

PART 3 - EXECUTION: N/A

END OF SECTION

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