INVITATION FOR BID
IFB #13-1542CD
REHABILITATION OF HEADWORKS AND CLARIFIER 3 AND 4 AT THE SOUTHWEST WATER RECLAMATION FACILITY

Manatee County, a political subdivision of the State of Florida, (hereinafter the "County") will receive sealed Bids from individuals, corporations, partnerships, and other legal entities organized under the laws of the State of Florida or authorized to conduct business in the State of Florida.

NON-MANDATORY INFORMATION CONFERENCE
In order to insure that all prospective Bidders have sufficient information and understanding of the County's needs, an Information Conference will be held on: **Thursday, August 29, 2013 at 10:00 AM** at the **Southwest Water Reclamation Facility, 5101 65th Street West, Bradenton, FL 34210**. Attendance is not mandatory, but is highly encouraged.

NOTE: **Article B.05 Inspection of Site (page 00020-2)** – All potential Contractors, it is mandatory that a site visit be performed at the location to familiarize yourselves with the full scope of the construction site.

DEADLINE FOR CLARIFICATION REQUESTS: **September 10, 2013 at 3:00 PM**
(Reference Bid Article A.06)

TIME AND DATE DUE: **September 20, 2013 at 3:00 PM**

Important Note: Lobbying is prohibited (reference Bid Article A.08).

FOR INFORMATION CONTACT:
Chris Daley-CPPB, Contract Specialist
(941) 749-3048, Fax (941) 749-3034
chris.daley@mymanatee.org
Manatee County Financial Management Department
Purchasing Division

AUTHORIZED FOR RELEASE: DWW

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SECTION 00010

INFORMATION TO BIDDERS

A.01 OPENING LOCATION

Sealed Bids will be **publicly opened** at **Manatee County Purchasing Division, 1112 Manatee Avenue West, Suite 803, Bradenton, Florida 34205** in the presence of County officials at the time and date stated, or soon thereafter. All Bidders or their representatives are invited to be present.

Any Bids received after the stated time and date will not be considered. It shall be the sole responsibility of the Bidder to have their Bid delivered to the Manatee County Purchasing Division for receipt on or before the stated time and date. If a Bid is sent by U.S. Mail, the Bidder shall be responsible for its timely delivery to the Purchasing Division. Bids delayed by mail shall not be considered, shall not be opened at the public opening, and arrangements shall be made for their return at the respondent's request and expense.

A.02 SEALED & MARKED

One original and two copies of your **signed Bid** shall be submitted in one **sealed** package, clearly marked on the outside **"Sealed Bid #13-1542CD- Rehabilitation of Headworks and Clarifier 3 and 4 at the Southwest Water Reclamation Facility"** with your company name.

Address package to: Manatee County Purchasing Division
1112 Manatee Avenue West, Suite 803
Bradenton, Florida 34205

A.03 SECURING OF DOCUMENTS

Complete individual copies of the Bidding documents for the project and/or products can be obtained, free of charge, at the Manatee County Public Works Department, 1022 26th Avenue East, Bradenton, FL 34208; (941) 708-7450, extension 7327 or 7334. Documents may be obtained between the hours of 8:00 AM and 4:00 PM Monday through Friday, with the exception of holidays. Complete set of the Bidding document must be used in preparing Bids. The County assumes no responsibility for errors and misinterpretations resulting from the use of incomplete sets of Bidding documents.

A.04 BID DOCUMENTS

Bids on http://www.mymanatee.org, Bid documents and the Notices of Source Selection related to those Bids are available for download in a portable document format (.PDF) file on the Manatee County web page on the Purchasing tab under "Bids." You may view and print these files using Adobe Acrobat software. You may download a free copy of this software (Adobe) from the Owner's web page if you do not have it.

A.04 BID DOCUMENTS (Continued)

Manatee County collaborates with the Manatee Chamber of Commerce on distributing solicitations using the RFP Tool web page on the Chambers website: http://www.Manateechamber.com to post Bid documents in a portable document format (.PDF) file. This step is in addition to the posting on Manatee County Government web pages.

Manatee County may also use an internet service provider to distribute Bids. A link to that service, http://www.DemandStar.com, is provided on this web site under the Tab "DemandStar". Participation in the DemandStar system is not a requirement for doing business with Manatee County.

Note: The County posts the Notice of Source Selection seven (7) calendar days prior to the effective date of the Award.

IT IS THE RESPONSIBILITY OF EACH CONTRACTOR, PRIOR TO SUBMITTING THEIR BID, TO CONTACT THE MANATEE COUNTY PURCHASING DIVISION (see contact information on page one of this document) TO DETERMINE IF ADDENDA WERE ISSUED AND TO MAKE SUCH ADDENDA A PART OF THEIR BID .

A.05 MODIFICATION OF BID SPECIFICATIONS

If a Bidder wishes to recommend changes to the Bid specifications, the Bidder shall furnish in writing, data and information necessary to aid the Owner in evaluating the request to modify the specifications. The Owner is not obligated to make any changes to the Bid specifications. Unless an addendum is issued, the Bid specifications shall remain unaltered. **Bidders must fully comply with the Bid specifications, terms, and conditions.**

A.06 DEADLINE FOR CLARIFICATION REQUESTS

September 10, 2013 at 3:00 PM shall be the deadline to submit all inquiries, suggestions, or requests concerning interpretation, clarification or additional information pertaining to the Invitation for Bids to the Manatee County Purchasing Division.

This deadline has been established to maintain fair treatment for all potential Bidders, while maintaining the expedited nature of the Economic Stimulus that the contracting of this Work may achieve.

A.07 CLARIFICATION & ADDENDA

Each Bidder shall examine all Invitation for Bid documents and shall judge all matters relating to the adequacy and accuracy of such documents. Any inquiries, suggestions or requests concerning interpretation, clarification or additional information pertaining to the Invitation for Bids shall be made through the Manatee County Purchasing Division. The County shall not be responsible for oral interpretations given by any County employee, representative, or others. The

A.07 CLARIFICATION & ADDENDA (Continued)

issuance of a written addendum is the only official method whereby interpretation, clarification or additional information can be given.

If any addenda are issued to this Invitation for Bid, the County will broadcast the addenda on the DemandStar distribution system to "Planholders" on this web service, and post the documents on the Purchasing Division's web page at http://www.mymanatee.org which can be accessed by clicking on the "Purchasing" button and then clicking on the "Bids" button. It shall be the responsibility of each Bidder, prior to submitting their Bid, to contact Manatee County Purchasing (see contact on page 1) to determine if addenda were issued and to make such addenda a part of their Bid.

A.08 LOBBYING

After the issuance of any Invitation for Bid, prospective Bidders, or any agent, representative or person acting at the request of such Bidder shall not contact, communicate with or discuss any matter relating in any way to the Invitation for Bid with any officer, agent or employee of Manatee County other than the Purchasing Official or as directed in the Invitation for Bid. This prohibition includes the act of carbon copying officers, agents or employees of Manatee County on email correspondence. This requirement begins with the issuance of an Invitation for Bid, and ends upon execution of the final Contract or when the invitation has been canceled. Violators of this prohibition shall be subject to sanctions as provided in the Manatee County Purchasing Code of Law Chapter 2-26.

A.09 UNBALANCED BIDDING PROHIBITED

Manatee County recognizes that large and/or complex projects will often result in a variety of methods, sources, and prices. However, where in the opinion of the County such variation does not appear to be justified, given Bid specifications and industry and market conditions, the Bid will be presumed to be unbalanced. Examples of unbalanced Bids will include:

1. Bids showing omissions, alterations of form, additions not specified or required conditional or unauthorized alternate Bids.

2. Bids quoting prices that substantially deviate, either higher or lower, from those included in the Bids of competitive Bidders for the same line item unit costs.

3. Bids where the unit costs offered are in excess of or below reasonable cost analysis values.

A.09 UNBALANCED BIDDING PROHIBITED (Continued)

In the event the County determines that a Bid is presumed unbalanced, it will request the opportunity to, and reserves the right to, review all source quotes, Bids, price lists, letters of intent, etc., which the Bidder obtained and upon which the Bidder relied upon to develop the Bid. The County reserves the right to reject as non-responsive any presumptive unbalanced Bids where the Bidder is unable to demonstrate the validity and/or necessity of the unbalanced unit costs.

A.10 FRONT END LOADING OF BID PRICING PROHIBITED

Prices offered for performance and/or acquisition activities to occur early in the project schedule, such as mobilization; clearing and grubbing; or maintenance of traffic; that are substantially higher than pricing of competitive Bidders within the same portion of the project schedule, will be presumed to be front end loaded. Front end loaded Bids could reasonably appear to be an attempt to obtain unjustified early payments creating a risk of insufficient incentive for the Contractor to complete the Work or otherwise creating an appearance of an under-capitalized Bidder.

In the event the County determines that a Bid is presumed to be front end loaded, it will request the opportunity to, and reserves the right to, review all source quotes, Bids, price lists, letters of intent, etc., which the Bidder obtained and upon which the Bidder relied upon to develop the pricing or acquisition timing for these Bid items. The County reserves the right to reject as non-responsive any presumptive front end loaded Bids where the Bidder is unable to demonstrate the validity and/or necessity of the front end loaded costs.

A.11 WITHDRAWAL OF OFFERS

Contractors may withdraw offers as follows: a) Mistakes discovered before the opening of a solicitation may be withdrawn by written notice from the Bidder submitting the offer. This request must be received in the office designated for receipt of offers in the solicitation document prior to the time set for delivery and opening of the offers. A copy of the request shall be retained and the unopened offer returned to that Contractor. b) After the responses to a solicitation are opened or a selection has been determined, but before a Contract is signed, a Contractor alleging a material mistake of fact may be permitted to withdraw their offer if: (1) the mistake is clearly evident on the solicitation document; or (2) the Bidder submits evidence which clearly and convincingly demonstrates that a mistake was made. Request to withdraw an offer must be in writing and approved by the Purchasing Official.

A.12 IRREVOCABLE OFFER

Any Bid may be withdrawn up until the date and time set for opening of the Bid. Any Bid not so withdrawn shall, upon opening, constitute an irrevocable offer for a period of ninety (90) days to sell to Manatee County the goods or services set forth in the attached specifications until one or more of the Bids have been duly accepted by the County.

A.13 BID EXPENSES

All expenses for making Bids to the County are to be borne by the Bidder.

A.14 RESERVED RIGHTS

The County reserves the right to accept or reject any and/or all Bids, to waive irregularities and technicalities, and to request resubmission. Also, the County reserves the right to accept all or any part of the Bid and to increase or decrease quantities to meet additional or reduced requirements of the County. Any sole response received by the first submission date may or may not be rejected by the County depending on available competition and current needs of the County. For all items combined, the Bid of the lowest responsive, responsible Bidder will be accepted, unless all Bids are rejected. The lowest responsible Bidder shall mean **that Bidder who makes the lowest Bid to sell goods and/or services of a quality which** meets or exceeds the quality of goods and/or services set forth in the attached specifications or otherwise required by the County, and who is fit and capable to perform the Bid as made.

To be responsive, a Bidder shall submit a Bid which conforms in all material respects to the requirements set forth in the Invitation for Bid. To be a responsible Bidder, the Bidder shall have the capability in all respects to perform fully the Contract requirements, and the tenacity, perseverance, experience, integrity, reliability, capacity, facilities, equipment, and credit which will assure good faith performance. Also, the County reserves the right to make such investigation as it deems necessary to determine the ability of any Bidder to furnish the service requested. Information the County deems necessary to make this determination shall be provided by the Bidder. Such information may include, but shall not be limited to current financial statements, verification of availability of equipment and personnel, and past performance records.

A.15 APPLICABLE LAWS

Bidder must be authorized to transact business in the State of Florida. All applicable laws and regulations of the State of Florida and ordinances and regulations of Manatee County will apply to any resulting Agreement. Any involvement with any Manatee County procurement shall be in accordance with Manatee County Purchasing Ordinance as amended. Any actual or prospective Bidder who is aggrieved in connection with the solicitation or award of a Contract may protest to the Board of County Commissioners of Manatee County as required in Manatee County Code of Laws.

A.16 COLLUSION

By offering a submission to this Invitation for Bid, the Bidder certifies that he has not divulged, discussed or compared their Bid with other Bidder, and has not colluded with any other Bidder or parties to this Bid whatsoever. Also, Bidder certifies, and in the case of a joint Bid each party thereto certifies as to their own organization, that in connection with this Bid:

A.16 COLLUSION (Continued)

a. any prices and/or cost data submitted have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices and/or cost data, with any other Bidder or with any competitor;

b. any prices and/or cost data quoted for this Bid have not been knowingly disclosed by the Bidder and will not knowingly be disclosed by the Bidder, prior to the scheduled opening, directly or indirectly to any other Bidder or to any competitor;

c. no attempt has been made or will be made by the Bidder to induce any other person or firm to submit or not to submit a Bid for the purpose of restricting competition;

d. the only person or persons interested in this Bid, principal or principals is/are named therein and that no person other than therein mentioned has any interest in this Bid or in the Contract to be entered into; and

e. no person or agency has been employed or retained to solicit or secure this Contract upon an agreement or understanding or a commission, percentage, brokerage, or contingent fee excepting bona fide employees or established commercial agencies maintained by Bidder for purpose of doing business.

A.17 CODE OF ETHICS

With respect to this Bid, if any Bidder violates, directly or indirectly, the ethics provisions of the Manatee County Purchasing Ordinance and/or Florida criminal or civil laws related to public procurement, including but not limited to Florida Statutes Chapter 112, Part II, Code of Ethics for Public Officers and Employees, such Bidder will be disqualified from eligibility to perform the Work described in this Invitation for Bid, and may also be disqualified from furnishing future goods or services to, and from submitting any future Bids to supply goods or services to, Manatee County.

By submitting a Bid, the Bidder represents to the County that all statements made and materials submitted are truthful, with no relevant facts withheld. If a Bidder is determined to have been untruthful in its Bid or any related presentation, such Bidder will be disqualified from eligibility to perform the Work described in this Invitation for Bid, and may also be disqualified from furnishing future goods or services to, and from submitting any future Bids to supply goods or services to, Manatee County.

A.18 BID FORMS

Bids must be submitted on attached County forms, although additional pages may be attached. **Bidders must fully complete all pages of the Bid Forms. Bid Forms must be executed by an authorized signatory who has the legal authority to make the offer and bind the company. Bidders must fully comply with all Bid specifications, terms and conditions.** Failure to comply shall result in Contract default, whereupon, the defaulting Contractor shall be required to pay for any and all re-procurement costs, damages, and attorney fees as incurred by the County.

A.19 LEGAL NAME

Bids shall clearly indicate the legal name, address and telephone number of the Bidder. Bids shall be signed above the typed or printed name and title of the signer. The signer must have the authority to bind the Bidder to the submitted Bid.

A.20 PUBLIC CONTRACTING AND ENVIRONMENTAL CRIMES

A person or affiliate who has been placed on the State's convicted vendor list following a conviction for a public entity crime, as that term is defined in Florida Statute (F.S.) § 287.133, may not submit a Bid, Proposal, or reply on a Contract to provide any goods or services to a public entity; may not submit a Bid, Proposal, or reply on a Contract with a public entity for the construction or repair of a public building or public work; may not submit Bids, Proposals or replies on leases of real property to a public entity; may not be awarded or perform work as a Contractor, Supplier, Subcontractor, or Consultant under a Contract with any public entity; and may not transact business with any public entity in excess of the threshold amount provided in F.S. § 287.017 for CATEGORY TWO for a period of thirty-six (36) months following the date of being placed on the convicted list.

In addition, the Manatee County Code of Laws prohibits the award of any Contract to any person or entity who/which has, within the past five (5) years, been convicted of, or admitted to in court or sworn to under oath, a public entity crime or of any environmental law that, in the reasonable opinion of the Purchasing Official, establishes reasonable grounds to believe the person or business entity will not conduct business in a responsible matter. To insure compliance with the foregoing, the Code requires all persons or entities desiring to Contract with the County to execute and file with the Purchasing Official an affidavit, executed under the pain and penalties of perjury, confirming that person, entity and any person(s) affiliated with the entity, does not have such a record and is therefore eligible to seek and be awarded business with the County. In the case of a business entity other than a partnership or a corporation, such affidavit shall be executed by an authorized agent of the entity. In the case of a partnership, such affidavit shall be executed by the general partner(s). A Public Contracting and Environmental Crimes Certification form is attached for this purpose.

A.21 DISCOUNTS

Any and all discounts must be incorporated in the prices contained in the Bid and not shown separately. The prices as shown on the Bid Form shall be the price used in determining Award.

A.22 TAXES

Manatee County is exempt from Federal Excise and State Sales Taxes. (F.E.T. Exempt Cert. No. 59-78-0089K; FL Sales Tax Exempt Cert. No. 85-8012622206C-6); therefore, the Contractor is prohibited from delineating a separate line item in his Bid for any sales or service taxes. Nothing herein shall affect the Contractor's normal tax liability.

A.23 DESCRIPTIVE INFORMATION

Unless otherwise specifically provided in the specifications, all equipment, materials and articles incorporated in the Work covered by this Contract shall be new and of the most suitable grade for the purpose intended. Unless otherwise specifically provided in the specifications, reference to any equipment, material, article or patented process, by trade name, brand name, make or catalog number, shall be regarded as establishing a standard of quality and shall not be construed as limiting competition.

A.24 AMERICANS WITH DISABILITIES ACT

The Board of County Commissioners of Manatee County, Florida, does not discriminate upon the basis of any individual's disability status. This non-discrimination policy involves every aspect of the County's functions including one's access to, participation, employment, or treatment in its programs or activities. Anyone requiring reasonable accommodation for an **Information Conference** or **Bid Opening** should contact the person named on the first page of this Bid document at least twenty-four (24) hours in advance of either activity.

A.25 EQUAL EMPLOYMENT OPPORTUNITY CLAUSE

In accordance with the provisions of Title VI of the Civil Rights Act of 1964 and Title 15, Part 8 of the Code of Federal Regulations, Manatee County hereby notifies all prospective offerors that they will affirmatively ensure minority business enterprises will be afforded full opportunity to participate in response to this advertisement and will not be discriminated against on the grounds of race, color or national origin in consideration for an Award of Contract.

A.26 MBE/WBE

The State of Florida, **Office of Supplier Diversity** provides the certification process and the database for identifying certified MBE/WBE firms. This service may be directly accessed at: http://www.osd.dms.state.fl.us/iframe.htm

If you have any questions regarding this State service, please contact their office at (850) 487-0915.

A.27 MATHEMATICAL ERRORS

In the event of multiplication/extension error(s), the unit price shall prevail. In the event of addition error(s) the extension totals will prevail. All Bids shall be reviewed mathematically and corrected, if necessary, using these standards, prior to additional evaluation.

A.28 DISCLOSURE

Upon receipt, all inquiries and responses to inquiries related to this Invitation for Bid becomes "Public Records", and shall be subject to public disclosure consistent with Chapter 119, Florida Statues.

Bids become subject to disclosure thirty (30) days after the opening or if a notice of intended Award decision is made earlier than this time as provided by F.S. 119.071(1)(b). No announcement or review of the offer shall be conducted at the public opening.

Based on the above, the County will receive Bids at the date and time stated, and will make public at the opening the names of the business entities of all that submitted an offer and any amount presented as a total offer without any verification of the mathematics or the completeness of the offer.

If the County rejects all Bids and concurrently notices its intent to reissue the solicitation, the rejected Bids are exempt from public disclosure until such time as the County provides notice of an intended decision concerning the reissued solicitation or until the County withdraws the reissued solicitation. A Bid is not exempt for longer than 12 months after the initial notice rejecting all Bids.

NOTE: ANY OR ALL STATEMENTS CONTAINED IN THE FOLLOWING SECTIONS: BASIS OF AWARD, TERMS AND CONDITIONS OF THE CONTRACT, OR SPECIFICATIONS, WHICH VARY FROM THE INFORMATION TO BIDDERS, SHALL HAVE PRECEDENCE.

END OF SECTION A

SECTION 00020
BASIS OF AWARD

B.01 BASIS OF AWARD

Award shall be to the lowest, responsive, responsible Bidder meeting specifications and having the lowest Total Bid Price for **Bid "A** for the requirements listed on the Bid Form for the Work as set forth in this Invitation for Bid. Bid prices shall include costs for furnishing all labor, equipment and/or materials for the completion of the Work in accordance with and in the manner set forth and described in the Contract documents to the County's satisfaction within the prescribed time.

Only one schedule for Completion of the Work shall be considered. Only one Award shall be made.

NOTE: Inspection of the site is a pre-requisite to be considered for award of this Bid.

In evaluating Bids, the County shall consider the qualifications of the Bidders; and if required, may also consider the qualifications of the Subcontractors, Suppliers, and other persons and organizations proposed. County may also consider the operating costs, maintenance requirements, performance data and guarantees of major items of materials and equipment proposed for incorporation in the Work.

Whenever two or more Bids are equal with respect to price, the Bid received from a local business shall be given preference in Award. Whenever two or more Bids which are equal with respect to price are received, and neither of these Bids are from a local business, the Award shall be determined by a chance drawing, coin toss, or similar tie-breaking method conducted by the Purchasing Division and open to the public.

B.02 SUBCONTRACTORS

Subcontractors shall be bound by the terms and conditions of this Contract insofar as it applies to their work, but this shall not relieve the prime Contractor from the full responsibility of the County for the proper completion of all Work to be executed under this Contract.

The employment of unauthorized aliens by any Contractor is considered a violation of Section 274 (e) of the Immigration and Employment Act. If the Contractor knowingly employs unauthorized aliens, such violation shall be cause for unilateral cancellation of this Agreement.

B.03 QUALIFICATIONS OF BIDDERS

No person who is not certified or registered as a General Contractor pursuant to Florida Statutes, Chapter 489 on the day the Bid is submitted, and who has continuously held that certification or registration for a period of at least three (3) consecutive years immediately prior to the day the Bid is submitted, may be qualified to bid on this project. In the event that a Bidder is a business organization, including a partnership, corporation, business trust or other legal entity as set forth in F.S. 489.119(2), then the Bidder shall only be qualified to bid on this project if: 1) the Bidder (the business organization) is on the day the Bid is submitted, and for at least three (3) consecutive years immediately prior to the day the Bid is submitted has been, in continuous existence, properly licensed and registered as required by Florida law; and 2) the Bidder, on the day the Bid is submitted, has a certified or registered Qualifying Agent, as required by F.S. 489.119, and that Qualifying Agent has been the same Qualifying Agent of the Bidder for a period of at least three (3) consecutive years immediately prior to the day the Bid is submitted.

A complete list of all Subcontractors proposed for any portion of the Work may be requested of any Bidder deemed necessary by the County. Subcontracts shall be awarded only to those Subcontractors considered satisfactory by the County.

B.04 PREPARATION OF CONTRACT

A written notice confirming Award or recommendation thereof will be forwarded to the successful Bidder accompanied by the required number of unsigned counterparts of the Agreement. Within ten (10) days thereafter, successful Bidder shall sign and deliver the required number of counterparts of the Agreement with any other required documents to County. (Note: Contract must be approved in accordance with the Manatee County Code of Laws, Chapter 2-26, and the Administrative Standards and Procedures Manual approved by the County Administrator).

B.05 INSPECTION OF SITE

Inspection of the site is a requirement to be considered for award of this Bid. Prior to submitting a Bid, each Bidder shall examine the site and all conditions thereon fully familiarizing themselves with the full scope of the project. Failure to become familiar with site conditions will in no way relieve the successful Bidder from the necessity of furnishing any materials or performing any Work that is required to complete the project in accordance with the plans and specifications. Site visit (s) shall be acknowledged in Section 00300, Bid Form page # 00300-1.

END OF SECTION B

SECTION 00030

GENERAL TERMS AND CONDITIONS OF THE CONTRACT

C.01 CONTRACT FORMS

The Agreement resulting from the acceptance of a Bid shall be in the form of the Agreement stated in this Bid.

C.02 ASSIGNMENT OF CONTRACT

Contractor shall not assign, transfer, convey, sublet or otherwise dispose of this Contract or of his right, title, or interest therein, or his power to execute such Contract, or to assign any monies due or to become due there under to any other person, firm or corporation unless first obtaining the written consent of the County. The giving of such consent to a particular Subcontractor assignment shall not dispense with the necessity of such consent to any further or other assignment.

C.03 COMPLETION OF WORK

The Work will be completed and ready for final inspection within the specified calendar days from the date the Contract time commences to run. Only one Bid shall be considered based on **425 calendar days**. Only one Award shall be made.

C.04 LIQUIDATED DAMAGES

If the Contractor refuses or fails to prosecute the Work, or any separable part thereof, with such diligence as will hinder its completion within the time specified, the County may seek damages. The actual damages for delay will be impossible to determine and in lieu thereof, the Contractor shall pay to the County the sum of **$1148** as fixed, agreed, and liquidated damages for each calendar day of the delay until the Work is finally accepted by the County and the Contractor and his Surety shall be liable for the amount thereof.

C.05 PAYMENT

Contractor may apply for partial payment on monthly estimates, based on the amount of work done or completed in compliance with the provisions of the Contract. Contractor shall submit an application, on a standard pay application form provided or approved by the County, of an approximate estimate of the proportionate value of the Work done, items and locations of the Work performed up to and including the last day of the period then ending. The County will then review said estimate and make any necessary revisions so that the estimate can receive approval for payment. If the Contractor and the County do not agree on the approximate estimate of the proportionate value of the Work done for any pay period, the determination of the County will be binding. The amount of said estimate after deducting any required retainage and all previous payments shall be due and payable to the Contractor, twenty (20) business days if County is its own Engineer of Record (EOR) or twenty-five (25) business days if outside agent

C.05 PAYMENT (Continued)

approval is required after the pay estimate has been approved by the agent for the County.

In accordance with the Prompt Payment Act, F.S. § 218.735(7), a Punch List shall be formulated.

Time allowed for development of punch list:

1. Awarded Contracts with an estimated cost of less than $10 million will be within thirty (30) calendar days after reaching substantial completion. Substantial completion is defined as reaching beneficial occupancy or use.

2. Awarded Contracts with a cost of $10 million dollars or more will be within thirty (30) calendar days OR if extended by Contract, up to sixty (60) calendar days after reaching substantial completion. Substantial completion is defined as reaching beneficial occupancy or use.

The final Contract completion date must be at least thirty (30) days after delivery of the list of items. If the list is not provided to the awarded Contractor by the agreed upon date, the Contract completion time must be extended by the number of days the County exceeds the delivery date.

It is the Contractor's responsibility for the care of the materials. Any damage to or loss of said materials is the full responsibility of the Contractor. Any periodical pay estimate signed by the Contractor shall be final as to the Contractor for any or all Work covered by the periodical pay estimate.

Any requests for payment of materials stored on site must be accompanied with a paid receipt. The Contractor warrants and guarantees that title to all work, materials and equipment covered by any application for payment, whether incorporated in the project or not, will pass to the County at the time of payment free and clear of all liens, claims, security interests and encumbrances (hereafter referred to as "Liens").

The Contractor agrees to furnish an affidavit stating that all laborers, material men, and Subcontractors have been paid on the project for Work covered by the application for payment and that a partial or complete release of lien, as may be necessary, be properly executed by the material men, laborers, Subcontractors on the project for Work covered by the application for payment, sufficient to secure the County from any claim whatsoever arising out of the aforesaid Work.

When the Contractor has completed the Work in compliance with the terms of the Contract documents, he shall notify the County in writing that the project is ready for final inspection. The County will then advise the Contractor as to the arrangements for final inspection and what Work, if any, is required to prepare the project or a portion thereof for final inspection. When the County determines the project or portion thereof is ready for final inspection, the County shall perform same. Upon completion of final inspection, the County will notify Contractor of all particulars in

C.05 PAYMENT (Continued)

which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies. When all such errors have been corrected, a final re-inspection will be made. The process will be repeated until, in the opinion of the County, the project has been completed in compliance with the terms of the Contract documents.

When final acceptance has been made by the County, the County will make final payment of the Contract amount, plus all approved additions, less approved deductions and previous payments made. The Contract will be considered complete when all Work has been finished, the final inspection made, approved as-builts received, and the project finally accepted in writing by the County. The Contractor's responsibility shall then terminate except as otherwise stated.

C.06 RETAINAGE

A retainage of 10% of the total Work in place shall be withheld until 50% complete. After 50% completion, the retainage shall be reduced to 5% of the total Work in place until final completion and acceptance of the Work by the County. Upon final acceptance, the remaining retainage shall be included in the final payment.

C.07 WARRANTY AND GUARANTEE PROVISIONS

All work, materials, and equipment furnished as defined herein shall be guaranteed and warranted by the Contractor for a minimum period of three (3) years, unless otherwise specified, from final acceptance by the County to be free from defects due either to faulty materials or equipment or faulty workmanship.

All materials, equipment, and workmanship furnished and installed by the Contractor is warranted and guaranteed by the Contractor to meet the required standards and to accomplish the purposes and functions of the project as defined, detailed, and specified herein.

The County shall, following discovery thereof, promptly give written notice to the Contractor of faulty materials, equipment, or workmanship within the period of the guarantee and the Contractor shall promptly replace any part of the faulty equipment, material, or workmanship at his own cost. These warranty and guarantee provisions create no limitations on the County as to any claims or actions for breach of guaranty or breach of warranty that the County might have against parties other than the Contractor, and do not constitute exclusive remedies of the County against the Contractor.

C.08 ROYALTIES AND PATENTS

The Contractor shall pay all royalties and license fees for equipment or processes in conjunction with the equipment and/or services being furnished. Contractor shall defend all suits or claims for infringement of any patent, trademark or copyright, and shall save the County harmless from loss on account thereof, including costs and attorney's fees.

C.09 AUTHORIZED PRODUCT REPRESENTATION

The Contractor, by virtue of submitting the name and specifications of a manufacturer's product, will be required to furnish the named manufacturer's product. Failure to perform accordingly may, in the County's sole discretion, be deemed a breach of Contract, and shall constitute grounds for the County's immediate termination of the Contract.

C.10 REGULATIONS

It shall be the responsibility of the Bidder to assure compliance with any OSHA, EPA and/or other federal or State of Florida rules, regulations or other requirements, as each may apply.

C.11 CANCELLATION

Any failure of the Contractor to furnish or perform the Work (including, but not limited to, commencement of the Work, failure to supply sufficient skilled workers or suitable materials or equipment) in accordance with the Contract, the County may order the stop of the Work, or any portion thereof, until the cause for such order has been eliminated. If the Contractor persistently fails to perform the Work in accordance with the Contract, the County reserves the right to terminate the Contract and select the next qualified Bidder or re-advertise this procurement in part or in whole. The County reserves the right to cancel all or any undelivered or unexecuted portion of this Contract with or without cause.

C.12 INDEMNIFICATION

The Contractor covenants and agrees to indemnify and save harmless the County, its agents and employees, from and against all claims, suits, actions, damages, causes of action, or judgments arising out of the terms of the resulting Agreement for any personal injury, loss of life, or damage to the property sustained as a result of the performance or non-performance of services or delivery of goods; from and against any orders, judgments, or decrees, which may be entered against the County, its agents or employees; and from and against all costs, attorney's fees, expenses and other liabilities incurred in the defense of any such claim, suit or action, and the investigation thereof. Nothing in the Award, resulting Agreement, Contract or Purchase Order shall be deemed to affect the rights, privileges and immunities of the County as set forth in F.S. § 768.28.

C.13 MANUALS, SCHEMATICS, HANDBOOKS (IF APPLICABLE)

All manuals, schematics and handbooks shall be provided which are applicable to the equipment delivered. An operators manual, parts manual and technician manual must also be provided. Parts lists (manuals) must include OEM part numbers for items not manufactured by the Bidder. Contractor shall furnish two (2) copies of each.

C.14 INSURANCE

The Contractor will not commence Work under a Contract until all insurance under this section and such insurance coverage as might be required by the County has been obtained. The Contractor shall obtain, and submit to purchasing within ten (10) calendar days of request, at his expense, the following minimum amounts of insurance (inclusive of any amounts provided by an umbrella or excess policy):

a. Workers' Compensation/Employers' Liability

Part One - There shall be no maximum limit (other than as limited by the applicable statute) for liability imposed by Florida Workers' Compensation Act or any other coverage required by the Contract documents which are customarily insured under Part One of the standard Workers' Compensation Policy.

Part Two - The minimum amount of coverage required by the Contract documents which are customarily insured under Part Two of the standard Workers' Compensation Policy shall be:

(Each Accident)	$100,000
(Disease-Policy Limit)	$500,000
(Disease-Each Employee)	$100,000

b. Commercial General Liability

The limits are to be applicable only to Work performed under this Contract and shall be those that would be provided with the attachment of the Amendment of Limits of Insurance (Designated Project or Premises) endorsement (ISO Form CG 25 03) a Commercial General Liability Policy with the following minimum limits.

General Aggregate:	
Products/Completed Operations Aggregate	$1,000,000
Personal and Advertising Injury	$1,000,000
Each Occurrence	$1,000,000
Fire Damage (Any One Fire)	$Nil
Medical Expense (Any One Person)	$Nil

ADDITIONAL INSURED: Manatee County, a political subdivision of the State of Florida, shall be specifically named as additional insured on the Commercial General Liability Policy.

c. Business Auto Policy

Each Occurrence Bodily Injury and Property Damage Liability Combined	$300,000
Annual Aggregate (if applicable)	$1,000,000

ADDITIONAL INSURED: Manatee County, a political subdivision of the State of Florida, shall be specifically named as additional insured on the Business Auto Policy.

C.14 INSURANCE (Continued)

d. County's Protective Liability Coverage

The minimum Owner's Protective OPC Policy limits per occurrence and, if subject to an aggregate, annual aggregate to be provided by the Contractor shall be the same as the amounts shown above as the minimum per occurrence and general policy aggregate limits respectively required for the Commercial General Liability coverage. The limits afforded by the OPC Policy and any excess policies shall apply only to the County and the County's officials, officers, agents and employees and only to claims arising out of or in connection with the Work under this Contract.

e. Property Insurance

If this Contract includes construction of or additions to above ground buildings or structures, Contractor shall provide "**Builder's Risk**" insurance with the minimum amount of insurance to be 100% of the value of such addition(s), building(s), or structure(s).

f. Installation Floater

If this Contract does not include construction of or additions to above ground building or structures, **but does involve** the installation of machinery or equipment, Contractor shall provide an "**Installation Floater**" with the minimum amount of insurance to be 100% of the value of such addition(s), building(s), or structure(s).

g. Certificates of Insurance and Copies of Policies

Certificates of Insurance in triplicate evidencing the insurance coverage specified herein shall be filed with the Purchasing Official before operations are begun. The required certificates of insurance shall name the types of policy, policy number, date of expiration, amount of coverage, companies affording coverage, and also shall refer specifically to the Bid number and title of the project. All insurance policies required herein shall be issued by companies that are authorized to do business under the laws of the State of Florida and hold an A.M. Best rating of A- or better. Insurance, as specified herein, shall remain in force and effect for the duration of the project including any warranty periods.

h. **Complete Policies:** The entire and complete insurance policies required herein shall be provided to the County on request.

If the initial insurance expires prior to the completion of operations and/or services by the Contractor, renewal certificates of insurance and required copies of policies shall be furnished by the Contractor and delivered to the Purchasing Official thirty (30) days prior to the date of their expiration. Nothing herein shall in any manner create any liability of the County in connection with any claim against the Contractor for labor, services, or materials, or of Subcontractors; and nothing herein shall limit the liability of the Contractor or Contractor's sureties to the County or to any workers, suppliers, material men or employees in relation to this Contract.

C.14 INSURANCE (Continued)

i. Certification Requirements – In order for the certificate of insurance to be accepted it must comply with the following:

1. The certificate holder shall be:
   Manatee County Board of Commissioners, a political subdivision of the State of Florida
   P.O. Box 1000
   Bradenton, FL 34206-1000

2. Certificate shall be mailed to:
   Manatee County Purchasing Division
   1112 Manatee Avenue West, Suite 803
   Bradenton, FL 34205
   Attn: Chris Daley-CPPB, Contract Specialist

C.15 BID BOND/CERTIFIED CHECK

By offering a submission to this Invitation for Bid, the Bidder agrees should the Bidder's Bid be accepted, **to execute the form of Contract and present the same to Manatee County for approval within ten (10) calendar days after notice of Intent to Award**. The Bidder further agrees that failure to execute and deliver said form of Contract **within ten (10) calendar days** will result in damages to Manatee County and as guarantee of payment of same a Bid Bond/Certified Check shall be enclosed within the submitted sealed Bid in the amount of five (5%) percent of the total amount of the Bid. The Bidder further agrees that in case the Bidder fails to enter into a Contract, as prescribed by Manatee County, the Bid Bond/Certified Check accompanying the Bid shall be forfeited to Manatee County as agreed liquidated damages. If the County enters into a Contract with a Bidder, or if the County rejects any and/or all Bids, accompanying bond will be promptly returned.

C.16 PERFORMANCE AND PAYMENT BONDS

The successful Bidder shall furnish surety bonds using the Public Construction Bond form prescribed in F.S. § 255.05, which is provided herein, as security for faithful performance of the Contract awarded as a result of this Bid and for the payment of all persons performing labor and/or furnishing material in connection therewith. Failure to provide the required bonds on the prescribed form may result in successful Bidder being deemed nonresponsive. Bonds must be in the form prescribed in F.S. § 255.05, and must not contain notice, demand or other terms and conditions, including informal pre-claim meetings, not provided for in F.S. § 255.05.

Surety of such bonds shall be in an amount equal to the Bid Award (100% each) issued by a duly authorized and nationally recognized surety company, authorized to do business in the State of Florida, satisfactory to this County. The attorney-in-fact who signs the bonds must file with the bonds, a certificate and effective dated copy of power-of-attorney. Performance and Payment Bonds shall be issued to Manatee County, a political subdivision of the State of Florida, within ten (10) calendar days after notification of Intent to Award.

C.16 PERFORMANCE AND PAYMENT BONDS (Continued)

In addition, pursuant to F.S. § 255.05(1)(b), prior to commencing Work, the Contractor shall be responsible and bear all costs associated to record the Performance and Payment Bond with the Manatee County Clerk of the Circuit Court. A certified copy of said recording shall be furnished to the Purchasing Division upon filing. Pursuant to F.S. § 255.05(1)(b), the County will make no payment to the Contractor until the Contractor has complied with this paragraph.

Furnishing of the recorded Performance and Payment Bonds shall be requisite to execution of a Contract with the County. Said Performance and Payment Bonds will remain in force for the duration of the Contract with the premiums paid by the Contractor. Failure of the successful Bidder to execute such Contract and to supply the required bonds shall be just cause for cancellation of the Award. The County may then contract with another acceptable Bidder or re-advertise this Invitation for Bid. If another Bidder is accepted, and notice given within ninety (90) days after the opening of the Bids, this acceptance shall bind the Bidder as though they were originally the successful Bidder.

Failure of the County at any time to require performance by the Contractor of any provisions set out in the Contract will in no way affect the right of the County, thereafter, to enforce those provisions.

C.17 NO DAMAGES FOR DELAY

No claim for damages or any claim other than for an extension of time shall be made or asserted against the County by reason of any delays. The Contractor shall not be entitled to an increase in the Total Contract Price or payment or compensation of any kind from the County or direct, indirect, consequential impact or other costs, expenses for damages, including but not limited to costs of acceleration or inefficiency arising because of delay, disruption, interference or hindrance from any cause whatsoever; provided, however, that this provision shall not preclude recovery or damages by the Contractor for hindrance or delays due solely to fraud, bad faith, or active interference on part of the County or its agents. Otherwise, the Contractor shall only be entitled to extensions of the Contract time as the sole and exclusive remedy for such resulting delay, in accordance with and to the extent specifically provided above.

C.18 NO INTEREST

Any monies not paid by the County when claimed to be due to the Contractor under this Contract shall not be subject to interest including prejudgment interest. Any monies not paid by the County when claimed to be due to the Contractor for damages awarded in the case of construction delays shall not be subject to prejudgment interest.

C.19 CONSTRUCTION OF CONTRACT

This Contract and the rights and responsibilities hereunder shall not be construed more strongly against either party, regardless of the extent to which such party may have participated in the preparation hereof.

C.20 BE GREEN

All Bidders are encouraged to use as many **environmentally preferable** "green" products, materials, supplies, etc. as possible in order to promote a safe and healthy environment. **Environmentally preferable are products or services that have a reduced adverse effect on the environment**. Provide detail of your organization's initiative and its ability to meet the goal of environmental sustainability.

END OF SECTION C

SECTION 00100

BID SUMMARY

D.01 THE WORK

The Work included in this Bid consists of rehabilitation of the Headworks and Clarifier numbers 3 and 4 at the Manatee County Southwest Water Reclamation Facility located at 5106 65th Street West in Bradenton, Florida.

The rehabilitation work for the Headworks consists of the following:

1. Demolition of the concrete channel liner system, conveyors, grit cyclones and classifiers, area lighting, and electrical and I&C conduits.
2. Inspection of concrete channels and covers to establish limits of repair.
3. New coatings/liner system for concrete channels.
4. Concrete and steel rehabilitation and repair.
5. New screenings conveyors and grit cyclones and classifiers.
6. New electrical and I&C wiring and conduits from existing power source for new equipment and new lighting facility.

The rehabilitation work for Clarifier numbers 3 and 4 consists of the following:

1. Demolition of the clarifier mechanisms (including effluent launders), RAS pump nos. 4-6 and VFD's, scum ejectors, area lighting, and electrical and I&C conduits.

2. New clarifier mechanisms with scum troughs and weirs, RAS pump nos. 4-6 with VFD's, scum pumping systems, sluice gates for isolation, and associated scum piping connections.

3. New clarifier control panel, new electrical distribution equipment, new electrical and I&C wiring and conduits from source to new clarifiers, scum pumps, and RAS pumps. New area lighting for clarifiers and new lighting for RAS pump station.

The successful Contractor shall furnish all shop drawings, working drawings, labor, materials, equipment, tools, services and incidentals necessary to complete all Work required by these specifications.

The successful Contractor shall perform the Work complete, in place and ready for continuous service and shall include any repairs, replacements, and/or restoration required as a result of damages caused prior to acceptance by the Owner.

The successful Contractor shall furnish and install all materials, equipment and labor which is reasonably and properly inferable and necessary for the proper completion of the Work, whether specifically indicated in the Bid documents or not.

D.02 SUBCONTRACTORS, SUPPLIERS AND OTHERS

The identity of Subcontractors, Suppliers, and other persons and organizations (including those who are to furnish the principal items of material and equipment) may be requested by the County for each Bid item from any of the Bidders; and the Bidder shall respond within five (5) days after the date of such request. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, persons or organization if requested by County. If County, after due investigation, has reasonable objection to any proposed Subcontractor, supplier, other person or organization, County may, before the Notice of Award is given, request the apparent successful Bidder to submit an acceptable substitute without an increase in Contract price or Contract time.

If apparent successful Bidder declines to make any such substitution, County may award the Contract to the next lowest qualified Bidder that proposes to use acceptable Subcontractors, Suppliers, and other persons who County does not make written objection to. Contractor shall not be required to employ any Subcontractor, Supplier, other person or organization who Contractor has reasonable objection to.

Subcontractors shall be bound by the terms and conditions of this Contract insofar as it applies to their work, but this shall not relieve the prime Contractor from the full responsibility to the County for the proper completion of all Work to be executed under this Contract.

D.03 BIDS

Bids are to be submitted in **triplicate, one original and two copies**, upon the County supplied forms. All blank spaces must be filled in as noted with amounts extended and totaled and no changes shall be made in the wording of the forms or in the items mentioned therein. In the event a change is made in your submittal, the Bidder shall write its initials by the change. Any Bid may be rejected which contains any omissions, alterations, irregularities of any kind, or which shall in any manner fail to conform to Bid requirements.

A Bid made by an individual, either in his/her own or proper person or under a trade or firm name, shall be executed under the individual's signature. If made by a partnership, the Bid shall be executed by two or more of the general partners. If made by a corporation, the Bid shall be executed by its President or other legally authorized corporate officer or agent.

D.04 EXAMINATION OF BID DOCUMENTS AND SITE

It is the responsibility of each Bidder before submitting a Bid, to (a) examine the Bid documents thoroughly; (b) visit the site to become familiar with local conditions that may affect cost, progress, performance, or furnishing of the Work; (c) consider federal, state, and local codes, laws, and regulations that may affect costs, progress, performance, or furnishing of the Work; (d) study and carefully correlate Bidder's observations with the Bid documents; and (e) notify County of all conflicts, errors, or discrepancies in the Bid document.

D.04 EXAMINATION OF BID DOCUMENTS AND SITE (Continued)

Each Bidder may, at Bidder's own expense, make or obtain any additional examinations, investigations, explorations, tests and studies, and obtain any additional information and data which pertain to the physical conditions at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing of the Work and which Bidder deems necessary to determine his Bid for performing and furnishing the Work in accordance with the time, price and other terms and conditions of the Bid documents. County will provide each Bidder access to the site to conduct such explorations and tests.

Bidder shall fill all holes, clean up and restore the site to its former condition upon completion of such explorations. The lands upon which the Work is to be performed, rights-of-way and easements for access thereto, and other lands designated for use by Contractor in performing the Work are identified in the Bid documents.

All additional lands and access thereto required for temporary construction facilities or storage of materials and equipment are to be provided by Contractor. Easements for permanent structures or permanent changes in existing structures are to be obtained and paid for by County unless otherwise provided in the Bid documents.

D.05 MATERIALS AND WORKMANSHIP

All materials and apparatus required for this Work, except as specified otherwise, shall be new, of first class quality, and shall be furnished, delivered, connected and finished in every detail. Construction shall be prescribed by good industry practice and in accordance with manufacturer’s recommendations for the type being installed.

Use skilled workman trained and experienced in the necessary trades and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this section.

D.06 REGULATIONS AND MATERIAL DISPOSAL

It shall be the responsibility of the Contractor to assure compliance with any OSHA, EPA, federal, state, and/or local rules, regulations or other requirements as each may apply.

D.07 PROJECT CLOSE-OUT

Clean construction site and remove any and all excess materials. Correct any damages to property that may have occurred as a result of installation and/or delivery. Repair and patch all surfaces cut for installation. The Contractor shall remedy any deficiencies promptly should the County determine any Work is incomplete or defective.

When the County determines the Work is acceptable in accordance with this Invitation for Bid, the Contractor shall provide the close out submittals, including but not necessarily limited to the following:

1 set	Certificate of Warranties	
1 set	Manufacturer's Product Literature	(when applicable)
1 set	Project Record Drawings	
1 set	Subcontractor Information	(when applicable)

D.08 DISCRETIONARY WORK

This Bid item entails minor increases (that may be directed by staff) to existing Bid item quantities or minor modification items not bid which were unforeseen and necessary during the construction to provide a safe, complete project in accordance with Bid documents. (This will not affect the requirement for change orders involving major modifications to the project.) Payment for all Work under this item shall be made only at the County's discretion in order to satisfactorily complete the project. In general, this item is for unanticipated conflicts and/or design changes required during construction which are necessary to complete the project without changing the initial Scope of Work and without costly delays.

D.09 PROGRESS REQUIREMENTS

All Work done under this Contract shall be done with a minimum of inconvenience to the private property owners in the area. The Contractor shall coordinate his Work with private property owners such that existing utility services are maintained and they have access to their property at all times.

END OF SECTION D

SECTION 00150

MANATEE COUNTY LOCAL PREFERENCE LAW AND VENDOR REGISTRATION

E.01 Vendor Registration

All vendors are encouraged to register with Manatee County using the on-line "Vendor Registration" web page on www.mymanatee.org.

Enclosed are a copy of the current Manatee County law that details the County's Local Preference and the County's definition of a local business.

If you assert that your firm meets the stated definition of a local business, we ask that in addition to registering on the County's web page, you fill out the attached "**Affidavit As To Local Business Form"** that is included in this section, have the completed document notarized, and mail the original to the following address: Manatee County Purchasing Division, 1112 Manatee Avenue West, Suite 803, Bradenton, FL 34205.

Your cooperation in registering your business with Manatee County will enhance our opportunities to identify sources for goods and services, plus identify local businesses. This information is used for soliciting quotations up to $250,000.00 and for competitive solicitations of larger purchases.

You will note that Manatee County collaborates with the Manatee Chamber of Commerce, posting Bids on www.manateechamber.com as well as using the same vendor categories for registration.

Our staff can assist you with your registration as needed. Our office hours are 8:00 A.M. to 5:00 P.M., Monday through Friday on regular business days. Please call (941) 749-3014 if you wish to have a Purchasing staff member assist you.

Quick steps to registration: **www.mymanatee.org**

A link to "Purchasing" is listed under "Quick Links" on page one of the County web site.

On the left hand side of the Purchasing web page, click on "Vendor Registration".

This will bring up the Vendor Registration form for on-line input. Please note that the definition of a "local business" changed on March 17, 2009. The web page will be updated to include the current law which has been provided in this section of the Bid.

Thank you for reviewing this information and considering registering your business with Manatee County. Registration is not mandatory; however, by taking the time to register, you are helping the County to provide timely notifications of Quotation, Bid and Proposal opportunities to your business.

E.02 Section 2-26-6. Local preference, tie Bids, **local business defined.**

a) Whenever a responsible local business Bidder and a responsible non-local business Bidder are found, upon the opening of Bids, to have both submitted the lowest responsive Bid, the Bid of the local Bidder shall be awarded the Contract. Should more than one responsible local business Bidder match the responsible non-local business Bidder's lowest responsive Bid, or should no responsible local business Bidder match the lowest responsive Bid but two or more responsible non-local business Bidders submit lowest responsive Bids for equal amounts, then the Award of the Contract shall be determined by a chance drawing, coin toss, or similar tie-breaking method conducted by the Purchasing Division and open to the public. Any Bidders seeking to be recognized as local businesses for purposes of this local business preference provision may be required by the terms of the Bid announcement to certify they meet the definition of local business set forth in this section, and to register as a local business with the County in the manner prescribed by the County to facilitate the County's ability to track the Award of Contracts to local businesses and to allow the County to provide future notifications to its local businesses concerning other Bidding opportunities.

b) Nothing herein shall be deemed to prohibit the inclusion of requirements with respect to operating and maintaining a local place of business in any Invitation for Bids when the Bidder's location materially affects the provisions of the services or supplies that are required by the invitation.

c) **Local business is defined as a business legally authorized to engage in the sale of the goods and/or services to be procured, and which certifies within its Bid that for at least six (6) months prior to the announcement of the solicitation of Bids it has maintained a physical place of business in Manatee, Desoto, Hardee, Hillsborough, Pinellas or Sarasota County with at least one full-time employee at that location.**

d) **Each solicitation for Bids made by the County shall contain terms expressly describing the local business preference policies of the County, and shall provide that by electing to submit a Bid pursuant to an Invitation for Bid, all Bidders are deemed to understand and agree to those policies**.

e) For all Contracts for architecture, professional engineering, or other professional services governed by Florida Statute § 287.055, the Consultants' Competitive Negotiation Act, the County shall include the local business status of a firm among the factors considered when selecting which firms are "most highly qualified." In determining which firm is the "most qualified" for purposes of negotiating a satisfactory Contract, preference shall be given to a local business where all other relevant factors are equal.

E.02 Section 2-26-6. Local preference, tie Bids, **local business defined** (Continued)

f) Local preference shall not apply to the following categories of Contracts:

1. Goods or services provided under a cooperative purchasing agreement or similar "piggyback" contract;

2. Contracts for professional services subject to Florida Statute § 287.055, the Consultants' Competitive Negotiation Act, except as provided for in subsection (e) above;

3. Purchases or Contracts which are funded, in whole or in part, by a governmental or other funding entity, where the terms and conditions of receipt of the funds prohibit the preference;

4. Purchases or Contracts made pursuant to a non-competitive award process, unless otherwise provided by this section;

5. Any Bid announcement which specifically provides that the general local preference policies set forth in this section are suspended due to the unique nature of the goods or services sought, the existence of an emergency as found by either the County Commission or County Administrator, or where such suspension is, in the opinion of the County Attorney, required by law.

g) To qualify for local preference under this section, **a local business must certify to the County that it:**

1. Has not within the five (5) years prior to the Bid announcement admitted guilt or been found guilty by any court or state or federal regulatory enforcement agency of violation of any criminal law, or a law or administrative regulation regarding fraud;

2. Is not currently subject to an unresolved citation or notice of violation of any Manatee County Code provision, except citations or notices which are the subject of a current legal appeal, as of the date of the Bid announcement;

3. Is not delinquent in the payment of any fines, liens, assessments, fees or taxes to any governmental unit or taxing authority within Manatee County, except any such sums which are the subject of a current legal appeal.

Ref: Ordinance 09-21 and 09-23 **PASSED AND DULY ADOPTED** in open session, with a quorum present and voting, on the 17th day of March, 2009.

END OF SECTION E

MANATEE COUNTY GOVERNMENT
AFFIDAVIT AS TO LOCAL BUSINESS
(*Complete and Initial Items B-F)*

A. Authorized Representative

I, [name] _____, am the [title] _____and the duly authorized representative of: [name of business] _____, and that I possess direct personal knowledge to make informed responses to these certifications and the legal authority to make this Affidavit on behalf of myself and the business for which I am acting; and by electing to submit a Bid pursuant to this Invitation for Bids, shall be deemed to understand and agree to the local business preference policies of Manatee County; and that I have the direct knowledge to state that this firm complies with all of the following conditions to be considered to be a local business as required by the Manatee County Code of Law, Section 2-26-6.

B. Place of Business: I certify that the above business is legally authorized to engage in the sale of goods and/or services and has a physical place of business in Manatee, DeSoto, Hardee, Hillsborough, Pinellas or Sarasota County with at least one (1) fulltime employee at that location. The physical address of the location which meets the above criteria is:_____ [Initial]_____

Business Phone Number:_____

Email Address: _____

C. Business History: I certify that business operations began at the above physical address with at least one fulltime employee on [date] _____ [Initial] _____

D. Criminal Violations: I certify that within the past five (5) years of the date of this Bid announcement, this business has not admitted guilt nor been found guilty by any court or local, state or federal regulatory enforcement agency of violation of any criminal law or administrative regulation regarding fraud. [Initial]_____

E. Citations or Code Violations: I certify that this business is not currently subject to any unresolved citation or notice of violation of any Manatee County Code provision, with the exception of citations or notices which are the subject of a legal current appeal within the date of this Bid announcement. [Initial] _____

F. Fees and Taxes: I certify that this business is not delinquent in the payment of fines, liens, assessments, fees or taxes to any governmental unit or taxing authority within Manatee County, with the exception of those which are the subject of a current legal appeal. [Initial]_____

Each of the above certifications is required to meet the qualification of "local business" under Manatee County Code of Laws, 2-26-6.

Signature of Affiant_____

STATE OF FLORIDA
COUNTY OF_____

Sworn to (or affirmed) and subscribed before me this _____ day of _____, 20_____, by (name of person making statement).

(Notary Seal) Signature of Notary:_____

Name of Notary: (Typed or Printed)_____

Personally Known ____ OR Produced Identification ____ Type of Identification Produced _____

Submit executed copy to Manatee County Purchasing Division - 1112 Manatee Avenue West - Suite 803 - Bradenton, FL 34205

SECTION 00300

BID FORM

(SUBMIT IN TRIPLICATE)

For: IFB #13-1542CD- REHABILITATION OF HEADWORKS AND CLARIFIER 3 AND 4 AT THE SOUTHWEST WATER RECLAMATION FACILITY

TOTAL BID PRICE (BID "A"): _____
Based on a Completion Time of 425 calendar days

Only one schedule for Completion of the Work shall be considered. Only one Award shall be made. We, the undersigned, hereby declare that we have carefully reviewed the Bid documents, and with full knowledge and understanding of the aforementioned herewith submit this Bid, meeting each and every specification, term, and condition contained in the Invitation for Bids, in its entirety.

We understand that the Bid package, in its entirety, including but not limited to, all specifications, terms, and conditions in their entirety shall be made a part of any Agreement or Contract between Manatee County and the successful Bidder. Failure to comply shall result in Contract default, whereupon, the defaulting Contractor shall be required to pay for any and all re-procurement costs, damages, and attorney fees as incurred by the County.

Communications concerning this Bid shall be addressed as follows: **(Complete all fields)**

BIDDER'S NAME: _____

MAILING ADDRESS: _____

TELEPHONE: (_____) _____ FAX: (_____) _____

EMAIL ADDRESS: _____

FL CONTRACTOR LICENSE#_____

LICENSE IN THE NAME OF: _____

STATE OF INCORPORATION_____ (if applicable)

I,_____ **on** [date]_____**attest that I have visited the project site(s) to familiarize myself with the full Scope of Work required for the Bid.**

Acknowledge Addendum No.____ Dated: _____ Acknowledge Addendum No._____ Dated: _____
Acknowledge Addendum No.____ Dated: _____ Acknowledge Addendum No._____ Dated: _____
Acknowledge Addendum No.____ Dated: _____ Acknowledge Addendum No._____ Dated: _____

AUTHORIZED SIGNATURE(S): _____

Name and Title of Above Signer(s): _____

BID FORM

(Submit in Triplicate) Section 00300

REHABILITATION OF HEADWORKS AND CLARIFIER 3 AND 4 AT THE SOUTHWEST WATER RECLAMATION FACILITY

Bid "A" Based on Completion Time of 425 Calendar Days

ITEM NO.	DESCRIPTION	EST. QTY.	U/M	UNIT PRICE	EXTENDED PRICE
	MOBILIZATION/DEMOBILIATION				
1	MOBILIZATION/ DEMOBILIZATION	1	LS	$	$
	SUBTOTAL (MOBILIZATION/DEMOBILIZATION ONLY)				
	HEADWORKS REHABILITATION				
2	CONVEYERS	2	EA	$	$
3	CLASSIFIERS AND PIPING	2	EA	$	$
4	JIB CRANES AND HOISTS	2	EA	$	$
5	EXISTING CHANNEL LINER REMOVAL, NEW LINER, AND CONCRETE REPAIRS	1,000	SF	$	$
6	EPOXY INJECTION FOR CONCRETE CRACK REPAIR	150	LF	$	$
7	ANTI-SLIP SAFETY TREADS FOR STAIRS	180	LF	$	$
8	ELECTRICAL AND INSTRUMENTATION	1	LS	$	$
9	DISCRETIONARY WORK (USED ONLY WITH COUNTY APPROVAL)				$85,000.00
	SUBTOTAL (HEADWORKS REHABILITATION ONLY)				$

Bidder Name: _____

Authorized Signature: _____

BID FORM

(Submit in Triplicate) Section 00300

REHABILITATION OF HEADWORKS AND CLARIFIER 3 AND 4 AT THE SOUTHWEST WATER RECLAMATION FACILITY

Bid "A" Based on Completion Time of 425 Calendar Days

ITEM NO.	DESCRIPTION	EST. QTY.	U/M	UNIT PRICE	EXTENDED PRICE
CLARIFIER 3 AND 4 REHABILITATION					
10	**Miscellaneous Work and Cleanup**	1	LS	$	$
11	**Clarifier Mechanisms**	2	EA	$	$
12	**Scum System**	2	EA	$	$
13	**RAS Pumps**	3	EA	$	$
14	**Electrical and Instrumentation**	1	LS	$	$
15	**Structural Inspection and Repair Allowance**				$40,000.00
16	**DISCRETIONARY WORK (USED ONLY WITH COUNTY APPROVAL)**				$50,000.00
	SUBTOTAL (CLARIFIER 3 AND 4 REHABILITATION ONLY)				$
	TOTAL PRICE FOR BID "A" - Based on Completion Time of 425 Calendar Days				$

Bidder Name: _____

Authorized Signature: _____

SWORN STATEMENT

THE FLORIDA TRENCH SAFETY ACT

THIS FORM MUST BE SIGNED IN THE PRESENCE OF A NOTARY PUBLIC OR BY AN OFFICER AUTHORIZED TO ADMINISTER OATHS.

1. This Sworn Statement is submitted with IFB No**. 13-1542CD**
2. This Sworn Statement is submitted by_____ whose business address is_____ and, if applicable, its Federal Employer Identification Number (FEIN) is_____. If the entity has no FEIN, include the Social Security Number of the individual signing this sworn statement _____.
3. Name of individual signing this Sworn Statement is: _____, Whose relationship to the above entity is: _____.
4. The Trench Safety Standards that will be in effect during the construction of this project shall include, but are not limited to: Laws of Florida, Chapters 90-96, TRENCH SAFETY ACT, and OSHA RULES AND REGULATIONS 29 CFR 1926.650 Subpart P, effective October 1, 1990.
5. The undersigned assures that the entity will comply with the applicable Trench Safety Standards and agrees to indemnify and hold harmless the County and Engineer, and any of their agents or employees from any claims arising from the failure to comply with said standard.
6. The undersigned has appropriated the following costs for compliance with the applicable standards:

Trench Safety Measure (Description)	Units of Measure (LF, SY)	Unit Quantity	Unit Cost	Extended Cost
a. _____	_____	_____	$_____	_____
b. _____	_____	_____	$_____	_____
c. _____	_____	_____	$_____	_____
d. _____	_____	_____	$_____	_____

7. The undersigned intends to comply with these standards by instituting the following procedures:

_____

_____

_____

THE UNDERSIGNED, in submitting this Bid, represents that they have reviewed and considered all available geotechnical information and made such other investigations and tests as they may deem necessary to adequately design the trench safety system(s) to be utilized on this project.

_____

(AUTHORIZED SIGNATURE / TITLE)

SWORN to and subscribed before me this _____ day of _____, 20_____.

(Impress official seal)

Notary Public, State of Florida: _____

My commission expires: _____

SECTION 00430

CONTRACTOR'S QUESTIONNAIRE

(Submit in Triplicate)

The Bidder warrants the truth and accuracy of all statements and answers herein contained. (Attach additional pages if necessary.)

THIS QUESTIONNAIRE MUST BE COMPLETED AND SUBMITTED WITH YOUR BID

1. License #: _____

   License Issued to: _____

   Date License Received (MM/DD/YR): _____

   Company Name: _____

   _____

   Company's Physical Address

   _____

   City

   _____State of Incorporation, if applicable _____ (Zip Code)

   (_____) _____Telephone Number; (___) _____Fax Number

   Email Address: _____

2. Bidding as an individual ___a partnership: __ a corporation; ___a joint venture__

3. If a partnership: list names and addresses of partners; if a corporation: list names of officers, directors, shareholders, and state of incorporation; if joint venture: list names and address of ventures' and the same if any venture are a corporation for each such corporation, partnership, or joint venture:

   _____

   _____

   _____

   _____

4. Your organization has been in business (under this firm's name) as a

   _____

   For how many years? _____ Is this firm in bankruptcy? _____

   _____Years holding a Certified General Contractors License

   _____

   _____

   _____Years experience performing this type of project

   (Attach a list of projects where this specific type of work was performed)

BIDDER: _____

4. (Continued)

   Has license ever been suspended, revoked, removed or under investigation?
   _____

   _____

5. Describe and give the date and County of the last three government or private work of similar scope you've completed which are similar in cost, type, size, and nature as the one proposed (for a public entity), include contact name and phone number. Provide the budget, actual cost, size and summary of work for each project. Attach additional pages as necessary. (Note: If listing a Manatee County reference they should not be directly associated with this project)
   _____

   _____

   _____

6. Have you ever been assessed liquidated damages under a Contract during the past five (5) years? If so, state when, where (contact name, address and phone number) and why.
   _____

   _____

   _____

7. Have you ever failed to complete work awarded to you? Or provide projects not completed within Contract time. If so, state when, where (contact name, address, phone number) and why.
   _____

   _____

   _____

   _____

   _____

8. Have you ever been debarred or prohibited from bidding on a governmental entity's construction project? If yes, name the entity and describe the circumstances:
   _____

   _____

   _____

BIDDER: _____

9. What specific steps have you taken to examine the physical conditions at or contiguous to the site, including but not limited to, the location of existing underground facilities? Have you visited the site(s)? _____
Provide date(s) of site visit: _____

_____

_____

_____

10. What specific physical conditions, including, but not limited to, the location of existing underground facilities have you found which will, in any manner, affect cost, progress, performance, or finishing of the Work?

_____

_____

_____

11. Will you subcontract any part of this Work? If so, describe which major portion(s):

_____

_____

_____

12. If any, list (with Contract amount) WBE/MBE to be utilized:

_____

_____

_____

13. What equipment do you own to accomplish this Work? (A listing may be attached)

_____

_____

_____

14. What equipment will you purchase/rent for the Work? (Specify which)

_____

_____

_____

BIDDER: _____

15. List the following in connection with the Surety which is providing the Bond(s):

Surety's Name: _____

Surety's Address: _____

Surety's Address: _____

Name, address and phone number of Surety's resident agent for service of process in Florida:

_____

_____

_____

_____

Phone: (_____) _____

Email_____

BIDDER: _____

SECTION 00491

PUBLIC CONTRACTING AND ENVIRONMENTAL CRIMES CERTIFICATION

SWORN STATEMENT PURSUANT TO ARTICLE V,
MANATEE COUNTY PURCHASING ORDINANCE

THIS FORM MUST BE SIGNED AND SWORN TO IN THE PRESENCE OF A NOTARY PUBLIC OR OTHER OFFICIAL AUTHORIZED TO ADMINISTER OATHS.

This sworn statement is submitted to the Manatee County Board of County Commissioners by

_____

[Print individual's name and title]

____ for _____[print name of entity submitting sworn statement]

whose business address is _____

and (if applicable) its Federal Employer Identification Number (FEIN) is _____.If the entity has no FEIN, include the Social Security Number of the individual signing this sworn statement: _____

I understand that no person or entity shall be awarded or receive a County Contract for public improvements, procurement of goods or services (including professional services) or a County lease, franchise, concession or management Agreement, or shall receive a grant of County monies unless such person or entity has submitted a written certification to the County that it has not:

(1) been convicted of bribery or attempting to bribe a public officer or employee of Manatee County, the State of Florida, or any other public entity, including, but not limited to the Government of the United States, any state, or any local government authority in the United States, in that officer's or employee's official capacity; or

(2) been convicted of an agreement or collusion among Bidders or prospective Bidders in restraint of freedom of competition, by agreement to bid a fixed price, or otherwise; or

(3) been convicted of a violation of an environmental law that, in the sole opinion of the County's Purchasing Official, reflects negatively upon the ability of the person or entity to conduct business in a responsible manner; or

(4) made an admission of guilt of such conduct described in items (1), (2) or (3) above, which is a matter of record, but has not been prosecuted for such conduct, or has made an admission of guilt of such conduct, which is a matter of record, pursuant to formal prosecution. An admission of guilt shall be construed to include a plea of nolo contendere; or

(5) where an officer, official, agent or employee of a business entity has been convicted of or has admitted guilt to any of the crimes set forth above on behalf of such an entity and pursuant to the direction or authorization of an official thereof (including the person committing the offense, if he is an official of the business entity), the business shall be chargeable with the conduct herein above set forth. A business entity shall be chargeable with the conduct of an affiliated entity, whether wholly owned, partially owned, or one which has common ownership or a common Board of Directors. For purposes of this Form, business entities are affiliated if, directly or indirectly, one business entity controls or has the power to control another business entity, or if an individual or group of individuals controls or has the power to control both entities. Indicia of control shall include, without limitation, interlocking management or ownership, identity of interests among family members, shared organization of a business entity following the ineligibility of a business entity under this Article, or using substantially the same management, ownership or principles as the ineligible entity.

(Cont'd.)

Any person or entity who claims that this Article is inapplicable to him/her/it because a conviction or judgment has been reversed by a court of competent jurisdiction shall prove the same with documentation satisfactory to the County's Purchasing Official. Upon presentation of such satisfactory proof, the person or entity shall be allowed to contract with the County.

I UNDERSTAND THAT THE SUBMISSION OF THIS FORM TO THE CONTRACTING OFFICER FOR MANATEE COUNTY IS VALID THROUGH DECEMBER 31 OF THE CALENDAR YEAR IN WHICH IT IS FILED. I ALSO UNDERSTAND THAT ANY CONTRACT OR BUSINESS TRANSACTION SHALL PROVIDE FOR SUSPENSION OF PAYMENTS, OR TERMINATION, OR BOTH, IF THE CONTRACTING OFFICER OR THE COUNTY ADMINISTRATOR DETERMINES THAT **SUCH PERSON OR ENTITY HAS MADE FALSE CERTIFICATION.**

_____
[Signature]

STATE OF FLORIDA
COUNTY OF _____

Sworn to and subscribed before me this ____ day of _____, 20_____ by _____

Personally known _____ OR Produced identification _____
[Type of identification]

_____ My commission expires _____
Notary Public Signature

_____
[Print, type or stamp Commissioned name of Notary Public]

Signatory Requirement - In the case of a business entity other than a partnership or a corporation, this affidavit shall be executed by an authorized agent of the entity. In the case of a partnership, this affidavit shall be executed by the general partner(s). In the case of a corporation, this affidavit shall be executed by the corporate president.

SECTION 00500
FORM OF AGREEMENT
BETWEEN THE
COUNTY OF MANATEE, FLORIDA
AND THE CONTRACTOR AS IDENTIFIED BELOW
ON THE BASIS OF A STIPULATED UNIT COST CONTRACT PRICE

THIS AGREEMENT is made and entered into by and between the COUNTY OF MANATEE, a political subdivision of the State of Florida, hereinafter referred to as the "COUNTY" and **XXXXXXXXXXXX**, hereinafter referred to as the "CONTRACTOR," duly authorized to transact business in the State of Florida, with offices located at **XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX**.

ARTICLE 1. WORK

CONTRACTOR shall furnish all labor, materials, supplies, and other items required to complete the Work for **IFB #13-1542CD Rehabilitation of Headworks and Clarifier 3 and 4 at the Southwest Water Reclamation Facility** in strict accordance with Contract documents and any duly authorized subsequent addenda thereto, all of which are made a part hereof.

ARTICLE 2. COMPENSATION

As compensation to the CONTRACTOR, the COUNTY shall pay and the CONTRACTOR will accept as full consideration for the performance of all Work required by **IFB #13-1542CD Rehabilitation of Headworks and Clarifier 3 and 4 at the Southwest Water Reclamation Facility**, subject to additions and deductions as provided therein, the sum of **$XXXXX** for Bid "**A**" based on a completion time of **425** calendar days.

ARTICLE 3. LIQUIDATED DAMAGES

Time is of the essence in this Agreement. As of the date of this Agreement, the damages that will be suffered by the County in the event of the Contractor's failure to timely complete the Work are impossible to determine. In lieu thereof, it is agreed that if the Contractor fails to achieve substantial completion of the Work within 425 calendar days of issuance of the Notice to Proceed (accounting, however, for any extensions of

time granted pursuant to approved change orders), the Contractor shall pay to the County, as liquidated damages (and not as a penalty), the sum of $1148 per calendar day for each day beyond 425 days until the Contractor achieves substantial completion. The County shall have the option of withholding said liquidated damages from any pay application(s) thereafter submitted by the Contractor. Alternatively, the Contractor shall immediately pay said sums to the County upon the County's demand for same.

ARTICLE 4. ENGINEER

The County of Manatee, Public Works Department, is responsible as the COUNTY and Carollo Engineers hereinafter referred to as "ENGINEER," designed this project and is responsible for technical/engineering reviews and decisions. The ENGINEER is a member of the COUNTY'S project management team which is collectively responsible in ensuring the Work is completed in accordance with the Contract documents.

All communications involving this project will be addressed to: Anthony Benitez, Project Engineer II, Public Works Department and to the Engineer of Record, Eric Peters, Carollo Engineers. All invoicing will be addressed to the attention of: Anthony Benitez (address noted below) with invoice copies sent to Eric Peters, Carollo Engineers, Inc. (address noted below).

Manatee County Public Works Department
IFB #13-1542CD
Attention: Anthony Benitez
Project Engineer II
1022 26th Avenue East
Bradenton, FL 34208
(941) 708-7450 ext. 7333

Carollo Engineers, Inc.
IFB #13-1542CD
Attn: Eric Peters
Project Manager
401 North Cattlemen Road, # 306
Sarasota, FL 34232
(941) 371-9832

Where the terms ENGINEER and/or COUNTY are used in the Contract Documents, it shall mean the COUNTY'S project management team.

ARTICLE 5. CONTRACTOR'S REPRESENTATIONS

In order to induce COUNTY to enter into this Agreement, CONTRACTOR makes the following representations:

5.1 CONTRACTOR has familiarized itself with the nature and extent of the Bid documents, Work, site, locality and all local conditions and laws and regulations that in any manner may affect cost, progress, performance or furnishing of the Work.

5.2 CONTRACTOR has studied carefully all drawings of the physical conditions upon which CONTRACTOR is entitled to rely.

5.3 CONTRACTOR has obtained and carefully studied (or assumes responsibility for obtaining and carefully studying) all such examinations, investigations, explorations, tests, reports and studies which pertain to the physical conditions at or contiguous to the site or which otherwise may affect the cost, progress, performance or furnishing of the Work as CONTRACTOR considers necessary for the performance or furnishing of the Work at the Contract price, within the Contract time and in accordance with the other terms and conditions of the Bid documents; and no additional examinations, investigations, explorations, tests, reports, studies or similar information or data are or will be required by CONTRACTOR for such purposes.

5.4 CONTRACTOR has reviewed and checked all information and data shown or indicated on the Bid documents with respect to existing underground facilities at or contiguous to the site and assumes responsibility for the accurate location of said underground facilities. Any additional examinations, investigations, explorations, tests, reports, studies or similar information or data in respect of said underground facilities conducted by the CONTRACTOR will be done at the CONTRACTOR'S expense.

5.5 CONTRACTOR has correlated the results of all such observations, examinations, investigations, explorations, tests, reports and studies with the terms and conditions of the Bid.

5.6 CONTRACTOR has given COUNTY written notice of all conflicts, errors or discrepancies that have been discovered in the Bid documents and the written resolution thereof by OWNER is acceptable to CONTRACTOR.

5.7 CONTRACTOR shall schedule and perform the Work subject to COUNTY'S approval and shall hold COUNTY harmless from all liabilities incurred due to CONTRACTOR'S failure to coordinate with the COUNTY.

ARTICLE 6. CONTRACT DOCUMENTS

The Contract documents which comprise the entire Agreement between COUNTY and CONTRACTOR concerning the Work consist of the following:

6.1 This Agreement and Bid document **IFB #13-1542CD**

6.2 Public Construction Bond Form and Insurance Certificate(s)

6.3 Drawings/Plans (not attached)

6.4 Addendum number # to # inclusive

6.5 CONTRACTOR'S Bid Form

6.6 Reports

6.7 The following, which may be delivered or issued after the effective date of the Agreement and are not attached hereto: all written change orders and other documents amending, modifying, or supplementing the Contract documents.

6.8 The documents listed in paragraphs above are attached to this Agreement (except as noted otherwise above). There are no Contract documents other than those listed above in this Article 6.

ARTICLE 7. MISCELLANEOUS

7.1 Terms used in this Agreement are defined in Article 1 of the General Conditions.

7.2 No assignment by a party hereto of any rights under or interest in the Contract documents will be binding on another party hereto without the written consent of the party sought to be bound; and specifically but without limitation, monies that may become due and monies that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law); and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignee from any duty or responsibility under the Contract documents.

7.3 COUNTY and CONTRACTOR each binds itself, its partners, successors, assigns and legal representatives to the other party hereto, its partners, successors, assigns and legal representatives in respect of all covenants, agreements, and obligations contained in the Contract documents.

AGREEMENT

IFB #13-1542CD

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be duly executed by their authorized representatives.

CONTRACTOR

By: _____

_____
Print Name & Title of Signer

Date: _____

COUNTY OF MANATEE, FLORIDA

By: _____
Melissa M. Wendel, CPPO
Purchasing Official

Date: _____

MANATEE COUNTY GOVERNMENT
PUBLIC CONSTRUCTION BOND

Bond No. _____
(Enter bond number)

BY THIS BOND, We_____, located at _____, as
(Name of Contractor) (Address)

Principal and _____, a corporation, whose address is
(Name of Surety)

_____

are bound to Manatee County, a political subdivision of the State of Florida, herein called County, in the sum of $ _____, for payment of which we bind ourselves, our heirs, personal representatives, successors, and assigns, jointly and severally.

WHEREAS, the Contractor has entered into Contract No. IFB #13-1542CD with the County for the project titled Rehabilitation of Headworks and Clarifier 3 and 4 at the Southwest Water Reclamation Facility, with conditions and provisions as are further described in the aforementioned Contract, which Contract is by reference made a part hereof for the purposes of explaining this bond.

THE CONDITION OF THIS BOND is that if Principal:

1. Performs Contract No. IFB #13-1542CD, between Principal and County for construction of

Rehabilitation of Headworks and Clarifier 3 and 4 at the Southwest Water Reclamation Facility, the Contract being made a part of this bond by reference, at
(Title of Project)

the times and in the manner prescribed in the Contract; and

2. Promptly makes payments to all claimants, as defined in Section 255.05(1), Florida Statutes, supplying Principal with labor, materials, or supplies, used directly or indirectly by Principal in the prosecution of the Work provided for in the Contract; and

3. Pays County all losses, damages, expenses, costs, and attorney's fees, including appellate proceedings, that County sustains because of a default by Principal under the Contract; and

4. Performs the guarantee of all Work and materials furnished under the Contract for the time specified in the Contract, then this bond is void; otherwise it remains in full force.

Any action instituted by a claimant under this bond for payment must be in accordance with the notice and time limitation provisions in Section 255.05(2), Florida Statutes.

Any changes in or under the Contract documents and compliance or noncompliance with any formalities connected with the Contract or the changes does not affect Surety's obligation under this bond.

DATED ON _____.

CONTRACTOR AS PRINCIPAL	**SURETY**
Company Name	Company Name
Signature	Signature
Print Name & Title	Print Name & Title
(Corporate Seal)	*(Corporate Seal)*

AGENT or **BROKER**

Company Name

Address

Telephone

Licensed Florida Insurance Agent? ☐ **Yes** ☐ **No**

License #: _____

State of: _____

County of: _____

City of: _____

SECTION 00700

GENERAL CONDITIONS

ARTICLE 1. DEFINITIONS

Whenever used in the Bid documents, the following terms have the meaning indicated which are applicable to both the singular and plural thereof:

Addendum - Written or graphic instruments issued prior to the opening of Bids which clarify or change the Bidding documents or the Contract documents.

Agreement - The written Agreement between Owner and Contractor covering the Work to be performed; other Contract documents are attached to the Agreement and made a part thereof as provided therein.

Application for Payment - The form accepted by the Project Representative which is to be used by Contractor in requesting progress or final payments and which is to include such supporting documentation as is required by the Contract documents.

Award - Acceptance of the Bid from the person, firm, or corporation which in the Owner's sole and absolute judgment will under all circumstances best serve the public interest. Award shall be made in accordance with Manatee County Code of Laws.

Bid - The offer of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

Bidder - One who submits a Bid directly to the Owner, as distinct from a Sub-bidder, who submits a Bid to a Bidder.

Bidding Documents - Consists of the Invitation for Bid, which includes but is not limited to the Bid Form, drawings, technical specifications, terms and conditions, and the proposed Contract documents (including all addenda issued prior to receipt of Bids); and becomes a part of the Agreement.

Bonds - Performance and payment bonds and other instruments of security.

Change Order - A document recommended by the Project Representative which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract price or the Contract time, issued on or after the effective date of the Agreement.

Compensable Delay - Any delay beyond the control and without the fault or negligence of the Contractor resulting from Owner-caused changes in the Work, differing site conditions, suspensions of the Work, or termination for convenience by Owner.

Contract Documents - The Agreement, addenda (which pertain to the Contract documents), Contractor's Bid (including documentation accompanying the Bid and any post-Bid documentation submitted prior to the Notice of Award), the bonds, the specifications, special provisions and the drawings, together with all amendments, modifications and supplements issued on or after the effective date of the Agreement.

Contract Price - The monies payable by Owner to Contractor under the Contract documents as stated in the Agreement.

Contract Time - The number of days or the date stated in the Notice to Proceed for the completion of the Work.

Contractor - The person, firm or corporation with whom Owner has entered into an Agreement.

Days - All references to days are to be considered calendar days except as specified differently.

Defective - An adjective which when modifying the Work refers to work that is unsatisfactory, faulty or deficient, or does not conform to the Contract documents, or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract documents, or has been damaged prior to Project Representative's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner).

Discretionary – Payment for all Work that shall be made only at the Owner’s discretion in order to satisfactorily complete the project in accordance with the plans and specifications.

Drawings - The drawings which show the character and Scope of Work to be performed and which have been prepared or approved by Engineer and are referred to in the Bidding and Contract documents.

Effective Date of the Agreement - The date indicated in the Agreement on which it becomes effective (date of execution).

Excusable Delay - Any delay beyond the control and without the negligence of the Contractor, the Owner, or any other Contractor caused by events or circumstances such as, but not limited to, acts of God or of the public enemy, fires, floods, freight embargoes, acts of government other than Owner or epidemics. Labor disputes and above average rainfall shall give rise only to excusable delays.

Field Order - A written order issued by Project Representative which orders minor changes in the Work, but which does not involve a change in the Contract price or the Contract time.

Float or Slack Time - The time available in the progress schedule during which an unexpected activity can be completed without delaying substantial completion of the Work.

Inexcusable Delay - Any delay caused by events or circumstances within the control of the Contractor, such as inadequate crewing, slow submittals, etc., which might have been avoided by the exercise of care, prudence, foresight, or diligence on the part of the Contractor.

Non-prejudicial Delay - Any delay impacting a portion of the Work within the available total float or slack time and not necessarily preventing completion of the Work within the Contract time.

Notice of Award - The written notice to the successful Bidder stating Award has been approved by the Board of County Commissioners; or by the Purchasing Official in accordance with Manatee County Code of Laws, Chapter 2-26, Manatee County Purchasing Ordinance.

Notice of Intent to Award - The written notice to the apparent low Bidder stating Award has been recommended with final Award to be authorized by the Board of County Commissioners.

Notice to Proceed - Written notice by Owner (after execution of Contract) to Contractor fixing the date on which the Contract time will commence to run and on which Contractor shall start to perform (ten (10) days from date of such notice) Contractor's obligations under the Contract documents.

Owner - Manatee County, Florida, Board of County Commissioners.

Preconstruction Conference - Prior to starting the Work, a meeting scheduled by Owner with Contractor to review the Work schedules, to establish procedures for handling shop drawings and other submissions, for processing periodical pay estimates, and such other matters as may be pertinent to the project.

Prejudicial Delay - Any excusable or compensable delay impacting the Work and exceeding the total float available in the progress schedule, thus preventing completion of the Work within the Contract time unless the Work is accelerated.

Pre-operation Testing - All field inspections, installation checks, water tests, performance tests and necessary corrections required of Contractor to demonstrate that individual components of the Work have been properly constructed and do operate in accordance with the Contract documents for their intended purposes.

Project - The total construction of which the Work to be provided under the Contract documents may be the whole or a part as indicated elsewhere in the Contract documents.

Project Representative - The authorized representative of Owner who is assigned to the project or any part thereof.

Schedule of Values – Unit prices shall be established for this Contract by the submission of a schedule of values. The Contractor shall submit a schedule of values within ten (10) days of Notice to Proceed date. The schedule shall include quantities and prices of items equaling the Total Bid Price and will subdivide the Work into components in sufficient detail to serve as the basis for progress payments during construction. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work. Upon request of the County, the Contractor shall support the values with data which will substantiate their correctness.

Shop Drawings - All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for Contractor to illustrate some portion of the Work and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams and other information prepared by a supplier and submitted by Contractor to illustrate material or equipment for some portion of the Work.

Special Provisions: As required to define work or procedures not covered in the standard specifications, and as necessary to supplement or modify items in the standard specifications.

Specifications - Those portions of the Contract documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.

Subcontractor - An individual or corporation having a direct contact with Contractor or with any other Subcontractor for the performance of a part of the Work at the site. Such person or firm has contractual relations with the Contractor, not with the Owner.

Substantial Completion - The Work (or a specified part thereof) has progressed to the point when, in the opinion of the Engineer as evidenced by Engineer's definitive certificate of substantial completion, it is sufficiently complete in accordance with Contract documents so that the Work can be utilized for the purposes for which it is intended; or if there be no such certificate issued, when final payment is due.

Successful Bidder - The lowest, responsible and responsive Bidder to whom an Award is made.

Supplier - A manufacturer, fabricator, supplier, distributor, material man or vendor.

Underground Facilities - All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments and any encasement containing such facilities which have been installed underground to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or

other communications, cable television, sewage and drainage removal, traffic or other control systems or water.

Unit Price Work - Work to be paid for on the basis of unit prices.

Work - The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract documents. Work is the result of performing services, furnishing labor and furnishing and incorporating materials and equipment into the construction, all as required by the Contract documents.

Work Directive Change - A written directive to Contractor, issued on or after the effective date of the Agreement and signed by Owner and recommended by Project Representative ordering an addition, deletion or revision in the Work, or responding to differing or unforeseen physical conditions under which the Work is to be performed or to emergencies. A work directive change may not change the Contract price or the Contract time; but is evidence that the parties expect that the change directed or documented by a work directive change will be incorporated in a subsequently issued change order following negotiations by the parties as to its effect, if any, on the Contract price or Contract time.

Written Amendment - A written amendment of the Contract documents, signed by Owner and Contractor on or after the effective date of the Agreement and normally dealing with the non-engineering or non-technical rather than strictly work related aspects of the Contract documents.

ARTICLE 2. PRELIMINARY MATTERS

Computation of Time: When time is referred to in the Contract documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or legal holiday, such day will be omitted from the computation.

2.1 The Contractor must submit a proposed schedule of the Work at the preconstruction conference. The purpose of this schedule is to enable the Owner to govern the Work, to protect the functions of the local government and its citizens and to aid in providing appropriate surveillance. The Owner shall have the right to reschedule Work provided such rescheduling is in accord with the remainder of terms of the Contract. The schedule shall show, as a minimum, the approximate dates on which each segment of the Work is expected to be started and finished, the proposed traffic flows during each month, the anticipated earnings by the Contractor for each month and the approximate number of crews and equipment to be used. The Owner, after necessary rescheduling and obtaining additional information for specific purposes, shall review and approve the schedule. The Contractor shall also forward to the Owner, as soon as practicable after the first day of each month, a summary report of the progress of the various parts of the Work under the Contract, in fabrication and in the field, stating the existing status, estimated time of completion and cause of delay, if

any. Together with the summary report, the Contractor shall submit any necessary revisions to the original schedule for the Owner's review and approval. In addition, more detailed schedules may be required by the Owner for daily traffic control.

2.2 A Notice to Proceed may be given at any time within thirty (30) days after the effective date of the Agreement. The Contract time will commence at the time specified in such notice. Contractor shall start to perform the Work on the date specified in the Notice to Proceed, but no Work shall be done at the site prior to the date on which the Contract time commences to run.

2.3 If at any time the materials and appliances to be used appear to the Owner as insufficient or improper for securing the quality of Work required or the required rate of progress, the Owner may order the Contractor to increase his efficiency or to improve the character of his Work and the Contractor shall conform to such an order. The failure of the Owner to demand any increase of such efficiency of any improvement shall not release the Owner from his obligation to secure the quality of Work or the rate of progress necessary to complete the Work within the limits imposed by the Contract. The Owner may require the Contractor to remove from the Work such employees as the Owner deems incompetent, careless, insubordinate or otherwise objectionable, or whose continued employment on the Work is deemed to be contrary to the Owner's interest.

2.4 The Owner reserves the right to let other Contracts in connection with this Work. The Contractor shall afford other Contractors reasonable opportunity for the introduction and storage of their materials and execution of their Work, and promptly connect and coordinate the Work with theirs.

ARTICLE 3. CONTRACT DOCUMENTS: INTENT, AMENDING, RE-USE

3.1 The Contract documents comprise the entire Agreement between Owner and Contractor concerning the Work. The Contract documents are complementary; what is called for by one is as binding as if called for by all. The Contract documents will be construed in accordance with the laws and ordinances of the State of Florida and Manatee County.

Should a conflict exist within the Contract documents, the precedence in ascending order of authority are as follows: 1) Standard Printed Contract Documents, 2) Special Conditions, 3) General Conditions, and 4) Drawings.
Note: Computed dimensions shall govern over scaled dimensions.

3.2 It is the intent of the Contract documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract documents. Any work, materials or equipment that may reasonably be inferred from the Contract documents as being required to produce the intended result will be supplied whether or not specifically called for. When words which have a well-known technical or trade meaning are used to describe work, materials, or

equipment, such words shall be interpreted in accordance with that meaning. Reference to standard specifications, manuals or codes of any technical society, organization or association, or to the laws or regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual, code or laws or regulations in effect at the time of opening of Bids, except as may be otherwise specifically stated. However, no provision of any referenced standard specification, manual or code (whether or not specifically incorporated by reference in the Contract documents) shall be effective to change the duties and responsibilities of Owner, Contractor or Engineer, or any of their agents or employees from those set forth in the Contract documents.

3.3 The Contract documents may be amended to provide for additions, deletions and revisions in the Work or to modify the terms and conditions thereof in one or more of the following ways:

3.3.1 A Formal Written Amendment

3.3.2 A Change Order

3.3.3 Administrative Contract Adjustment (ACA)

3.3.4 A Work Directive Change

3.4 In addition, the requirements of the Contract documents may be supplemented and minor variations and deviations in the Work may be authorized in one or more of the following ways:

3.4.1 Discretionary Work – Field Directive

3.4.2 Engineer's approval of a Shop Drawing or sample

ARTICLE 4. CONTRACTOR'S RESPONSIBILITIES

4.1 Contractor shall keep on the Work at all times during its progress a competent resident superintendent; who shall be the Contractor's representative at the site and shall have authority to act on behalf of Contractor. All communications given to the superintendent shall be as binding as if given to Contractor.

4.2 Contractor shall provide competent, suitable qualified personnel to survey and lay out the Work and perform construction as required by the Contract documents. Contractor shall at all times maintain good discipline and order at the site. Except in connection with the safety or protection of persons or the Work or property at the site or adjacent thereto and except as otherwise indicated in the Contract documents, all Work at the site shall be performed during regular working hours and Contractor will not permit overtime work or the

performance of work on Saturday, Sunday or legal holiday without Owner's written consent given after prior notice to Engineer (at least seventy-two (72) hours in advance).

4.2.1 Contractor shall pay for all additional engineering charges to the Owner for any overtime work which may be authorized. Such additional engineering charges shall be a subsidiary obligation of Contractor and no extra payment shall be made by Owner on account of such overtime work. At Owner's option, overtime costs may be deducted from Contractor's monthly payment request or Contractor's retainage prior to release of final payment.

4.3 Unless otherwise specified, Contractor shall furnish and assume full responsibility for all bonds, insurance, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities and all other facilities and incidentals necessary for the furnishing, performance, testing, start-up and completion of the Work.

4.4 All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract documents. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment. All materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with the instruction of the applicable supplier except as otherwise provided in the Contract documents.

4.5 Contractor shall be fully responsible to Owner for all acts and omissions of the Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under a direct or indirect Contract with Contractor just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract documents shall create any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other person or organization, nor shall it create any obligation on the part of Owner to pay or to see to the payment of any monies due any such Subcontractor, Supplier or other person or organization.

4.6 Permits: Unless otherwise provided, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work.

4.7 During the progress of the Work, Contractor shall keep the premises free from accumulation of waste materials rubbish and other debris resulting from the Work. At the completion of the Work, Contractor shall remove all waste

materials, rubbish, and debris from and about the premises as well as all tools, appliances, construction equipment and machinery and surplus materials and shall leave the site clean and ready for occupancy by Owner. Contractor shall restore to original conditions all property not designated for alteration by the Contract documents.

4.8 Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

4.9 Safety and Protection: Contractor shall comply with the Florida Department of Commerce Safety Regulations and any local safety regulations. Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Contractor shall take all necessary precautions for the safety of and shall provide the necessary protection to prevent damage, injury or loss to:

4.9.1 all employees on the work and other persons and organizations who may be affected thereby;

4.9.2 all the work and materials and equipment to be incorporated therein, whether in storage on or off the site; and

4.9.3 other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities and underground facilities not designated for removal, relocation or replacement in the course of construction.

4.9.4 Contractor shall comply with all applicable laws and regulations of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall provide and maintain all passageways, guard fences, lights and other facilities for the protection required by public authority or local conditions. Contractor shall provide reasonable maintenance of traffic way for the public and preservation of the Owner’s business, taking into full consideration all local conditions. Contractor's duties and responsibilities for the safety and protection of the Work shall continue until such time as all the Work is completed.

4.10 Emergencies: In emergencies affecting the safety or protection of persons or the Work or property at the site or adjacent thereto, Contractor, without special instruction or authorization from Engineer or Owner, is obligated to act to prevent threatened damage, injury or loss. Contractor shall give Owner prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract documents have been caused thereby. If Owner

determines that a change in the Contract documents is required because of the action taken in response to an emergency, a work directive change or change order will be issued to document the consequences of the changes or variation.

4.11 For substitutes not included with the Bid, but submitted after the effective date of the Agreement, Contractor shall make written application to Engineer for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar and of equal substance to that specified and be suited to the same use as that specified. The application will also contain an itemized estimate of all costs and delays or schedule impacts that will result directly or indirectly from review, acceptance and provisions of such substitute, including costs of redesign and claims of other Contractors affected by the resulting change, all of which will be considered by the Engineer in evaluating the proposed substitute. Engineer may require Contractor to furnish at Contractor's expense, additional data about the proposed substitute. In rendering a decision, Owner/Engineer and Contractor shall have access to any available float time in the construction schedule. In the event that substitute materials or equipment not included as part of the Bid, but proposed after the effective date of the Agreement, are accepted and are less costly than the originally specified materials or equipment, then the net difference in cost shall be credited to the Owner and an appropriate change order executed.

4.11.1 If a specific means, method, technique, sequence of procedure of construction is indicated in or required by the Contract documents, Contractor may furnish or utilize a substitute means, method, sequence, technique or procedure of construction acceptable to Engineer if Contractor submits sufficient information to allow Engineer to determine that the substitute proposed is equivalent to that indicated or required by the Contract documents.

4.11.2 Engineer will be allowed a reasonable time within which to evaluate each proposed substitute. Engineer will be the sole judge of acceptability and no substitute will be ordered, installed or utilized without Engineer's prior written acceptance which will be evidenced by either a change order or an approved shop drawing. Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

4.11.3 Contractor shall reimburse Owner for the charges of Engineer and Engineer's Consultants for evaluating each proposed substitute submitted after the effective date of the Agreement and all costs resulting from any delays in the Work while the substitute was undergoing review.

4.12 The Contractor shall furnish, free of charge, all labor, stakes, surveys, batter boards for structures, grade lines and other materials and supplies and shall set construction stakes and batter boards for establishing lines, position of structures, slopes and other controlling points necessary for the proper prosecution of the construction work. Where rights-of-way, easements, property lines or any other conditions which make the lay-out of the project or parts of the project critical are involved, the Contractor will employ a competent surveyor who is registered in the State of Florida for lay-out and staking. These stakes and marks shall constitute the field control by and in accord with which the Contractor shall govern and execute the Work. The Contractor will be held responsible for the preservation of all stakes, marks and if for any reason any of the stakes or marks or batter boards become destroyed or disturbed, they will be immediately and accurately replaced by the Contractor.

4.13 The Contractor has, by careful examination, satisfied himself as to the nature and location of the Work and all other matters which can in any way affect the Work under this Contract, including, but not limited to details pertaining to boring, as shown on the drawings, are not guaranteed to be more than a general indication of the materials likely to be found adjacent to holes bored at the site of the Work, approximately at the locations indicated. The Contractor shall examine boring data, where available, and make his own interpretation of the subsoil investigations and other preliminary data, and shall base his Bid on his own opinion of the conditions likely to be encountered. In no event shall an extension of time be considered for any conditions that existed at the time of bidding, nor shall the Contractor receive extra compensation for completion of the project as intended by the drawings and in keeping with the Contact documents. No verbal agreement or conversation with any officer, agent or employee of the Owner, before or after the execution of this Contract, shall affect or modify any of the terms or obligations herein contained.

4.14 If the Contractor, in the course of the Work, finds that the drawings and/or Contract documents cannot be followed, he shall immediately inform the Owner in writing, and the Owner shall promptly check the accuracy of the information. Any work done after such discovery, until any necessary changes are authorized, will be done at the Contractor's risk.

ARTICLE 5. OWNER'S RESPONSIBILITIES

5.1 Owner shall furnish the data required of Owner under the Contract documents promptly and shall make payments to the Contractor within a reasonable time (no more than twenty (20) days) after the Work has been accepted by the Owner. The form of all submittals, notices, change orders and other documents permitted or required to be used or transmitted under the Contract documents shall be determined by the Owner/Engineer. Standard County forms shall be utilized.

5.2 The Owner shall provide the lands upon which the Work under this Contract is to be done, except that the Contractor shall provide all necessary additional land required for the erection of temporary construction facilities and storage of his materials, together with right of access to same.

5.3 The Owner shall have the right to take possession of and use any completed portions of the Work, although the time for completing the entire Work or such portions may not have expired, but such taking possession and use shall not be deemed an acceptance of any Work not completed in accordance with the Contract documents.

ARTICLE 6. CHANGES IN THE WORK

6.1 Without invalidating the Agreement and without notice to any Surety, Owner may, at any time, order additions, deletions or revisions in the Work. These will be authorized by a written amendment, a change order, or a work directive change. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract documents (except as otherwise specifically provided).

6.2 Contractor shall not be entitled to an increase in the Contract price or an extension of the Contract time with respect to any Work performed that is not required by the Contract documents as amended, modified and supplemented.

6.3 Owner and Contractor shall execute appropriate change orders (or written amendments) covering changes in the Work which are ordered by Owner, or which may be required because of acceptance of defective Work.

6.4 At any time Engineer may request a quotation from Contractor for a proposed change in the Work and within twenty-one (21) calendar days after receipt, Contractor shall submit a written and detailed proposal for an increase or decrease in the Contract price or Contract time for the proposed change. Engineer shall have twenty-one (21) calendar days after receipt of the detailed proposal to respond in writing. The proposal shall include an itemized estimate of all costs and time for performance that will result directly or indirectly from the proposed change. Unless otherwise directed, itemized estimates shall be in sufficient detail to reasonably permit an analysis by Engineer of all material, labor, equipment, subcontracts, overhead costs and fees, and shall cover all Work involved in the change, whether such Work was deleted, added, changed or impacted. Notwithstanding the request for quotation, Contractor shall carry on the Work and maintain the progress schedule. Delays in the submittal of the written and detailed proposal will be considered non-prejudicial.

ARTICLE 7. CHANGE OF CONTRACT PRICE

7.1 The Contract price constitutes the total compensation (subject to authorized adjustments) payable to Contractor for performing the Work. All duties, responsibilities and obligations assigned to or undertaken by Contractor shall be at his expense without change in the Contract price.

7.2 The Contract price may only be changed by change order or by a written amendment. Any claim for an increase or decrease in the Contract price shall be based on written notice delivered by the party making the claim to the other party. Notice of the amount of the claim with supporting data shall be delivered within ten (10) days from the beginning of such occurrence and shall be accompanied by claimant's written statement that the amount claimed covers all known amounts (direct, indirect and consequential) to which the claimant is entitled as a result of the occurrence of said event.

7.3 The value of any Work covered by a change order or of any claim for an increase or decrease in the Contract price shall be determined in one of the following ways (at Owner's discretion):

7.3.1 Where the Work involved is covered by unit prices contained in the Contract documents, cost will be determined by application of such unit prices to the quantities of the items involved.

7.3.2 By mutual acceptance of lump sum.

7.3.3 On the basis of the cost of the Work, plus a 15% Contractor's fee for overhead and profit. (Contractor shall submit an itemized cost breakdown together with supporting data.)

7.4 Either Owner or Contractor may make a claim for an adjustment in the Contract price. The unit price of an item of Unit Price Work shall be subject to re-evaluation and adjustment under the following conditions:

7.4.1 If the total cost of a particular item of Unit Price Work amounts to 5% or more of the Contract price and the variation in the quantity of the particular item of Unit Price Work performed by Contractor differs by more than 15% from the estimated quantity of such item indicated in the Agreement; and

7.4.2 If there is no corresponding adjustment with respect to any other item of Work; and

7.4.3 If a Contractor believes that it has incurred additional expense as a result thereof; or

7.4.4 If Owner believes that the quantity variation entitles it to an adjustment in the unit price; or

7.4.5 If the parties are unable to agree as to the effect of any such variations in the quantity of Unit Price Work performed.

ARTICLE 8. CHANGE OF CONTRACT TIME

8.1 Contract time may only be changed by a change order or a written amendment. Any claim for an extension or shortening of the Contract time shall be based on written notice delivered by the party making the claim to the other party. Notice of the extent of the claim with supporting data shall be delivered within fifteen (15) days from detection or beginning of such occurrence and shall be accompanied by the claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant has reason to believe it is entitled as a result of the occurrence of said event.

8.2 The Contract time will be extended in an amount equal to time lost due to delays beyond the control of Contractor. Such delays shall include, but not be limited to, acts or neglect by Owner or others performing additional Work; or to fires, floods, epidemics, abnormal weather conditions or acts of God.

8.3 All time limits stated in the Contract documents are of the essence.

ARTICLE 9. WARRANTY, TEST/INSPECTION, CORRECTION

9.1 Contractor warrants (for a minimum period of three (3) years or as otherwise stated herein) and guarantees to Owner that all Work will be in accordance with the Contract documents and will not be defective; that Owner, representatives of Owner, governmental agencies with jurisdictional interests will have access to the Work at reasonable time for their observation, inspecting and testing (Contractor shall give Engineer timely notice of readiness of the Work for all required approvals and shall assume full responsibility, including costs, in obtaining required tests, inspections, and approval certifications and/or acceptance, unless otherwise stated by Owner).

9.2 If any Work (including work of others) that is to be inspected, tested, or approved is covered without written concurrence of Engineer, it must, if requested by Engineer, be uncovered for observation. Such uncovering shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice. Neither observations by Engineer nor inspections, tests, or approvals by others shall relieve Contractor from Contractor's obligations to perform the Work in accordance with the Contract documents.

9.3 If the Work is defective, or Contractor fails to supply sufficient skilled workers, or suitable materials or equipment, or fails to furnish or perform the Work in such a way that the completed Work will conform to the Contract documents, Owner may order Contractor to stop the Work, or any portion thereof and terminate payments to the Contractor until the cause for such order has been eliminated. Contractor shall bear all direct, indirect and consequential costs for satisfactory reconstruction or removal and replacement with non-defective Work, including, but not limited to fees and charges of engineers, architects, attorneys and other professionals and any additional expenses experienced by Owner due to delays to other Contractors performing additional Work and an appropriate deductive change order shall be issued. Contractor shall further bear the responsibility for maintaining schedule and shall not be entitled to an extension of the Contract time and the recovery of delay damages due to correcting or removing defective Work.

9.3.1 If Contractor fails within seven (7) days after written notice to correct defective Work, or fails to perform the Work in accordance with the Contract documents, or fails to comply with any other provision of the Contract documents, Owner may correct and remedy any such deficiency to the extent necessary to complete corrective and remedial action. Owner may exclude Contractor from all or part of the site, take possession of all or part of the Work, Contractor's tools, construction equipment and machinery at the site or for which Owner has paid Contractor but which are stored elsewhere. All direct and indirect costs of Owner in exercising such rights and remedies will be charged against Contractor in an amount approved as to reasonableness by Engineer and a change order will be issued incorporating the necessary revisions.

9.3.2 If within three (3) years after the date of completion or such longer period of time as may be prescribed by laws or regulations or by the terms of any applicable special guarantee required by the Contract documents, any Work is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner’s written instructions, either correct such defective Work or if it has been rejected by Owner, remove it from the site and replace it with non-defective Work. If Contractor does not promptly comply with the terms of such instruction, Owner may have the defective Work corrected/removed and all direct, indirect and consequential costs of such removal and replacement will be paid by Contractor.

ARTICLE 10. SUSPENSION/TERMINATION OF WORK

10.1 Owner may, at any time and without cause, suspend the Work or any portion thereof for a period of not more than ninety (90) days by written notice to Contractor, which will fix the date on which Work will be resumed. Contractor shall be allowed an increase in the Contract price or an extension of the Contract

time, or both, directly attributable to any suspension if Contractor makes an approved claim therefore.

10.2 Owner may terminate the Contract if Contractor commences a voluntary case under any chapter of the Bankruptcy Code or any similar action by filing a petition under any other federal or state law relating to the bankruptcy or insolvency; if a petition is filed against the Contractor under any chapter of the Bankruptcy Code or similar relief under any other federal or state law; if Contractor persistently fails to perform the Work in accordance with the Contract documents; if Contractor disregards laws or regulations of any public body having jurisdiction or the Engineer; or otherwise violates in any substantial way any provisions of the Contract.

10.2.1 Owner may, after giving Contractor (and the Surety, if there is one) seven (7) days written notice and to the extent permitted by laws and regulations, terminate the services of Contractor; exclude Contractor from the site and take possession of the Work and of all Contractor's tools, construction equipment and machinery at the site and use the same to the full extent they could be used (without liability to Contractor for trespass or conversion); incorporate in the Work all materials and equipment stored at the site or for which Owner has paid Contractor but which are stored elsewhere, and finish the Work as Owner may deem expedient. In such case, Contractor shall not be entitled to receive any further payment beyond an amount equal to the value of material and equipment not incorporated in the Work, but delivered and suitably stored, less the aggregate of payments previously made. If the direct and indirect costs of completing the Work exceed the unpaid balance of the Contract price, Contractor shall pay the difference to Owner. Such costs incurred by Owner shall be verified by Owner and incorporated in a change order; but in finishing the Work, Owner shall not be required to obtain the lowest figure for the Work performed. Contractor's obligations to pay the difference between such costs and such unpaid balance shall survive termination of the Agreement.

10.3 If, through no act or fault of Contractor, the Work is suspended for a period of more than ninety (90) days by Owner or under an order of court or other public authority, or Engineer fails to act on any application or fails to pay Contractor any sum finally determined to be due; then Contractor may, upon seven (7) days written notice to Owner terminate the Agreement and recover from Owner payment for all Work executed, any expense sustained plus reasonable termination expenses. In lieu of terminating the Agreement, if Engineer has failed to act on any application of payment or Owner has failed to make any payment as aforesaid, Contractor may upon seven (7) days written notice to Owner stop the Work until payment of all amounts then due.

ARTICLE 11. CONTRACT CLAIMS

11.1 The rendering of a decision by Engineer with respect to any such claim, dispute or other matter (except any which have been waived by the making or acceptance of final payment) will be a condition precedent to any exercise by Owner or Contractor of such right or remedies as either may otherwise have under the Contract documents or by laws or regulations in respect of any such claim, dispute or other matter. No action, either at law or at equity, shall be brought in connection with any such claim, dispute or other matter later than thirty (30) days after the date on which Owner/Engineer has rendered such written decision in respect thereof. Failure to bring an action within said thirty (30) day period shall result in Engineer's decision being final and binding on the Contractor. In no event may any such action be brought after the time at which instituting such proceedings would be otherwise barred by the applicable statute of limitations.

11.2 Before bringing any action in court pertaining to any claim, dispute or other matter in question(s) arising out of or relating to the Contract documents or the breach thereof, or Engineer's final decision, except for claims which have been waived by the making and acceptance of final payment, the Contractor shall first submit written notice(s) of Contract claims to the Purchasing Official for a decision; within the earlier of sixty (60) days after the last date on which the Contractor provided any goods or services required by the Contract or after the date on which the Contractor knew or should have known such a claim existed. The Manatee County Code of Laws, Section 2-26-63, Contract Claims, details the requirements and process for such a claim.

ARTICLE 12. RESIDENT PROJECT REPRESENTATIVE - DUTIES, RESPONSIBILITIES

12.1 Resident Project Representative is Engineer/Owner's Agent, who will act as directed by and under the supervision of the Engineer, and who will confer with Owner/Engineer regarding his actions. Resident Project Representative's dealing in matters pertaining to the on-site Work shall, in general, be only with the Owner/Engineer and Contractor and dealings with Subcontractors shall only be through or with the full knowledge of Contractor.

12.2 Resident Project Representative will:

12.2.1 Review the progress schedule, schedule of shop drawing submissions and schedule of values prepared by Contractor and consult with Owner/Engineer concerning their acceptability.

12.2.2 Attend preconstruction conferences. Arrange a schedule of progress meetings and other job conferences as required in consultation with Owner/Engineer and notify those expected to attend in advance. Attend meetings and maintain and circulate copies of minutes thereof.

12.2.3 Serve as Owner/Engineer's liaison with Contractor, working principally through Contractor's superintendent and assist him in understanding the intent of the Contract documents. As requested by Owner/Engineer, assist in obtaining additional details or information when required at the job site for proper execution of the Work.

12.2.4 Receive and record date of receipt of shop drawings and samples, receive samples which are furnished at the site by Contractor and notify Owner/Engineer of their availability for examination.

12.2.5 Advise Owner/Engineer and Contractor or his superintendent immediately of the commencement of any Work requiring a shop drawing or sample submission if the submission has not been approved by the Owner/Engineer.

12.2.6 Conduct on-site observations of the Work in progress to assist Owner/Engineer in determining if the Work is proceeding in accordance with the Contract documents and that completed Work will conform to the Contract documents.

12.2.7 Report to Owner/Engineer whenever he believes that any Work is unsatisfactory, faulty or defective or does not conform to the Contract documents, or does not meet the requirements of any inspections, tests or approvals required or if Work has been damaged prior to final payment; and advise Owner/Engineer when he believes Work should be corrected or rejected or should be uncovered of observation or requires special testing, inspection or approval.

12.2.8 Verify that tests, equipment and system start-ups and operating and maintenance instructions are conducted as required by the Contract documents and in the presence of the required personnel, and that Contractor maintains adequate records thereof; observe, record and report to Engineer appropriate details relative to the test procedures and start-ups.

12.2.9 Accompany visiting inspectors representing public or other agencies having jurisdiction over the project; record the outcome of these inspections and report to Owner/Engineer.

12.2.10 Transmit to Contractor, Owner/Engineer's clarifications and interpretations of the Contract documents.

12.2.11 Consider and evaluate Contractor's suggestions or modifications in drawings or Contract Documents and report them with recommendations to Owner/Engineer.

12.2.12 Maintain at the job site orderly files for correspondence, reports of job conferences, shop drawings and sample submissions, reproductions of original Contract documents including all addenda, change orders, field orders, additional drawings issued subsequent to the execution of the Contract, Owner/Engineer's clarifications and interpretations of the Contract documents, progress reports and other project related documents.

12.2.13 Keep a diary or log book, recording hours on the job site, weather conditions, data relative to questions of extras or deductions; list of visiting officials and representatives or manufacturers, fabricators, suppliers and distributors; daily activities, decisions, observations in general and specific observations in more detail as in the case of observing test procedures. Send copies to Owner/Engineer.

12.2.14 Record names, addresses and telephone numbers of all Contractors, Subcontractors and major Suppliers of materials and equipment.

12.2.15 Furnish Owner/Engineer periodic reports as required of progress of the Work and Contractor's compliance with the approved progress schedule and schedule of shop drawing submissions.

12.2.16 Consult with Owner/Engineer in advance of scheduling major tests, inspections or start of important phases of the Work.

12.2.17 Report immediately the occurrence of any accident.

12.2.18 Review applications for payment with Contractor for compliance with the established procedure for their submission and forward them with recommendations to Owner/Engineer, noting particularly their relation to the Schedule of Values, Work completed and materials and equipment delivered at the site but not incorporated in the Work.

12.2.19 During the course of the Work, verify that certificates, maintenance and operations manuals and other data required to be assembled and furnished by Contractor are applicable to the items actually installed, and deliver this material to Owner/Engineer for his review prior to final acceptance of the Work.

12.2.20 Before Owner/Engineer issues a Certificate of Substantial Completion, submit to Contractor a list of observed items requiring completion or correction.

12.2.21 Conduct final inspection in the company of Owner/Engineer and Contractor and prepare a final list of items to be completed or corrected.

12.2.22 Verify that all items on final list have been completed or corrected and make recommendations to Owner/Engineer concerning acceptance.

12.3 Except upon written instructions of Owner/Engineer, Resident Project Representative:

12.3.1 Shall not authorize any deviation from the Contract documents or approve any substitute materials or equipment;

12.3.2 Shall not exceed limitations on Owner/Engineer's authority as set forth in the Contract documents;

12.3.3 Shall not undertake any of the responsibilities of Contractor, Subcontractors or Contractor's superintendent, or expedite the Work;

12.3.4 Shall not advise on or issue directions relative to any aspect of the means, methods, techniques, sequences or procedures of construction unless such is specifically called for in the Contract documents;

12.3.5 Shall not advise on or issue directions as to safety precautions and programs in connection with the Work;

12.3.6 Shall not authorize Owner to occupy the project in whole or in part; and

12.3.7 Shall not participate in specialized field or laboratory tests.

ARTICLE 13. APPRENTICES

13.1 If successful Contractor employs apprentices, he shall be governed and comply with the provisions of F.S. § 446.011.

NOTE: The form of all submittals, notices, change orders and other documents permitted or required to be used or transmitted under the Contract shall be determined by the County. Standard County forms shall be utilized.

END OF SECTION

MAILING LABEL

Cut along the outside border and affix this label to your sealed Bid envelope to identify it as a “Sealed Bid”. Be sure to include the name of the company submitting the Bid and the Bid due date and time where requested.

MAILING LABEL TO AFFIX TO OUTSIDE OF SEALED BID PACKAGE:

SEALED BID - DO NOT OPEN

CONTRACTOR: _____

SEALED BID NO: 13-1542CD

BID TITLE: REHABILITATION OF HEADWORKS AND CLARIFIER 3 AND 4 AT THE SOUTHWEST WATER RECLAMATION FACILITY

DUE DATE/TIME: _____ @ _____

SECTION A: COMPLIANCE WITH FEDERAL LAWS

A.01 FEDERAL REQUIREMENTS FOR CONSTRUCTION PROJECTS

a) **Davis Bacon Act,** as amended (40 U.S.C. 267a to a-7) – **Contractor is required to comply with the Davis-Bacon Act** (40 U.S.C 276a to a-7) and as supplemented by Department of Labor regulations (29 CFR part 5, "Labor Standards Provisions Applicable to Contracts governing Federally Financed and Assisted Construction"). Under this Act, contractors shall be required to pay wages to laborers and mechanics at a rate not less than the minimum wages specified in a wage determination made by the Secretary of labor. In addition, contractors shall be required to pay wages not less than once a week. (*See Attachment A for Current Federal Wage Decision); and*

b) Contract Work Hours and Safety Standards Act (40 U.S.C. 327 through 333) Contractor is required to comply with Sections 103 and 107 of the Contract Work Hours Safety Standards Act (40 U.S.C. 327-333), as supplemented by Department of Labor regulations (29 CFR, Part 5). Under Section 102 of the Act, each contractor shall be required to compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than 1 ½ times the basic rate of pay for all hours worked in excess of 40 hours in the work week. Section 107 of the Act is applicable to construction work and provides that no laborer or mechanic shall be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous; and

c) Copeland "Anti-Kickback" Act (18 U.S.C. 874 and 40 U.S. 276c) Contractor is required to comply with the Copeland "Anti-Kickback" Act (18 USC 874), as supplemented by Department of Labor Regulations (29 CFR Part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States"). The Act provides that each contractor shall be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation to which he is otherwise entitled.

A.02 **LABOR STANDARDS (PROJECTS OVER $2,000)**

The following Federal Labor Standards provisions are in effect and must be complied with by all contractors and Sub-Contractors. As before mentioned it is mandatory that these legislative acts are complied with. Specific reporting requirements include, but shall not be limited to the following:

a) Federal Wage Decision for Manatee County in Florida. Per the Davis-Bacon Act, these are applicable prevailing federal wage rates for this project. There are no State prevailing wage rates. These wage rates will be compared against those posted by the U.S. Department of Labor. In the event the Federal Wage Decision has been updated, proposers will be notified in writing in accordance with the current *Federal Wage Decision (Ref. Attachment A); and*

b) United States Department of Labor, Payroll Form WH-347 (OMB Approval No. 1215-0149) with accompanying Statement of Compliance. Per the Davis-Bacon Act and the Copeland Act, the awarded contractor and its subcontractor's are required to submit weekly payrolls, being accompanied by the Statement of Compliance, bearing an original signature. (*See Attachment B for the current Payroll Form WH-347 with the accompanying Statement of Compliance*

ATTACHMENT A
Federal Prevailing Wage Decisions

FEDERAL PREVAILING WAGE

General Wage Decision Number: FL130165 03/08/2013 FL165
Superseded General Decision Number: FL20120165
State: Florida
Construction Type: Heavy
County: Manatee County in Florida
Publication Date: 03/08/2013 – Modification Number 1

(SEE ATTACHED)

General Decision Number: FL130165 03/08/2013 FL165

Superseded General Decision Number: FL20120165

State: Florida

Construction Type: Heavy

County: Manatee County in Florida.

HEAVY CONSTRUCTION PROJECTS (Including Sewer and Water Lines)

Modification Number	Publication Date
0	01/04/2013
1	03/08/2013

* ELEC0915-003 12/01/2012

	Rates	Fringes
ELECTRICIAN	$ 25.13	34%+$0.25

ENGI0925-008 01/01/2012

	Rates	Fringes
POWER EQUIPMENT OPERATOR:		
Crawler Cranes; Truck Cranes; Pile Driver Cranes; Rough Terrain Cranes; and Any Crane not otherwise described below	$ 28.91	10.74
Hydraulic Cranes Rated 100 Tons or Above but Less Than 250 Tons; and Lattice Boom Cranes Less Than 150 Tons if not described below.	$ 29.91	10.74
Lattice Boom Cranes Rated at 150 Tons or Above; Friction Cranes of Any Size; Mobile Tower Cranes or Luffing Boom Cranes of Any Size; Electric Tower Cranes; Hydraulic Cranes Rated at 250 Tons or Above; and Any Crane Equipped with 300 Foot or More of Any Boom Combination	$ 30.91	10.74
Oiler	$ 22.38	10.74

IRON0397-006 07/01/2012

	Rates	Fringes
IRONWORKER, STRUCTURAL	$ 27.67	12.59

LABO0517-002 05/01/2008

	Rates	Fringes
LABORER: Grade Checker	$ 17.20	5.47

PAIN0088-008 07/01/2008

	Rates	Fringes
PAINTER: Brush, Roller and Spray	$ 16.00	6.85

SUFL2009-161 06/24/2009

	Rates	Fringes
CARPENTER	$ 14.95	2.92
CEMENT MASON/CONCRETE FINISHER	$ 14.77	3.50
LABORER: Common or General	$ 10.90	0.38
LABORER: Landscape	$ 7.25	0.00
LABORER: Pipelayer	$ 13.75	2.06
LABORER: Power Tool Operator (Hand Held Drills/Saws, Jackhammer and Power Saws Only)	$ 10.63	2.20
OPERATOR: Asphalt Paver	$ 11.59	0.00
OPERATOR: Backhoe Loader Combo	$ 16.10	2.44
OPERATOR: Backhoe/Excavator	$ 15.00	0.52
OPERATOR: Bulldozer	$ 17.00	0.00
OPERATOR: Grader/Blade	$ 16.00	2.84
OPERATOR: Loader	$ 14.75	0.00
OPERATOR: Mechanic	$ 14.32	0.00
OPERATOR: Roller	$ 10.76	0.00
OPERATOR: Scraper	$ 11.00	1.74
OPERATOR: Trackhoe	$ 20.92	5.50
OPERATOR: Tractor	$ 10.54	0.00
TRUCK DRIVER, Includes Dump Truck	$ 11.00	0.00

TRUCK DRIVER: Lowboy Truck.....$ 12.73 0.00

TRUCK DRIVER: Off the Road
Truck.....$ 12.21 1.97

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

==========

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is union or non-union.

Union Identifiers

An identifier enclosed in dotted lines beginning with characters other than "SU" denotes that the union classification and rate have found to be prevailing for that classification. Example: PLUM0198-005 07/01/2011. The first four letters , PLUM, indicate the international union and the four-digit number, 0198, that follows indicates the local union number or district council number where applicable , i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2011, following these characters is the effective date of the most current negotiated rate/collective bargaining agreement which would be July 1, 2011 in the above example.

Union prevailing wage rates will be updated to reflect any changes in the collective bargaining agreements governing the rates.

0000/9999: weighted union wage rates will be published annually each January.

Non-Union Identifiers

Classifications listed under an "SU" identifier were derived from survey data by computing average rates and are not union rates; however, the data used in computing these rates may include both union and non-union data. Example: SULA2004-007 5/13/2010. SU indicates the rates are not union majority rates, LA indicates the State of Louisiana; 2004 is the year of the survey; and 007 is an internal number used in producing the wage determination. A 1993 or later date, 5/13/2010, indicates the classifications and rates under that identifier were issued as a General Wage Determination on that date.

Survey wage rates will remain in effect and will not change until a new survey is conducted.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the

interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

==========

END OF GENERAL DECISION

ATTACHMENT B
Payroll Form WH-347

U.S. Department of Labor
Wage and Hour Division

PAYROLL

(For Contractor's Optional Use; See Instructions at www.dol.gov/whd/forms/wh347instr.htm)

Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number.

U.S. Wage and Hour Division

Rev. Dec. 2008

NAME OF CONTRACTOR ☐ OR SUBCONTRACTOR ☐ | ADDRESS | OMB No.: 1235-0008 Expires: 01/31/2015

PAYROLL NO. | FOR WEEK ENDING | PROJECT AND LOCATION | PROJECT OR CONTRACT NO.

(1) NAME AND INDIVIDUAL IDENTIFYING NUMBER (e.g., LAST FOUR DIGITS OF SOCIAL SECURITY NUMBER) OF WORKER	(2) NO. OF WITHHOLDING EXEMPTIONS	(3) WORK CLASSIFICATION	OT. OR ST.	(4) DAY AND DATE — HOURS WORKED EACH DAY	(5) TOTAL HOURS	(6) RATE OF PAY	(7) GROSS AMOUNT EARNED	(8) DEDUCTIONS — FICA	WITH-HOLDING TAX			OTHER	TOTAL DEDUCTIONS	(9) NET WAGES PAID FOR WEEK
			O											
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While completion of Form WH-347 is optional, it is mandatory for covered contractors and subcontractors performing work on Federally financed or assisted construction contracts to respond to the information collection contained in 29 C.F.R. §§ 3.3, 5.5(a). The Copeland Act (40 U.S.C. § 3145) contractors and subcontractors performing work on Federally financed or assisted construction contracts to "furnish weekly a statement with respect to the wages paid each employee during the preceding week." U.S. Department of Labor (DOL) regulations at 29 C.F.R. § 5.5(a)(3)(ii) require contractors to submit weekly a copy of all payrolls to the Federal agency contracting for or financing the construction project, accompanied by a signed "Statement of Compliance" indicating that the payrolls are correct and complete and that each laborer or mechanic has been paid not less than the proper Davis-Bacon prevailing wage rate for the work performed. DOL and federal contracting agencies receiving this information review the information to determine that employees have received legally required wages and fringe benefits.

Public Burden Statement

We estimate that is will take an average of 55 minutes to complete this collection, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. If you have any comments regarding these estimates or any other aspect of this collection, including suggestions for reducing this burden, send them to the Administrator, Wage and Hour Division, U.S. Department of Labor, Room S3502, 200 Constitution Avenue, N.W. Washington, D.C. 20210

(over)

Date _____

I, _____ _____
(Name of Signatory Party) (Title)

do hereby state:

(1) That I pay or supervise the payment of the persons employed by

_____ on the
(Contractor or Subcontractor)

_____; that during the payroll period commencing on the
(Building or Work)

_____ day of _____, _____, and ending the _____ day of _____, _____,

all persons employed on said project have been paid the full weekly wages earned, that no rebates have been or will be made either directly or indirectly to or on behalf of said

_____ from the full
(Contractor or Subcontractor)

weekly wages earned by any person and that no deductions have been made either directly or indirectly from the full wages earned by any person, other than permissible deductions as defined in Regulations, Part 3 (29 C.F.R. Subtitle A), issued by the Secretary of Labor under the Copeland Act, as amended (48 Stat. 948, 63 Start. 108, 72 Stat. 967; 76 Stat. 357; 40 U.S.C. § 3145), and described below:

_____

_____

_____

_____

(2) That any payrolls otherwise under this contract required to be submitted for the above period are correct and complete; that the wage rates for laborers or mechanics contained therein are not less than the applicable wage rates contained in any wage determination incorporated into the contract; that the classifications set forth therein for each laborer or mechanic conform with the work he performed.

(3) That any apprentices employed in the above period are duly registered in a bona fide apprenticeship program registered with a State apprenticeship agency recognized by the Bureau of Apprenticeship and Training, United States Department of Labor, or if no such recognized agency exists in a State, are registered with the Bureau of Apprenticeship and Training, United States Department of Labor.

(4) That:

(a) WHERE FRINGE BENEFITS ARE PAID TO APPROVED PLANS, FUNDS, OR PROGRAMS

☐ – in addition to the basic hourly wage rates paid to each laborer or mechanic listed in the above referenced payroll, payments of fringe benefits as listed in the contract have been or will be made to appropriate programs for the benefit of such employees, except as noted in section 4(c) below.

(b) WHERE FRINGE BENEFITS ARE PAID IN CASH

☐ – Each laborer or mechanic listed in the above referenced payroll has been paid, as indicated on the payroll, an amount not less than the sum of the applicable basic hourly wage rate plus the amount of the required fringe benefits as listed in the contract, except as noted in section 4(c) below.

(c) EXCEPTIONS

EXCEPTION (CRAFT)	EXPLANATION

REMARKS:

NAME AND TITLE	SIGNATURE

THE WILLFUL FALSIFICATION OF ANY OF THE ABOVE STATEMENTS MAY SUBJECT THE CONTRACTOR OR SUBCONTRACTOR TO CIVIL OR CRIMINAL PROSECUTION. SEE SECTION 1001 OF TITLE 18 AND SECTION 231 OF TITLE 31 OF THE UNITED STATES CODE.

MANATEE COUNTY
SOUTHWEST WATER RECLAMATION FACILITY
HEADWORKS REHABILITATION
MANATEE COUNTY PROJECT # 6036084

Technical Specifications

Prepared For:

MANATEE COUNTY

PUBLIC WORKS DEPARTMENT

March 2013

Prepared By:

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MANATEE COUNTY
SOUTHWEST WATER RECLAMATION FACILITY
FACILITY HEADWORKS REHABILITATION
MANATEE COUNTY PROJECT # 6036084

TABLE OF CONTENTS

DIVISION 1 – GENERAL REQUIREMENTS

DIVISION 2 – SITE WORK

DIVISION 3 – CONCRETE

SECTION 01005

GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE AND INTENT

A. Description
   1. The work to be done consists of the furnishing of all labor, materials and equipment, and the performance of all work included in this Contract.

B. Work Included
   1. The Contractor shall furnish all labor, superintendence, materials, plant, power, light, heat, fuel, water, tools, appliances, equipment, supplies, shop drawings, working drawings and other means of construction necessary or proper for performing and completing the work. He shall obtain and pay for all required permits necessary for the work, other than those permits such as FDEP permits. He shall perform and complete the work in the manner best calculated to promote rapid construction consistent with safety of life and property and to the satisfaction of the Engineer, and in strict accordance with the Contract Documents. The Contractor shall clean up the work and maintain it during and after construction, until accepted, and shall do all work and pay all costs incidental thereto. He shall repair or restore all structures and property that may be damaged or disturbed during performance of the work.
   2. The cost of incidental work described in these General Requirements, for which there are no specific Contract Items, shall be considered as part of the general cost of doing the work and shall be included in the prices for the various Contract Items. No additional payment will be made therefore.
   3. The Contractor shall provide and maintain such modern plant, tools, and equipment as may be necessary, in the opinion of the Engineer, to perform in a satisfactory and acceptable manner all the work required by this Contract. Only equipment of established reputation and proven efficiency shall be used. The Contractor shall be solely responsible for the adequacy of his workmanship, materials and equipment, prior approval of the Engineer notwithstanding.

C. Public Utility Installations and Structures
   1. Public utility installations and structures shall be understood to include all poles, tracks, pipes, wires, conduits, house service connections, vaults, manholes and all other appurtenances and facilities pertaining thereto whether owned or controlled by the Owner, other governmental bodies or privately owned by individuals, firms or corporations, used to serve the public with transportation, traffic control, gas, electricity, telephone, sewage, drainage, water or other public or private property which may be affected by the work shall be deemed included hereunder.
   2. The Contractor shall protect all public utility installations and structures from damage during the work. Access across any buried public utility installation or structure shall be made only in such locations and by means approved by the Engineer. The Contractor shall so arrange his operations as to avoid any damage to these facilities. All required protective devices and construction shall be provided by the Contractor at his expense. All existing public utilities

damaged by the Contractor which are shown on the Plans or have been located in the field by the utility shall be repaired by the Contractor, at his expense, as approved by the Engineer. No separate payment shall be made for such protection or repairs to public utility installations or structures.

3. Public utility installations or structures owned or controlled by the Owner or other governmental body, which are required by this contract to be removed, relocated, replaced or rebuilt by the Contractor not identified in any separate bid item shall be considered as a part of the general cost of doing the work and shall be included in the prices bid for the various contract items. No separate payment shall be made therefore.
4. Where public utility installations or structures owned or controlled by the Owner or other governmental body are encountered during the course of the work, and are not indicated on the Plans or in the Specifications, and when, in the opinion of the Engineer, removal, relocation, replacement or rebuilding is necessary to complete the work under this Contract, such work shall be accomplished by the utility having jurisdiction, or such work may be ordered, in writing by the Engineer, for the contractor to accomplish. If such work is accomplished by the utility having jurisdiction, it will be carried out expeditiously and the Contractor shall give full cooperation to permit the utility to complete the removal, relocation, replacement or rebuilding as required. If such work is accomplished by the Contractor, it will be in accordance with the General and Supplemental General Conditions.
5. The Contractor shall give written notice to Owner and other governmental utility departments and other owners of public utilities of the location of his proposed construction operations, at least forty-eight hours in advance of breaking ground in any area or on any unit of the work. This can be accomplished by making the appropriate contact with the Sunshine State One-Call of Florida, Inc. Call Center ("Call Sunshine") and per all requirements provided for in the Florida Underground Facilities Damage Prevention and Safety Act (Florida Statutes, Title XXXIII, Chapter 556).
6. The maintenance, repair, removal, relocation or rebuilding of public utility installations and structures, when accomplished by the Contractor as herein provided, shall be done by methods approved by the Engineer.

1.02 PLANS AND SPECIFICATIONS

A. Plans
   1. When obtaining data and information from the Plans, figures shall be used in preference to scaled dimensions, and large scale drawings in preference to small scale drawings.

B. Copies Furnished to Contractor
   1. The Contractor shall furnish each of the subcontractors, manufacturers, and material men such copies of the Contract Documents as may be required for their work. Additional copies of the Plans and Specifications, when requested, may be furnished to the Contractor at cost of reproduction.

C. Supplementary Drawings
   1. When, in the opinion of the Engineer, it becomes necessary to explain more fully the work to be done or to illustrate the work further or to show any changes which may be required, drawings known as Supplementary Drawings, with specifications pertaining thereto, will be prepared by the Engineer and five paper prints thereof will be given to the Contractor.

D. Contractor to Check Plans and Data
   1. The Contractor shall verify all dimensions, quantities and details shown on the Plans, Supplementary Drawings, Schedules, Specifications or other data received from the Engineer, and shall notify him of all errors, omissions, conflicts, and discrepancies found therein. Failure to discover or correct errors, conflicts or discrepancies shall not relieve the Contractor of full responsibility for unsatisfactory work, faulty construction or improper operation resulting there from nor from rectifying such conditions at his own expense. He will not be allowed to take advantage of any errors or omissions, as full instructions will be furnished by the Engineer, should such errors or omissions be discovered. All schedules are given for the convenience of the Engineer and the Contractor and are not guaranteed to be complete. The Contractor shall assume all responsibility for the making of estimates of the size, kind, and quality of materials and equipment included in work to be done under the Contract.

E. Specifications
   1. The Technical Specifications consist of three parts: General, Products and Execution. The General Section contains General Requirements which govern the work. Products and Execution modify and supplement these by detailed requirements for the work and shall always govern whenever there appears to be a conflict.

F. Intent
   1. All work called for in the Specifications applicable to this Contract, but not shown on the Plans in their present form, or vice versa, shall be of like effect as if shown or mentioned in both. Work not specified in either the Plans or in the Specifications, but involved in carrying out their intent or in the complete and proper execution of the work, is required and shall be performed by the Contractor as though it were specifically delineated or described.
   2. The apparent silence of the Specifications as to any detail, or the apparent omission from them of a detailed description concerning any work to be done and materials to be furnished, shall be regarded as meaning that only the best general practice is to prevail and that only material and workmanship of the best quality is to be used, and interpretation of these Specifications shall be made upon that basis.
   3. The inclusion of the Related Requirements (or work specified elsewhere) in the General part of the specifications is only for the convenience of the Contractor, and shall not be interpreted as a complete list of related Specification Sections.

1.03 MATERIALS AND EQUIPMENT

A. Manufacturer
   1. The names of proposed manufacturers, material men, suppliers and dealers who are to furnish materials, fixtures, equipment, appliances or other fittings shall be submitted to the Engineer for approval. Such approval must be obtained before shop drawings will be checked. No manufacturer will be approved for any materials to be furnished under this Contract unless he shall be of good reputation and have a plant of ample capacity. He shall, upon the request of the Engineer, be required to submit evidence that he has manufactured a similar product to the one specified and that it has been previously used for a like purpose for a sufficient length of time to demonstrate its satisfactory performance.

2. All transactions with the manufacturers or subcontractors shall be through the Contractor, unless the Contractor shall request, in writing to the Engineer, that the manufacturer or subcontractor deal directly with the Engineer. Any such transactions shall not in any way release the Contractor from his full responsibility under this Contract.
3. Any two or more pieces or material or equipment of the same kind, type or classification, and being used for identical types of services, shall be made by the same manufacturer.

B. Delivery
1. The Contractor shall deliver materials in ample quantities to insure the most speedy and uninterrupted progress of the work so as to complete the work within the allotted time. The Contractor shall also coordinate deliveries in order to avoid delay in, or impediment of, the progress of the work of any related Contractor.

C. Tools and Accessories
1. The Contractor shall, unless otherwise stated in the Contract Documents, furnish with each type, kind or size of equipment, one complete set of suitably marked high grade special tools and appliances which may be needed to adjust, operate, maintain or repair the equipment. Such tools and appliances shall be furnished in approved painted steel cases, properly labeled and equipped with good grade cylinder locks and duplicate keys.
2. Spare parts shall be furnished as specified.
3. Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, weight and principal rating data.

D. Installation of Equipment.
1. The Contractor shall have on hand sufficient proper equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character.
2. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Plans, unless directed otherwise by the Engineer during installation. All equipment shall be correctly aligned, leveled and adjusted for satisfactory operation and shall be installed so that proper and necessary connections can be made readily between the various units.
3. The Contractor shall furnish, install and protect all necessary anchor and attachment bolts and all other appurtenances needed for the installation of the devices included in the equipment specified. Anchor bolts shall be as approved by the Engineer and made of ample size and strength for the purpose intended. Substantial templates and working drawings for installation shall be furnished.
4. The Contractor shall, at his own expense, furnish all materials and labor for, and shall properly bed in non-shrink grout, each piece of equipment on its supporting base that rests on masonry foundations.
5. Grout shall completely fill the space between the equipment base and the foundation. All metal surfaces coming in contact with concrete or grout shall receive a coat of coal tar epoxy equal to Koppers 300M.

E. Service of Manufacturer's Engineer

1. The Contract prices for equipment shall include the cost of furnishing (as required by equipment specifications sections) a competent and experienced engineer or superintendent who shall represent the manufacturer and shall assist the Contractor, when required, to install, adjust, test and place in operation the equipment in conformity with the Contract Documents. After the equipment is placed in permanent operation by the Owner, such engineer or superintendent shall make all adjustments and tests required by the Engineer to prove that such equipment is in proper and satisfactory operating condition, and shall instruct such personnel as may be designated by the Owner in the proper operation and maintenance of such equipment.

1.04 INSPECTION AND TESTING

A. General
   1. Inspection and testing of materials will be performed by the Owner unless otherwise specified.
   2. For tests specified to be made by the Contractor, the testing personnel shall make the necessary inspections and tests and the reports thereof shall be in such form as will facilitate checking to determine compliance with the Contract Documents. Three (3) copies of the reports shall be submitted and authoritative certification thereof must be furnished to the Engineer as a prerequisite for the acceptance of any material or equipment.
   3. If, in the making of any test of any material or equipment, it is ascertained by the Engineer that the material or equipment does not comply with the Contract, the Contractor will be notified thereof and he will be directed to refrain from delivering said material or equipment, or to remove it promptly from the site or from the work and replace it with acceptable material, without cost to the Owner.
   4. Tests of electrical and mechanical equipment and appliances shall be conducted in accordance with recognized test codes of the ANSI, ASME, or the IEEE, except as may otherwise be stated herein.
   5. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

B. Costs
   1. All inspection and testing of materials furnished under this Contract will be performed by the Owner or duly authorized inspection engineers or inspections bureaus without cost to the Contractor, unless otherwise expressly specified.
   2. The cost of shop and field tests of equipment and of certain other tests specifically called for in the Contract Documents shall be borne by the Contractor and such costs shall be deemed to be included in the Contract price.
   3. Materials and equipment submitted by the Contractor as the equivalent to those specifically named in the Contract may be tested by the Owner for compliance. The Contractor shall reimburse the Owner for the expenditures incurred in making such tests on materials and equipment which are rejected for non-compliance.

C. Inspections of Materials
   1. The Contractor shall give notice in writing to the Engineer, at least two weeks in advance of his intention to commence the manufacture or preparation of

materials especially manufactured or prepared for use in or as part of the permanent construction. Such notice shall contain a request for inspection, the date of commencement and the expected date of completion of the manufacture of preparation of materials. Upon receipt of such notice, the Engineer will arrange to have a representative present at such times during the manufacture as may be necessary to inspect the materials or he will notify the Contractor that the inspection will be made at a point other than the point of manufacture, or he will notify the Contractor that inspection will be waived. The Contractor must comply with these provisions before shipping any material. Such inspection shall not release the Contractor from the responsibility for furnishing materials meeting the requirements of the Contract Documents.

D. Certificate of Manufacture
   1. When inspection is waived or when the Engineer so requires, the Contractor shall furnish to him authoritative evidence in the form of Certificates of Manufacture that the materials to be used in the work have been manufactured and tested in conformity with the Contract Documents. These certificates shall be notarized and shall include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

E. Shop Tests of Operating Equipment
   1. Each piece of equipment for which pressure, duty, capacity, rating, efficiency, performance, function or special requirements are specified shall be tested in the shop of the maker in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents. No such equipment shall be shipped to the work until the Engineer notifies the Contractor, in writing, that the results of such tests are acceptable.
   2. Five copies of the manufacturer's actual test data and interpreted results thereof, accompanied by a certificate of authenticity sworn to by a responsible official of the manufacturing company, shall be forwarded to the Engineer for approval.
   3. The cost of shop tests and of furnishing manufacturer's preliminary and shop test data of operating equipment shall be borne by the Contractor.

F. Preliminary Field Tests
   1. As soon as conditions permit, the Contractor shall furnish all labor, materials, and instruments and shall make preliminary field tests of equipment. If the preliminary field tests disclose any equipment furnished under this Contract which does not comply with the requirements of the Contract Documents, the Contractor shall, prior to the acceptance tests, make all changes, adjustments and replacements required. The furnishing Contractor shall assist in the preliminary field tests as applicable.

G. Final Field Tests
   1. Upon completion of the work and prior to final payment, all equipment and piping installed under this Contract shall be subjected to acceptance tests as specified or required to prove compliance with the Contract Documents.

   2. The Contractor shall furnish labor, fuel, energy, water and all other materials, equipment and instruments necessary for all acceptance tests, at no additional cost to the Owner. The Supplier shall assist in the final field tests as applicable.

H. Failure of Tests
   1. Any defects in the materials and equipment or their failure to meet the tests, guarantees or requirements of the Contract Documents shall be promptly corrected by the Contractor. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the Contract shall be final and conclusive. If the Contractor fails to make these corrections or if the improved materials and equipment, when tested, shall again fail to meet the guarantees of specified requirements, the Owner, notwithstanding its partial payment for work, and materials and equipment, may reject the materials and equipment and may order the Contractor to remove them from the site at his own expense.
   2. In case the Owner rejects any materials and equipment, then the Contractor shall replace the rejected materials and equipment within a reasonable time. If he fails to do so, the Owner may, after the expiration of a period of thirty (30) calendar days after giving him notice in writing, proceed to replace such rejected materials and equipment, and the cost thereof shall be deducted from any compensation due or which may become due the Contractor under his Contract.

I. Final Inspection
   1. During such final inspections, the work shall be clean and free from water. In no case will the final pay application be prepared until the Contractor has complied with all requirements set forth and the Engineer has made his final inspection of the entire work and is satisfied that the entire work is properly and satisfactorily constructed in accordance with the requirements of the Contract Document.

1.05 TEMPORARY STRUCTURES

A. Temporary Fences
   1. If, during the course of the work, it is necessary to remove or disturb any fence or part thereof, the Contractor shall, at his own expense, if so ordered by the Engineer, provide a suitable temporary fence which shall be maintained until the permanent fence is replaced. The Engineer shall be solely responsible for the determination of the necessity for providing a temporary fence and the type of temporary fence to be used.

1.06 TEMPORARY SERVICES

A. First Aid
   1. The Contractor shall keep upon the site, at each location where work is in progress, a completely equipped first aid kit and shall provide ready access thereto at all times when people are employed on the work.

1.07 LINES AND GRADES

A. Grade
   1. All work under this Contract shall be constructed in accordance with the lines and grades shown on the Plans, or as given by the Owner/Engineer. The full responsibility for keeping alignment and grade shall rest upon the Contractor.

B. Safeguarding Marks

1. The Contractor shall safeguard all points, stakes, grade marks, monuments and bench marks made or established on the work, bear the cost of reestablishing them if disturbed, and bear the entire expense of rectifying work improperly installed due to not maintaining or protecting or to removing without authorization such established points, stakes and marks.
2. The Contractor shall safeguard all existing and known property corners, monuments and marks adjacent to but not related to the work and, if required, shall bear the cost of reestablishing them if disturbed or destroyed.

C. Datum Plane
1. All elevations indicated or specified refer to the Mean Sea Level Datum of the NGVD 1929 Datum and/or NAVD 1988.

1.08 ADJACENT STRUCTURES AND LANDSCAPING

A. Responsibility
1. The Contractor shall also be entirely responsible and liable for all damage or injury as a result of his operations to all other adjacent public and private property, structures of any kind and appurtenances thereto met with during the progress of the work. The cost of protection, replacement in their original locations and conditions or payment of damages for injuries to such adjacent public and private property and structures affected by the work, whether or not shown on the Plans, and the removal, relocation and reconstruction of such items called for on the Plans or specified shall be included in the various Contract Items and no separate payments will be made therefore. Where such public and private property, structures of any kind and appurtenances thereto are not shown on the Plans and when, in the opinion of the Engineer, additional work is deemed necessary to avoid interference with the work, payment therefore will be made as provided for in the General Conditions.
2. Contractor is expressly advised that the protection of buildings, structures, tunnels, tanks, pipelines, etc. and related work adjacent and in the vicinity of his operations, wherever they may be, is solely his responsibility. Conditional inspection of buildings or structures in the immediate vicinity of the project which may reasonably be expected to be affected by the Work shall be performed by and be the responsibility of the Contractor.
3. Contractor shall, before starting operations, make an examination of the interior and exterior of the adjacent structures, buildings, facilities, etc., and record by notes, measurements, photographs, etc., conditions which might be aggravated by open excavation and construction. Repairs or replacement of all conditions disturbed by the construction shall be made to the satisfaction of the Owner and to the satisfaction of the Engineer. This does not preclude conforming to the requirements of the insurance underwriters. Copies of surveys, photographs, reports, etc., shall be given to the Engineer.
4. Prior to the beginning of any excavations, the Contractor shall advise the Engineer of all buildings or structures on which he intends to perform work or which performance of the project work will affect.

B. Protection of Trees
1. All trees and shrubs shall be adequately protected by the Contractor with boxes and otherwise and in accordance with ordinances governing the protection of trees. No excavated materials shall be placed so as to injure such trees or shrubs. Trees or shrubs destroyed by negligence of the Contractor or

his employees shall be replaced by him with new stock of similar size and age, at the proper season and at the sole expense of the Contractor.

2. Beneath trees or other surface structures, where possible, pipelines may be built in short tunnels, backfilled with excavated materials, except as otherwise specified, or the trees or structures carefully supported and protected from damage.
3. The Owner may order the Contractor, for the convenience of the Owner, to remove trees along the line or trench excavation. If so ordered, the Owner will obtain any permits required for removal of trees. Such tree removal ordered shall be paid for under the appropriate Contract Items.

C. Lawn Areas

1. Lawn areas shall be left in as good condition as before the starting of the work. Where sod is to be removed, it shall be carefully removed, and later replaced, or the area where sod has been removed shall be restored with new sod in the manner described in the Workmanship and Materials Paragraph in Section 02485, Seeding & Sodding.

D. Restoration of Fences

1. Any fence, or part thereof, that is damaged or removed during the course of the work shall be replaced or repaired by the Contractor and shall be left in as good a condition as before the starting of the work. The manner in which the fence is repaired or replaced and the materials used in such work shall be subject to the approval of the Engineer. The cost of all labor, materials, equipment, and work for the replacement or repair of any fence shall be deemed included in the appropriate Contract Item or items, or if no specific Item is provided therefore, as part of the overhead cost of the work, and no additional payment will be made therefore.

1.09 PROTECTION OF WORK AND PUBLIC

A. Barriers and Lights

1. During the prosecution of the work, the Contractor shall put up and maintain at all times such barriers and lights as will effectually prevent accidents. The Contractor shall provide suitable barricades, red lights, "danger" or "caution" or "street closed" signs and watchmen at all places where the work causes obstructions to the normal traffic or constitutes in any way a hazard to the public, in accordance with state and local requirements.

B. Smoke Prevention

1. A strict compliance with ordinances regulating the production and emission of smoke will be required. No open fires will be permitted.

C. Noise

1. The Contractor shall eliminate noise to as great an extent as practicable at all times. Air compressing plants shall be equipped with silencers and the exhaust of all engines or other power equipment shall be provided with mufflers. In the vicinity of hospitals and schools, special care shall be used to avoid noise or other nuisances. The Contractor shall strictly observe all local regulations and ordinances covering noise control.
2. Except in the event of an emergency, no work shall be done between the hours of 7:00 P.M. and 7:00 A.M., or on weekends. If the proper and efficient prosecution of the work requires operations during the night or weekends, the

written permission of the Owner shall be obtained before starting such items of the work.

D. Access to Public Services
   1. Neither the materials excavated nor the materials or plant used in the construction of the work shall be so placed as to prevent free access to all fire hydrants, valves or manholes.

E. Dust prevention
   1. The Contractor shall prevent dust nuisance from his operations or from traffic by keeping the roads and/or construction areas sprinkled with water at all times.

1.10 CUTTING AND PATCHING

A. The Contractor shall do all cutting, fitting or patching of his portion of the work that may be required to make the several parts thereof join and coordinate in a manner satisfactory to the Engineer and in accordance with the Plans and Specifications. The work must be done by competent workmen skilled in the trade required by the restoration.

1.11 CLEANING

A. During Construction
   1. During construction of the work, the Contractor shall, at all times, keep the site of the work and adjacent premises as free from material, debris and rubbish as is practicable and shall remove the same from any portion of the site if, in the opinion of the Engineer, such material, debris, or rubbish constitutes a nuisance or is objectionable.
   2. The Contractor shall remove from the site all of his surplus materials and temporary structures when no further need therefore develops.

B. Final Cleaning
   1. At the conclusion of the work, all equipment, tools, temporary structures and materials belonging to the Contractor shall be promptly taken away, and he shall remove and promptly dispose of all water, dirt, rubbish or any other foreign substances.
   2. The Contractor shall thoroughly clean all equipment and materials installed by him and shall deliver such materials and equipment undamaged in a bright, clean, polished and new operating condition.

1.12 MISCELLANEOUS

A. Protection Against Siltation and Bank Erosion
   1. The Contractor shall arrange his operations to minimize siltation and bank erosion on construction sites and on existing or proposed water courses and drainage ditches.
   2. The Contractor, at his own expense, shall remove any siltation deposits and correct any erosion problems as directed by the Engineer which results from his construction operations.

B. Protection of Wetland Areas

1. The Contractor shall properly dispose of all surplus material, including soil, in accordance with Local, State and Federal regulations. Under no circumstances shall surplus material be disposed of in wetland areas as defined by the Florida Department of Environmental Protection or Southwest Florida Water Management District.

C. Existing Facilities
   1. The work shall be so conducted to maintain existing facilities in operation insofar as is possible. Requirements and schedules of operations for maintaining existing facilities in service during construction shall be as described in the Special Provisions.

D. Use of Chemicals
   1. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, must show approval of either EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with instructions.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS/REQUIREMENTS INCLUDED

A. The work included in this contract consists of the following:
   1. Demolition of the concrete channel liner system, conveyors, grit cyclones and classifiers, area lighting, and electrical and I&C conduits.
   2. Inspection of concrete channels and covers to establish limits of repair.
   3. New coatings/liner system for concrete channels.
   4. Concrete and steel rehabilitation and repair.
   5. New screenings conveyors and grit cyclones and classifiers.
   6. New electrical and I&C wiring and conduits from existing power source for new
   7. Equipment and new lighting

B. The Contractor shall furnish all shop drawings, working drawings, labor, materials, equipment, tools, services and incidentals necessary to complete all work required by these Specifications and as shown on the Contract Drawings.

C. The Contractor shall perform the work complete, in place and ready for continuous service and shall include any repairs, replacements, and/or restoration required as a result of damages caused prior to acceptance by the Owner.

D. The Contractor shall furnish and install all materials, equipment and labor which is reasonably and properly inferable and necessary for the proper completion of the work, whether specifically indicated in the Contract Documents or not.

1.02 CONTRACTS

A. Construct all the Work under a single contract.

1.03 WORK SEQUENCE

A. Headworks Shutdown:
   1. Only one influent channel can be out of service for rehabilitation at a time.
   2. Contractor shall complete all work on one influent channel before beginning construction on the other influent channel. All work on the first influent channel, including the concrete and steel repairs, new coating, cyclone, grit classifier, conveyor, startup and testing, shall be completed prior to beginning work on the second channel.
   3. Coordinate with plant staff on sequence of headworks shutdown requirements.

B. All work done under this Contract shall be done with a minimum of inconvenience to the users of the system or facility. The Contractor shall coordinate his work with private property owners such that existing utility services are maintained to all users to the maximum extent possible.

C. The Contractor shall, if necessary and feasible, construct the work in stages to accommodate the Owner's use of the premises during the construction period; coordinate the construction schedule and operations with the Owner's Representative.

D. The Contractor shall, where feasible, construct the Work in stages to provide for public convenience and not close off public use of any facility until completion of construction to provide alternative usage.

1.04 CONSTRUCTION AREAS

A. The Contractor shall: Limit his use of the construction areas for work and for storage, to allow for:
   1. Work by other Contractors.
   2. Owner's Use.
   3. Public Use.

B. Coordinate use of work site under direction of Engineer or Owner's Representative.

C. Assume full responsibility for the protection and safekeeping of products under this Contract, stored on the site.

D. Move any stored products under the Contractor's control, which interfere with operations of the Owner or separate contractor.

E. Obtain and pay for the use of additional storage of work areas needed for Contractor operations.

1.05 OWNER OCCUPANCY

A. It is assumed that portions of the Work will be completed prior to completion of the entire Work. Upon completion of construction of each individual facility, including testing, if the Owner, at its sole discretion, desires to accept the individual facility, the Contractor will be issued a dated certificate of completion and acceptance for each individual facility. The Owner will assume ownership and begin operation of the individual facility on that date and the three-year guaranty period shall commence on that date. The Owner has the option of not accepting the entire work as a whole until it is completed, tested and approved by the Engineer and Owner.

1.06 PARTIAL OWNER OCCUPANCY

A. The Contractor shall schedule his operations for completion of portions of the Work, as designated, for the Owner's occupancy prior to substantial completion of the entire work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01015

CONTROL OF WORK

PART 1 GENERAL

1.01 WORK PROGRESS

A. The Contractor shall furnish personnel and equipment which will be efficient, appropriate and adequately sized to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the time stipulated in the Contract. If at any time such personnel appears to the Engineer to be inefficient, inappropriate, or insufficient for securing the quality of work required for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character, or increase the personnel and equipment and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

1.02 PRIVATE LAND

A. The Contractor shall not enter or occupy private land outside of easements, except by permission of the affected property owner.

1.03 WORK LOCATIONS

A. Work shall be located substantially as indicated on the drawings, but the Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons.

1.04 OPEN EXCAVATIONS

A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access to private property during construction shall be removed when no longer required. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of open trench, prohibiting stacking excavated material in the street and requiring that the trench shall not remain open overnight.

B. The Contractor shall take precautions to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles which could be dangerous to the public shall be barricaded and well lighted at all times when construction is not in progress.

1.05 DISTRIBUTION SYSTEMS AND SERVICES

A. The Contractor shall avoid interruptions to water, telephone, cable TV, sewer, gas, or other related utility services. He shall notify the Engineer and the appropriate agency well in advance of any requirement for dewatering, isolating, or relocating a section of a utility, so that necessary arrangements may be made.

B. If it appears that utility service will be interrupted for an extended period, the Engineer may order the Contractor to provide temporary service lines at the Contractor's expense. Inconvenience of the users shall be kept to the minimum, consistent with existing conditions. The safety and integrity of the systems are of prime importance in scheduling work.

1.06 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

A. The Contractor shall assume full responsibility for the protection of all buildings, structures and utilities, public or private, including poles, signs, services to building utilities, gas pipes, water pipes, hydrants, sewers, drains and electric and telephone cables and other similar facilities, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operation shall be repaired by the Contractor at his expense.

B. The Contractor shall bear full responsibility for obtaining locations of all underground structures and utilities (including existing water services, drain lines and sewers). Services to buildings shall be maintained and all costs or charges resulting from damage thereto shall be paid by the Contractor.

C. Protection and temporary removal and replacement of existing utilities and structures as described in this Section shall be a part of the work under the Contract and all costs in connection therewith shall be included in the unit prices established in the Bid.

D. If, in the opinion of the Engineer, permanent relocation of a utility owned by the Owner is required, he may direct the Contractor, in writing, to perform the work. Work so ordered will be paid for at the Contract unit prices, if applicable, or as extra work as classified in the General Conditions. If relocation of a privately owned utility is required, the Owner will notify the utility to perform the work as expeditiously as possible. The Contractor shall fully cooperate with the Owner and utility and shall have no claim for delay due to such relocation. The Contractor shall notify public utility companies in writing at least 48 hours (excluding Saturdays, Sundays and legal holidays) before excavating near their utilities.

1.07 TEST PITS

A. Test pits for the purpose of locating underground pipeline or structures in advance of the construction shall be excavated and backfilled by the Contractor immediately after the utility location and the surface shall be restored in a manner equal or better than the original condition. No separate payment will be made.

1.08 CARE AND PROTECTION OF PROPERTY

A. The Contractor shall be responsible for the preservation of all public and private property and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition equal or better to that existing before the damage was done, or he shall make good the damage in another manner acceptable to the Engineer.

B. All sidewalks which are disturbed by the Contractor's operations shall be restored to their original or better condition by the use of similar or comparable materials. All curbing shall be restored in a condition equal to the original construction and in accordance with the best modern practice.

C. Along the location of this work, all fences, walks, bushes, trees, shrubbery and other physical features shall be protected and restored in a thoroughly workmanlike manner unless otherwise shown on the drawings. Fences and other features removed by the Contractor shall be replaced in the location indicated by the Engineer as soon as conditions permit. All grass areas beyond the limits of construction which have been damaged by the Contractor shall be regraded and sodded to equal or exceed original conditions.

D. Trees close to the work which drawings do not specify to be removed, shall be boxed or otherwise protected against injury. The Contractor shall trim all branches that are liable to damage because of his operations, but in no case shall any tree be cut or removed without prior notification to the Engineer. All injuries to bark, trunk, limbs and roots of trees shall be repaired by dressing, cutting and painting according to approved methods, using only approved tools and materials.

E. The protection, removal and replacement of existing physical features along the line of work shall be a part of the work under the Contract and all costs in connection therewith shall be included in the unit and/or lump sum prices established under the items in the Bid.

1.09 MAINTENANCE OF TRAFFIC

A. Open pits, trenches, unpaved streets, debris, or other obstructions due to construction that will prevent the normal flow of traffic during an extended construction stoppage, for any reason, shall be minimized. In the event an extended construction stoppage is found to be necessary, Contractor shall, at his own expense, provide normal traffic flow during extended construction stoppage. Extended stoppage will be defined by the Engineer.

B. All excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, he shall repair the road surface, provide temporary roadways, erect wheel guards or fences, or take other safety measures which are satisfactory to the Engineer and Owner.

C. Detours around construction areas will be subject to the approval of the Owner and the Engineer. Where detours are permitted, the contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic

is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured, will be strictly controlled by the Owner.

1.10 WATER FOR CONSTRUCTION PURPOSES

A. In locations where public water supply is available, the Contractor may purchase water for all construction purposes.

B. The Contractor shall be responsible for paying for all water tap fees incurred for the purpose of obtaining a potable water service or temporary use meter.

1.11 MAINTENANCE OF FLOW

A. The Contractor shall, at his own cost, provide for the flow of sewers, drains and water courses interrupted during the progress of the work and shall immediately cart away and remove all offensive matter. The entire procedure of maintaining existing flow shall be fully discussed with the Engineer and Owner well in advance of the interruption of any flow.

1.12 CLEANUP

A. During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. He shall dispose of all residue resulting from the construction work and at the conclusion of the work, he shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures and any other refuse remaining from the construction operations and shall leave the entire site of the work in a neat and orderly condition.

1.13 COOPERATION WITHIN THIS CONTRACT

A. All firms or person authorized to perform any work under this Contract shall cooperate with the General Contractor and his subcontractors or trades and shall assist in incorporating the work of other trades where necessary or required.

B. Cutting and patching, drilling and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

1.14 PROTECTION OF CONSTRUCTION AND EQUIPMENT

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

B. All structures shall be protected in a manner approved by the Engineer. Should any of the floors or other parts of the structures become heaved, cracked, or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor, at his own expense and to the satisfaction of the Engineer. If, in the final inspection of the work, any defects, faults, or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. Further, the Contractor shall be fully responsible for the

satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the warranty period described in the Contract.

C. Further, the Contractor shall take all necessary precautions to prevent damage to any structure due to water pressure during and after construction and until such structure is accepted and taken over by the Owner.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

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SECTION 01030

SPECIAL PROJECT PROCEDURES

PART 1 GENERAL

1.01 PERMITS

A. Upon notice of award, the Contractor shall immediately apply for all applicable permits not previously obtained by the Owner to do the work from the appropriate governmental agency or agencies. No work shall commence until all applicable permits have been obtained and copies delivered to the Engineer. The costs for obtaining all permits shall be borne by the Contractor.

1.02 CONNECTIONS TO EXISTING SYSTEM

A. The Contractor shall perform all work necessary to locate, excavate, and prepare for connections to the terminus of the existing systems all as shown on the Drawings or where directed by the Owner/Engineer. The cost for this work and for the actual connection to the existing systems shall be included in the price bid for the project and shall not result in any additional cost to the Owner. The termination point for each contract shall be as shown on the Contract Drawings.

1.03 RELOCATIONS

A. The Contractor shall be responsible for the coordination of the relocation of structures, including but not limited to light poles, power poles, signs, sign poles, fences, piping, conduits and drains that interfere with the positioning of the work as set out on the Drawings. No relocation of the items under this Contract shall be done without approval from the Engineer.

1.04 EXISTING UNDERGROUND PIPING, STRUCTURES AND UTILITIES

A. The attention of the Contractor is drawn to the fact that during excavation, the possibility exists of the Contractor encountering various water, sewer, gas, telephone, electrical, or other utility lines not shown on the Drawings. The Contractor shall exercise extreme care before and during excavation to locate and flag these lines as to avoid damage to the existing lines. Cost for relocation of all existing lines shall be included in the price bid for the project. Should damage occur to an existing line, the Contractor shall bear the cost of all repairs.

B. It is the responsibility of the Contractor to ensure that all utility or other poles, the stability of which may be endangered by the close proximity of excavation, are temporarily stayed in position while work proceeds in the vicinity of the pole and that the utility or other companies concerned be given reasonable advance notice of any such excavation by the Contractor.

C. The existing utility locations are shown without express or implied representation, assurance, or guarantee that they are complete or correct or that they represent a true picture of underground piping to be encountered. The Contractor shall be responsible for notifying the various utility companies to locate their respective

utilities in advance of construction in conformance with all requirements provided for in the Florida Underground Facilities Damage Prevention and Safety Act (Florida Statutes, Title XXXIII, Chapter 556).

D. The existing piping and utilities that interfere with new construction shall be rerouted as shown, specified, or required. Before any piping and utilities not shown on the Drawings are disturbed, the Contractor shall notify the Engineer of the location of the pipeline or utility and shall reroute or relocate the pipeline or utility as directed. Cost for relocation of existing pipelines or utilities shall be included in the price bid for the project.

E. The Contractor shall exercise care in any excavation to locate all existing piping and utilities. All utilities which do not interfere with complete work shall be carefully protected against damage. Any existing utilities damaged in any way by the Contractor shall be restored or replaced by the Contractor at his expense as directed by the Engineer and/or the owner of the utility.

F. It is intended that wherever existing utilities such as water, sewer, gas, telephone, electrical, or other service lines must be crossed, deflection of the pipe within recommended limits and cover shall be used to satisfactorily clear the obstruction unless otherwise indicated in the Drawings. However, when in the opinion of the Engineer this procedure is not feasible, he may direct the use of fittings for a utilities crossing as detailed on the Drawings. No deflections will be allowed in gravity sanitary sewer lines or in existing storm sewer lines.

1.05 SUSPENSION OF WORK DUE TO WEATHER

A. Refer to FDOT Standards and Specifications Book, Section 8.

1.06 HURRICANE PREPAREDNESS PLAN

A. Within 30 days of the date of Notice to Proceed, the Contractor shall submit to the Engineer and Owner a Hurricane Preparedness Plan. The plan should outline the necessary measures which the Contractor proposes to perform at no additional cost to the Owner in case of a hurricane warning.

B. In the event of inclement weather, or whenever Engineer shall direct, Contractor shall insure that he and his Subcontractors shall carefully protect work and materials against damage or injury from the weather. If, in the opinion of the Engineer, any portion of work or materials is damaged due to the failure on the part of the Contractor or Subcontractors to protect the work, such work and materials shall be removed and replaced at the expense of the Contractor.

1.07 POWER SUPPLY

A. Electricity as may be required for construction and permanent power supply shall be secured and purchased by the Contractor.

1.08 SALVAGE

A. Any existing equipment or material, including, but not limited to, valves, pipes, fittings, couplings, etc., which is removed or replaced as a result of construction under this project may be designated as salvage by the Engineer or Owner and if so

shall be protected for a reasonable time until picked up by the Owner. Any equipment or material not worthy of salvaging, as directed by the Engineer, shall be disposed of by the Contractor at no additional cost.

1.09 DEWATERING

A. The Contractor shall do all groundwater pumping necessary to prevent flotation of any part of the work during construction operations with his own equipment.

B. The Contractor shall pump out water and wastewater which may seep or leak into the excavations for the duration of the Contract and with his own equipment. He shall dispose of this water in an appropriate manner.

1.10 ADDITIONAL PROVISIONS

A. Before commencing work on any of the existing pipelines, structures or equipment, the Contractor shall notify the Engineer, in writing, at least (ten) 10 calendar days in advance of the date he proposes to commence such work.

B. The Contractor shall provide, at his own expense, all necessary temporary facilities for access to and for protection of, all existing facilities. The Owner's personnel must have ready access at all times to the existing facilities. The Contractor is responsible for all damage to existing structures, equipment and facilities caused by his construction operations and must repair all such damage when and as ordered by the Engineer.

1.11 CONSTRUCTION CONDITIONS

A. The Contractor shall strictly adhere to the specific requirements of the governmental unit(s) and/or agency(ies) having jurisdiction over the work. Wherever there is a difference in the requirements of a jurisdictional body and these Specifications, the more stringent shall apply.

1.12 PUBLIC NUISANCE

A. The Contractor shall not create a public nuisance including but not limited to encroachment on adjacent lands, flooding of adjacent lands, excessive noise or dust.

B. Sound levels must meet Manatee County Ordinance #87-34, (which amends Ordinance 81-3, The Manatee County Noise Control Ordinance). Sound levels in excess of such ordinance are sufficient cause to have the work halted until equipment can be quieted to these levels. Work stoppage by the Engineer or County for excessive noise shall not relieve the Contractor of the other portions of this specification including, but not limited to contract time and contract price.

C. No extra charge may be made for time lost due to work stoppage resulting from the creation of a public nuisance.

1.13 WARRANTIES

A. All material supplied under these Specifications shall be warranted by the Contractor and the manufacturers for a period of three (3) years. Warranty period shall commence on the date of Owner acceptance.

B. The material shall be warranted to be free from defects in workmanship, design and materials. If any part of the system should fail during the warranty period, it shall be replaced at no expense to the Owner.

C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. The Contractor shall be responsible for obtaining warranties from each of the respective suppliers or manufacturers for all the material specified under these contract specifications,

D. In the event that the manufacturer is unwilling to provide a three (3) year warranty commencing at the time of Owner acceptance, the Contractor shall obtain from the manufacturer a four (4) year warranty starting at the time of equipment delivery to the job site. This four (4) year warranty shall not relieve the Contractor of the three (3) year warranty starting at the time of Owner acceptance of the equipment.

1.14 FUEL STORAGE & FILLING

A. If the contractor is storing fuel on site, or doing his own fuel filling of portable equipment (other than hand-held equipment), he is responsible for any required response, clean-up or reporting required, at no additional cost to the county.

B. The Contractor shall prepare and submit a fuel storage/spill abatement plan prior to start of construction if required.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01045

CUTTING AND PATCHING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall be responsible for all cutting, fitting and patching, including excavation and backfill, required to complete the work or to:
   1. Make its several parts fit together properly.
   2. Uncover portions of the work to provide for installation of ill-timed work.
   3. Remove and replace defective work.
   4. Remove and replace work not conforming to requirements of Contract Documents.
   5. Provide penetrations of non-structural surfaces for installation of piping and electrical conduit.

PART 2 PRODUCTS

2.01 MATERIALS

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

PART 3 EXECUTION

3.01 INSPECTION

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

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

C. Report unsatisfactory or questionable conditions to Engineer. Do not proceed with work until Engineer has provided further instructions.

3.02 PREPARATION

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

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

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

3.03 PERFORMANCE

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

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

C. Fit and adjust products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

D. Restore work which has been cut or removed; install new products to provide completed work in accordance with the requirements of the Contract Documents.

E. Replace surfaces airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

F. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes.

END OF SECTION

SECTION 01050

FIELD ENGINEERING AND SURVEYING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall provide and pay for field surveying service required for the project.

B. The Contractor shall furnish and set all necessary stakes to establish the lines and grades as shown on the Contract Drawings and layout each portion of the Work of the Contract.
   1. All survey work required in execution of Project.
   2. All costs of construction layout shall be included in the unit and lump sum prices contained in the respective divisions of the Contract Bid Form.
   3. Civil, structural or other professional engineering services specified or required to execute Contractor's construction methods.

1.02 QUALIFICATION OF SURVEYOR AND ENGINEER

A. All construction staking shall be conducted by or under the supervision of a Florida Registered Professional Surveyor and Mapper approved by the Owner. The Contractor shall be responsible for the layout of all such lines and grades, which will be subject to verification by the Engineer.

1.03 SURVEY REFERENCE POINTS

A. Locate and protect all survey monumentation, property corners and project control points prior to starting work and preserve all permanent reference points during construction. All costs associated with the replacement of all survey monumentation, property corners and project control points shall be borne by the Contractor.

B. Make no changes or relocations without prior written notice to Engineer.

C. Report to Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

D. Require surveyor to replace project control points which may be lost or destroyed.

E. Establish replacements based on original survey control.

1.04 PROJECT SURVEY REQUIREMENTS

A. The Contractor shall establish temporary bench marks as needed, referenced to data established by survey control points.

1.05 RECORDS

A. Maintain a complete, accurate log of all control and survey work as it progresses.

B. The Contractor shall employ a Professional Engineer or Surveyor registered in the State of Florida to verify survey data and properly prepare record drawings per Section 01720.

1.06 SUBMITTALS

A. Submit name and address of Professional Surveyor and Mapper to Engineer for Owner's approval.

B. Submit certificate signed by the Professional Surveyor and Mapper certifying that elevations and locations of improvements are in conformance, or nonconformance, with Contract Documents.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01090

REFERENCE STANDARDS

PART 1 GENERAL

1.01 REQUIREMENTS

Abbreviations and acronyms used in Contract Documents to identify reference standards.

A. Application: When a standard is specified by reference, comply with requirements and recommendations stated in that standard, except when requirements are modified by the Contract Documents, or applicable codes established stricter standards.

B. Publication Date: The most recent publication in effect on the date of issue of Contract Documents, except when a specific publication date is specified.

1.02 ABBREVIATIONS, NAMES AND ADDRESSES OR ORGANIZATIONS

Obtain copies of reference standards direct from publication source, when needed for proper performance of work, or when required for submittal by Contract Documents.

AA	Aluminum Association 818 Connecticut Avenue, N.W. Washington, DC 20006
AASHTO	American Association of State Highway and Transportation Officials 444 North Capital Street, N.W. Washington, DC 20001
ACI	American Concrete Institute Box 19150 Reford Station Detroit, MI 48219
AI	Asphalt Institute Asphalt Institute Building College Park, MD 20740
AISC	American Institute of Steel Construction 1221 Avenue of the Americas New York, NY 10020
AISI	American Iron and Steel Institute 1000 16th Street NW Washington, DC 20036

ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 179l Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
AWS	American Welding Society 2501 N.W. 7th Street Miami, FL 33125
CRSI	Concrete Reinforcing Steel Institute 180 North LaSalle Street, Suite 2110 Chicago, IL 60601
FDEP	Florida Department of Environmental Protection 3900 Commonwealth Blvd. Tallahassee, Florida 32399
FDOT	Florida Department of Transportation Standards Specifications for Road and Bridge Construction Maps & Publication Sales - Mail Station 12 605 Suwannee St. Tallahassee, FL 32399-0450
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Bldg. 197 Washington, DC 20407
MCUOD	Manatee County Utility Operations Department 4410 66th St. W. Bradenton, FL 34210
MLSFA	Metal Lath/Steel Framing Association 221 North LaSalle Street Chicago, IL 60601

MMA	Monorail Manufacturer's Association 1326 Freeport Road Pittsburgh, PA 15238
NAAMM	National Association of Architectural Metal Manufacturers 221 North LaSalle Street Chicago, IL 60601
NEMA	National Electrical Manufacturer's Assoc. 2101 L Street N.W. Washington, DC 20037
OHSA	Occupational Safety and Health Assoc. 5807 Breckenridge Pkwy., Suite A Tampa, FL 33610-4249
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 20076
PCI	Prestressed Concrete Institute 20 North Wacker Drive Chicago, IL 60606
SDI	Steel Door Institute 712 Lakewood Center North Cleveland, OH 44107
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association 8224 Old Court House Road Vienna, VA 22180
SSPC	Steel Structures Painting Council 402 24th Street, Suite 600 Pittsburgh, PA 15213
SWFWMD	Southwest Florida Water Management District 2379 Broad Street Brooksville, FL 34604-6899
UL	Underwriter's Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

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SECTION 01150

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SCOPE

A. The scope of this section of the Contract Documents is to further define the items included in each Bid Item in the Bid Form section of the Contract Documents. Payment will be made based on the specified items included in the description in this section for each bid item.

B. All contract prices included in the Bid Form section will be full compensation for all shop drawings, working drawings, labor, materials, tools, equipment, and incidentals necessary to complete the construction as shown on the Drawings and/or as specified in the Contract Documents to be performed under this Contract. Actual quantities of each item bid on a unit price basis will be determined upon completion of the construction in the manner set up for each item in this section of the Specifications. Payment for all items listed in the Bid Form will constitute full compensation for all work shown and/or specified to be performed under this Contract.

1.02 ESTIMATED QUANTITIES

A. The quantities shown are approximate and are given only as a basis of calculation upon which the award of the Contract is to be made. The Owner/Engineer does not assume any responsibility for the final quantities, nor shall the Contractor claim misunderstanding because of such estimate of quantities. Final payment will be made only for satisfactorily completed quantity of each item.

1.03 WORK OUTSIDE AUTHORIZED LIMITS

A. No payment will be made for work constructed outside the authorized limits of work.

1.04 MEASUREMENT STANDARDS

A. Unless otherwise specified for the particular items involved, all measurements of distance shall be taken horizontally or vertically.

1.05 AREA MEASUREMENTS

A. In the measurement of items to be paid for based on area of finished work, the lengths, and/or widths to be used in the calculations shall be the final dimensions measured along the surface of the completed work within the neat lines shown or designated.

1.06 LUMP SUM ITEMS

A. Where payment for items is shown to be paid for on a lump sum basis, no separate payment will be made for any item of work required to complete the lump sum items.

Lump sum contracts shall be complete, tested and fully operable prior to request for final payment. Contractor may be required to provide a breakdown of the lump sum totals.

1.07 UNIT PRICE ITEM

A. Separate payment will be made for the items of work described herein and listed on the Bid Form. Any related work not specifically listed, but required for satisfactory completion of the work shall be considered to be included in the scope of the appropriate listed work items.

B. No separate payment will be made for the following items and the cost of such work shall be included in the applicable pay items of work. Final payments shall not be requested by the Contractor or made by the Owner until as-built (record) drawings have been submitted and approved by the Engineer.
   1. Shop Drawings, Working Drawings.
   2. Clearing, grubbing, and grading except as hereinafter specified.
   3. Trench excavation, including necessary pavement removal and rock removal, except as otherwise specified.
   4. Dewatering and disposal of surplus water.
   5. Structural fill, backfill, and grading.
   6. Replacement of unpaved roadways, and shrubbery plots.
   7. Cleanup and miscellaneous work.
   8. Foundation and borrow materials, except as hereinafter specified.
   9. Testing and placing system in operation.
   10. Any material and equipment required to be installed and utilized for the tests.
   11. Pipe, structures, pavement replacement, asphalt and shell driveways, and/or appurtenances included within the limits of lump sum work, unless otherwise shown.
   12. Maintaining the existing quality of service during construction.
   13. Maintaining or detouring of traffic.
   14. Appurtenant work as required for a complete and operable system.
   15. Seeding and hydromulching.
   16. As-built Record Drawings.

BID ITEM NO. 1- MOBILIZATION/DEMOBILIZATION

Measurement and payment for this Bid Item shall include full compensation for the required 100 percent (100%) Performance Bond, 100 Percent (100%) Payment Bond, all required insurance for the project and the Contractor's mobilization and demobilization costs as shown in the Bid Form.

Payment for mobilization shall not exceed 10 percent (10%) of the total Contract cost unless the Contractor can prove to the Owner that his actual mobilization cost exceeds 10 percent (10%).

BID ITEM NO 2 - CONVEYORS

Payment for all work included under this Bid Item shall represent full compensation in accordance with the unit price bid for the removal and replacement of two screening conveyors, and installation of associated piping and valves; and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this unit price bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 3 – CLASSIFIERS AND PIPING

Payment for all work included under this Bid Item shall represent full compensation in accordance with the unit price bid for the removal and replacement of two classifiers and cyclones; removal and replacement of plant service water and grit slurry piping and valves; and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this unit price bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 4 – JIB CRANES AND HOISTS

Payment for all work included under this Bid Item shall represent full compensation in accordance with the unit price bid for two manual jib cranes and hoists; and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this unit price bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 5 – EXISTING CHANNEL LINER REMOVAL, NEW LINER, AND CONCRETE REPAIRS

Payment for all work under this Bid Item shall represent full compensation in accordance with the unit price bid per square foot of concrete channel liner removed, new liner system, and 2-inches in depth of concrete repairs as shown on the Bid Form. CONTRACTOR shall cut out the T-Lock in areas where the liner is damaged, repair damaged concrete to a maximum depth of 2-inches, replace liner, and dispose of demolition waste. Concrete shall be repaired with materials as specified in 03926, paragraph 2.01 with bonding agent as specified in 03926, paragraph 2.03 applied as instructed in 03926, paragraph 3.05C.

Measurement for the liner removal shall be per actual square foot with a maximum of 2-inches in concrete repairs as shown on the Contract Drawings sheet S-2 General Notes. If concrete repairs are deeper than 2-inches, the cost will be prorated in half inch increments for the area affected based on approval of the ENGINEER. Payment shall represent full compensation for all labor, materials, and equipment necessary to complete the work, ready for approval and acceptance by the Engineer/Owner.

BID ITEM NO 6 – EPOXY INJECTION FOR CONCRETE CRACK REPAIR

Payment for all work under this Bid Item shall be made at the applicable Contract unit price bid per linear foot of concrete crack repair as shown on the Bid Form for furnishing and injection of the installing the miscellaneous concrete, measured in place. Any crack repair necessary for replacing defective work or damaged caused by the Contractor shall be at the expense of the

Contractor. Epoxy injection specifically included under any other Bid Item will not be measured or paid for under this Bid Item.

Measurement for the epoxy injection shall be per actual linear foot of crack repaired as shown on the Contract Drawings or as ordered by the Engineer in writing. For payment purposes, depth of crack shall be assumed to be a uniform 2-inch over the measured linear foot of crack repaired. Payment shall represent full compensation for all labor, materials, and equipment for mixing and injection of the epoxy, and all incidentals necessary to complete the concrete work, ready for approval and acceptance by the Engineer/Owner.

BID ITEM NO 7 – ANTI-SLIP SAFETY TREADS FOR STAIRS

Payment for all work under this Bid Item shall be made at the applicable Contract unit price bid per linear foot of anti-slip safety threads on stairs, and all other materials and equipment necessary for a complete and fully operable system, as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

BID ITEM NO 8 – ELECTRICAL AND INSTRUMENTATION

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the Electrical and Instrumentation work including new conduit and wiring; new area lighting; removal and replacement of classifier and conveyor control panels, modification of existing MCC (motor control center), and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this lump sum bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 9 - DISCRETIONARY WORK

Payment for all work under this Bid Item and listed in the Bid Form shall be made only at the Owner's discretion in order to satisfactorily complete the project in accordance with the Plans and Specifications.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01152

REQUESTS FOR PAYMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Submit Applications for Payment to the Project Manager or as directed at the preconstruction meeting, in accordance with the schedule established by Conditions of the Contract and Agreement between Owner and Contractor.

1.02 FORMAT AND DATA REQUIRED

A. Submit payment requests in the form provided by the Owner with itemized data typed in accordance with the Bid Form.

B. Provide construction photographs in accordance with Contract Documents.

1.03 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

A. When the Owner or the Engineer requires substantiating data, Contractor shall submit suitable information with a cover letter.

B. Submit one copy of data and cover letter for each copy of application.

1.04 PREPARATION OF APPLICATION FOR FINAL PAYMENT

A. Fill in application form as specified for progress payments.

1.05 SUBMITTAL PROCEDURE

A. Submit applications for payment at the times stipulated in the Agreement.

B. Number: Three (3) copies of each application; all signed and certified by the Contractor.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01200

PROJECT MEETINGS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Owner or Engineer shall schedule the pre-construction meeting, periodic progress meetings and special meetings, if required, throughout progress of work.

B. Representatives of contractors, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.

C. The Contractor shall attend meetings to ascertain that work is expedited consistent with Contract Documents and construction schedules.

1.02 PRE-CONSTRUCTION MEETING

A. Attendance:
   1. Owner's Engineer.
   2. Owner's Project Manager
   3. Contractor.
   4. Resident Project Representative.
   5. Related Labor Contractor's Superintendent.
   6. Major Subcontractors.
   7. Major Suppliers.
   8. Others as appropriate.

B. Suggested Agenda:
   1. Distribution and discussion of:
      a. List of major subcontractors.
      b. Projected Construction Schedules.
      c. Coordination of Utilities
   2. Critical work sequencing.
   3. Project Coordination.
      a. Designation of responsible personnel.
      b. Emergency contact persons with phone numbers.
   4. Procedures and processing of:
      a. Field decisions.
      b. Submittals.
      c. Change Orders.
      d. Applications for Payment.
   5. Procedures for maintaining Record Documents.
   6. Use of premises:
      a. Office, work and storage areas.
      b. Owner's REQUIREMENTS.
   7. Temporary utilities.
   8. Housekeeping procedures.
   9. Liquidated damages.
   10. Equal Opportunity Requirements.
   11. Laboratory testing.
   12. Project / Job meetings: Progress meeting, other special topics as needed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01310

CONSTRUCTION SCHEDULE & PROJECT RESTRAINTS

PART 1 GENERAL

1.01 GENERAL

A. Construction under this contract must be coordinated with the Owner and accomplished in a logical order to maintain utilization and flow through existing facilities and public properties and rights-of-way and to allow construction to be completed within the time allowed by Contract Documents and in the manner set forth in the Contract.

1.02 CONSTRUCTION SCHEDULING GENERAL PROVISIONS

A. No work shall be done between 7:00 p.m. and 7:00 a.m. nor on weekends or legal holidays without written permission of the Owner. However, emergency work may be done without prior permission.

B. Night work may be established by the Contractor as regular procedure with the written permission of the Owner. Such permission, however, may be revoked at any time by the Owner if the Contractor fails to maintain adequate equipment and supervision for the proper execution and control of the work at night.

C. Due to potential health hazards and requirements of the State of Florida and the U.S. Environmental Protection Agency, existing facilities must be maintained in operation.

D. The Contractor shall be fully responsible for providing all temporary piping, plumbing, electrical hook-ups, lighting, temporary structure, or other materials, equipment and systems required to maintain the existing facility's operations. All details of temporary piping and temporary construction are not necessarily shown on the Drawings or covered in the Specifications. However, this does not relieve the Contractor of the responsibility to insure that construction will not interrupt proper facility operations.

E. The Contractor shall designate an authorized representative of his firm who shall be responsible for development and maintenance of the schedule and of progress and payment reports. This representative of the Contractor shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the commitments of the Contractor's schedule.

1.03 PROGRESS OF THE WORK

A. The work shall be executed with such progress as may be required to prevent any delay to the general completion of the work. The work shall be executed at such times and in or on such parts of the project and with such forces, materials and equipment to assure completion of the work in the time established by the Contract and in the manner set forth in the Contract.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The Contractor shall submit a critical path schedule as described herein.

B. The planning, scheduling, management and execution of the work is the sole responsibility of the Contractor. The progress schedule requirement is established to allow Engineer to review Contractor's planning, scheduling, management and execution of the work; to assist Engineer in evaluating work progress and make progress payments and to allow other contractors to cooperate and coordinate their activities with those of the Contractor.

2.02 FORM OF SCHEDULES

A. Prepare schedules using the latest version of Microsoft Project, or other Owner approved software, in the form of a horizontal bar chart diagram. The diagram shall be time-scaled and sequenced by work areas. Horizontal time scale shall identify the first work day of each week.

B. Activities shall be at least as detailed as the Schedule of Values. Activity durations shall be in whole working days. In addition, man-days shall be shown for each activity or tabulated in an accompanying report.

C. Diagrams shall be neat and legible and submitted on sheets at least 8-1/2 inches by 11 inches suitable for reproduction. Scale and spacing shall allow space for notations and future revisions.

2.03 CONTENT OF SCHEDULES

A. Each monthly schedule shall be based on data as of the last day of the current pay period.

B. Description for each activity shall be brief, but convey the scope of work described.

C. Activities shall identify all items of work that must be accomplished to achieve substantial completion, such as items pertaining to Contractor's installation and testing activities; items pertaining to the approval of regulatory agencies; contractor's time required for submittals, fabrication and deliveries; the time required by Engineer to review all submittals as set forth in the Contract Documents; items of work required of Owner to support pre-operational, startup and final testing; time required for the relocation of utilities. Activities shall also identify interface milestones with the work of other contractors performing work under separate contracts with Owner.

D. Schedules shall show the complete sequence of construction by activities. Dates for beginning and completion of each activity shall be indicated as well as projected percentage of completion for each activity as of the first day of each month.

E. Submittal schedule for shop drawing review, product data, and samples shall show the date of Contractor submittal and the date approved submittals will be required by the Engineer, consistent with the time frames established in the Specifications.

F. For Contract change orders granting time extensions, the impact on the Contract date(s) shall equal the calendar-day total time extension specified for the applicable work in the Contract change orders.

G. For actual delays, add activities prior to each delayed activity on the appropriate critical path(s). Data on the added activities of this type shall portray all steps leading to the delay and shall further include the following: separate activity identification, activity description indicating cause of the delay, activity duration consistent with whichever set of dates below applies, the actual start and finish dates of the delay or, if the delay is not finished, the actual start date and estimated completion date.

H. For potential delays, add an activity prior to each potentially delayed activity on the appropriate critical path(s). Data for added activities of this type shall include alternatives available to mitigate the delay including acceleration alternatives and further show the following: separate activity identification, activity description indicating cause of the potential delay and activity duration equal to zero work days.

2.04 SUPPORTING NARRATIVE

A. Status and scheduling reports identified below shall contain a narrative to document the project status, to explain the basis of Contractor's determination of durations, describe the Contract conditions and restraints incorporated into the schedule and provide an analysis pertaining to potential problems and practical steps to mitigate them.

B. The narrative shall specifically include:
   1. Actual completion dates for activities completed during the monthly report period and actual start dates for activities commenced during the monthly report period.
   2. Anticipated start dates for activities scheduled to commence during the following monthly report period.
   3. Changes in the duration of any activity and minor logic changes.
   4. The progress along the critical path in terms of days ahead or behind the Contract date.
   5. If the Monthly Status Report indicates an avoidable delay to the Contract completion date or interim completion dates as specified in the Agreement, Contractor shall identify the problem, cause and the activities affected and provide an explanation of the proposed corrective action to meet the milestone dates involved or to mitigate further delays.
   6. If the delay is thought to be unavoidable, the Contractor shall identify the problem, cause, duration, specific activities affected and restraints of each activity.
   7. The narrative shall also discuss all change order activities whether included or not in the revised/current schedule of legal status. Newly introduced change order work activities and the CPM path(s) that they affect, must be specifically identified. All change order work activities added to the schedule shall conform with the sequencing and Contract Time requirements of the applicable Change Order.
   8. Original Contract date(s) shall not be changed except by Contract change order. A revision need not be submitted when the foregoing situations arise unless required by Engineer. Review of a report containing added activities will not be construed to be concurrence with the duration or restraints for such

added activities; instead the corresponding data as ultimately incorporated into the applicable Contract change order shall govern.

9. Should Engineer require additional data, this information shall be supplied by Contractor within 10 calendar days.

2.05 SUBMITTALS

A. Contractor shall submit estimated and preliminary progress schedules (as identified in the Terms and Conditions of the Contract and the General Conditions), monthly status reports, a start-up schedule and an as-built schedule report all as specified herein.

B. All schedules, including estimated and preliminary schedules, shall be in conformance with the Contract Documents.

C. The finalized progress schedule discussed in the Contract Documents shall be the first monthly status report and as such shall be in conformance with all applicable specifications contained herein.

D. Monthly Status Report submittals shall include three copies of a time-scaled (days after notice to proceed) diagram showing all contract activities and supporting narrative. The initial detailed schedule shall use the notice to proceed as the start date. The finalized schedule, if concurred with by Owner, shall be the work plan to be used by the contractor for planning, scheduling, managing and executing the work.

E. The schedule diagram shall be formatted as above. The diagram shall include (1) all detailed activities included in the preliminary and estimated schedule submittals, (2) calendar days prior to substantial completion, (3) summary activities for the remaining days. The critical path activities shall be identified, including critical paths for interim dates, if possible.

F. The Contractor shall submit monthly progress schedules with each month's application for payment.

G. Contractor shall submit three monthly status reports which will be retained by the Owner and Engineer.

2.06 MONTHLY STATUS REPORTS

A. Contractor shall submit three copies of detailed schedule status reports on a monthly basis with the Application for Payment. The first such status report shall be submitted with the first Application for Payment and include data as of the last day of the pay period. The Monthly Report shall include a "marked-up" copy of the latest detailed schedule of legal status and a supporting narrative including updated information as described above. The Monthly Report will be reviewed by Engineer and Contractor at a monthly schedule meeting and Contractor will address Engineer's comments on the subsequent monthly report. Monthly status reports shall be the basis for evaluating Contractor's progress.

B. The "marked-up" diagram shall show, for the latest detailed schedule of legal status, percentages of completion for all activities, actual start and finish dates and remaining durations, as appropriate. Activities not previously included in the latest

detailed schedule of legal status shall be added, except that contractual dates will not be changed except by change order. Review of a marked-up diagram by Engineer will not be construed to constitute concurrence with the time frames, duration, or sequencing for such added activities; instead the corresponding data as ultimately incorporated into an appropriate change order shall govern.

2.07 STARTUP SCHEDULE

A. At least 60 calendar days prior to the date of substantial completion, Contractor shall submit a time-scaled (days after notice to proceed) diagram detailing the work to take place in the period between 60 days prior to substantial completion, together with a supporting narrative. Engineer shall have 10 calendar days after receipt of the submittal to respond. Upon receipt of Engineer's comments, Contractor shall make the necessary revisions and submit the revised schedule within 10 calendar days. The resubmittal, if concurred with by Owner, shall be the Work Plan to be used by Contractor for planning, managing, scheduling and executing the remaining work leading to substantial completion.

B. The time-scaled diagram shall use the latest schedule of legal status for those activities completed ahead of the last 60 calendar days prior to substantial completion and detailed activities for the remaining 60-day period within the time frames outlined in the latest schedule of legal status.

C. Contractor will be required to continue the requirement for monthly reports, as outlined above. In preparing this report, Contractor must assure that the schedule is consistent with the progress noted in the startup schedule.

2.08 REVISIONS

A. All revised Schedule Submittals shall be made in the same form and detail as the initial submittal and shall be accompanied by an explanation of the reasons for such revisions, all of which shall be subject to review by Engineer and concurrence by Owner. The revision shall incorporate all previously made changes to reflect current as-built conditions. Minor changes to the approved submittal may be approved at monthly meetings; a minor change is not considered a revision in the context of this paragraph.

B. A revised schedule submittal shall be submitted for review when required by Engineer.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01340

SHOP DRAWINGS, PROJECT DATA AND SAMPLES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall submit to the Engineer for review and approval: working drawings, shop drawings, test reports and data on materials and equipment (hereinafter in this section called data), and material samples (hereinafter in this section called samples) as are required for the proper control of work, including, but not limited to those working drawings, shop drawings, data and samples for materials and equipment specified elsewhere in the Specifications and in the Contract Drawings.

B. Within thirty (30) calendar days after the effective date of the Agreement, the Contractor shall submit to the Engineer, a complete list of preliminary data on items for which Shop Drawings are to be submitted. Included in this list shall be the names of all proposed manufacturers furnishing specified items and the date on which each Shop Drawing shall be submitted. Review of this list by the Engineer shall in no way relieve the Contractor from submitting complete Shop Drawings and providing materials, equipment, etc., fully in accordance with the Specifications. This procedure is required in order to expedite final review of Shop Drawings.

C. The Contractor is to maintain an accurate updated submittal log and will bring this log to each scheduled progress meeting with the Owner and the Engineer. This log should include the following items:
   1. Submittal description and number assigned.
   2. Date to Engineer.
   3. Date returned to Contractor (from Engineer).
   4. Status of Submittal (No exceptions taken, returned for confirmation or resubmittal, rejected).
   5. Date of Resubmittal and Return (as applicable).
   6. Date material released (for fabrication).
   7. Projected date of fabrication.
   8. Projected date of delivery to site.
   9. Projected date and required lead time so that product installation does not delay contact.
   10. Status of O&M manuals submitted.

1.02 CONTRACTOR'S RESPONSIBILITY

A. It is the duty of the Contractor to check all drawings, data and samples prepared by or for him before submitting them to the Engineer for review. Each and every copy of the Drawings and data shall bear Contractor's stamp showing that they have been so checked. Shop drawings submitted to the Engineer without the Contractor's stamp will be returned to the Contractor for conformance with this requirement. Shop drawings shall indicate any deviations in the submittal from requirements of the contract Documents.

B. Determine and verify:
   1. Field measurements.
   2. Field construction criteria.
   3. Catalog numbers and similar data.
   4. Conformance with Specifications and indicate all variances from the Specifications.

C. The Contractor shall furnish the Engineer a schedule of Shop Drawing submittals fixing the respective dates for the submission of shop and working drawings, the beginning of manufacture, testing and installation of materials, supplies and equipment. This schedule shall indicate those that are critical to the progress schedule.

D. The Contractor shall not begin any of the work covered by a drawing, data, or a sample returned for correction until a revision or correction thereof has been reviewed and returned to him, by the Engineer, with No Exceptions Taken or Approved As Noted.

E. The Contractor shall submit to the Engineer all drawings and schedules sufficiently in advance of construction requirements to provide no less than twenty-one (21) calendar days for checking and appropriate action from the time the Engineer receives them.

F. The Contractor shall submit five (5) copies of descriptive or product data submittals to complement shop drawings for the Engineer plus the additional copies if the Contractor requires more than 1 being returned. The Engineer shall retain four (4) sets.

G. The Contractor shall be responsible for and bear all cost of damages which may result from the ordering of any material or from proceeding with any part of work prior to the completion of the review by Engineer of the necessary Shop Drawings.

1.03 ENGINEER'S REVIEW OF SHOP DRAWINGS AND WORKING DRAWINGS

A. The Engineer's review of drawings, data and samples submitted by the Contractor shall cover only general conformity to the Specifications, external connections and dimensions which affect the installation.

B. The review of drawings and schedules shall be general and shall not be construed:
   1. As permitting any departure from the Contract requirements.
   2. As relieving the Contractor of responsibility for any errors, including details, dimensions and materials.
   3. As approving departures from details furnished by the Engineer, except as otherwise provided herein.

C. If the drawings or schedules as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in Contract Price or time for performance, the Engineer may return the reviewed drawings without noting any exception.

D. When reviewed by the Engineer, each of the Shop and Working Drawings shall be identified as having received such review being so stamped and dated. Shop

Drawings stamped "REJECTED" and with required corrections shown shall be returned to the Contractor for correction and resubmittal.

E. Resubmittals will be handled in the same manner as first submittals. On resubmittals, the Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, to revisions other than the corrections requested by the Engineer on previous submissions. The Contractor shall make any corrections required by the Engineer.

F. If the Contractor considers any correction indicated on the drawings to constitute a change to the Contract Drawings or Specifications, the Contractor shall give written notice thereof to the Engineer.

G. The Engineer shall review a submittal/resubmittal a maximum of two (2) times after which cost of review shall be borne by the Contractor. The cost of engineering shall be equal to the Engineer's actual payroll cost.

H. When the Shop and Working Drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

I. No partial submittals shall be reviewed. Incomplete submittals shall be returned to the Contractor and shall be considered not approved until resubmitted.

1.04 SHOP DRAWINGS

A. When used in the Contract Documents, the term "Shop Drawings" shall be considered to mean Contractor's plans for material and equipment which become an integral part of the Project. These drawings shall be complete and detailed. Shop Drawings shall consist of fabrication, drawings, setting drawings, schedule drawings, manufacturer's scale drawings and wiring and control diagrams. Cuts, catalogs, pamphlets, descriptive literature and performance and test data, shall be considered only as supportive to required Shop Drawings as defined above.

B. Drawings and schedules shall be checked and coordinated with the work of all trades involved, before they are submitted for review by the Engineer and shall bear the Contractor's stamp of approval and original signature as evidence of such checking and coordination. Drawings or schedules submitted without this stamp of approval and original signature shall be returned to the Contractor for resubmission.

C. Each Shop Drawing shall have a blank area 3-1/2 inches by 3-1/2 inches, located adjacent to the title block. The title block shall display the following:
   1. Number and title of the drawing.
   2. Date of Drawing or revision.
   3. Name of project building or facility.
   4. Name of contractor and subcontractor submitting drawing.
   5. Clear identification of contents and location of the work.
   6. Specification title and number.

D. If drawings show variations from Contract requirements because of standard shop practice or for other reasons, the Contractor shall describe such variations in his letter of transmittal. If acceptable, proper adjustment in the contract shall be

implemented where appropriate. If the Contractor fails to describe such variations, he shall not be relieved of the responsibility of executing the work in accordance with the Contract, even though such drawings have been reviewed.

E. Data on materials and equipment shall include, without limitation, materials and equipment lists, catalog sheets, cuts, performance curves, diagrams, materials of construction and similar descriptive material. Materials and equipment lists shall give, for each item thereon, the name and location of the supplier or manufacturer, trade name, catalog reference, size, finish and all other pertinent data.

F. For all mechanical and electrical equipment furnished, the Contractor shall provide a list including the equipment name and address and telephone number of the manufacturer's representative and service company so that service and/or spare parts can be readily obtained.

G. All manufacturers or equipment suppliers who proposed to furnish equipment or products shall submit an installation list to the Engineer along with the required shop drawings. The installation list shall include at least five installations where identical equipment has been installed and have been in operation for a period of at least one (1) year.

H. Only the Engineer will utilize the color "red" in marking shop drawing submittals.

1.05 WORKING DRAWINGS

A. When used in the Contract Documents, the term "working drawings" shall be considered to mean the Contractor's fabrication and erection drawings for structures such as roof trusses, steelwork, precast concrete elements, bulkheads, support of open cut excavation, support of utilities, groundwater control systems, forming and false work; underpinning; and for such other work as may be required for construction of the project.

B. Copies of working drawings as noted above, shall be submitted to the Engineer where required by the Contract Documents or requested by the Engineer and shall be submitted at least thirty (30) days (unless otherwise specified by the Engineer) in advance of their being required for work.

C. Working drawings shall be signed by a registered Professional Engineer, currently licensed to practice in the State of Florida and shall convey, or be accompanied by, calculation or other sufficient information to completely explain the structure, machine, or system described and its intended manner of use. Prior to commencing such work, working drawings must have been reviewed without specific exceptions by the Engineer, which review will be for general conformance and will not relieve the Contractor in any way from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error are assumed by the Contractor; the Owner and Engineer shall not have responsibility therefore.

1.06 SAMPLES

A. The Contractor shall furnish, for the review of the Engineer, samples required by the Contract Documents or requested by the Engineer. Samples shall be delivered to the Engineer as specified or directed. The Contractor shall prepay all shipping

charges on samples. Materials or equipment for which samples are required shall not be used in work until reviewed by the Engineer.

B. Samples shall be of sufficient size and quantity to clearly illustrate:
   1. Functional characteristics of the product, with integrally related parts and attachment devices.
   2. Full range of color, texture and pattern.
   3. A minimum of two samples of each item shall be submitted.

C. Each sample shall have a label indicating:
   1. Name of product.
   2. Name of Contractor and Subcontractor.
   3. Material or equipment represented.
   4. Place of origin.
   5. Name of Producer and Brand (if any).
   6. Location in project. (Samples of finished materials shall have additional markings that will identify them under the finished schedules.)
   7. Reference specification paragraph.

D. The Contractor shall prepare a transmittal letter in triplicate for each shipment of samples containing the information required above. He shall enclose a copy of this letter with the shipment and send a copy of this letter to the Engineer. Review of a sample shall be only for the characteristics or use named in such and shall not be construed to change or modify any Contract requirements.

E. Reviewed samples not destroyed in testing shall be sent to the Engineer or stored at the site of the work. Reviewed samples of the hardware in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in work shall match the reviewed samples. If requested at the time of submission, samples which failed testing or were rejected shall be returned to the Contractor at his expense.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01370

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall submit to the Engineer a Schedule of Values allocated to the various portions of the work, within 10 days after date of Notice to Proceed.

B. Upon request of the Engineer, the Contractor shall support the values with data which will substantiate their correctness.

C. The Schedule of Values shall be used only as the basis for the Contractor's Applications for Payment.

1.02 FORM AND CONTENT OF SCHEDULE OF VALUES

A. Schedule of Values will be considered for approval by Engineer upon Contractor's request. Identify schedule with:
   1. Title of Project and location.
   2. Project number.
   3. Name and address of Contractor.
   4. Contract designation.
   5. Date of submission.

B. Schedule of Values shall list the installed value of the component parts of the work in sufficient detail to serve as a basis for computing values for progress payments during construction.

C. Follow the table of contents for the Contract Document as the format for listing component items for structures:
   1. Identify each line item with the number and title of the respective major section of the specification.
   2. For each line item, list sub values of major products or operations under item.

D. Follow the bid sheets included in this Contract Documents as the format for listing component items for pipelines.

E. The sum of all values listed in the schedule shall equal the total Contract sum.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall employ a competent photographer to take construction record photographs or perform video, recording including furnishing all labor, materials, equipment and incidentals necessary to obtain photographs and/or video recordings of all construction areas.

B. Preconstruction record information shall consist of video recordings on digital video disks (DVD).

C. Construction progress information shall consist of photographs and digital photographs on a recordable compact disc (CD-R).

1.02 QUALIFICATIONS

A. All photography shall be done by a competent camera operator who is fully experienced and qualified with the specified equipment.

B. For the video recording, the audio portion should be done by a person qualified and knowledgeable in the specifics of the Contract, who shall speak with clarity and diction so as to be easily understood.

1.03 PROJECT PHOTOGRAPHS

A. Provide two prints of each photograph with each pay application.

B. Provide one recordable compact disc with digital photographs with each pay application.

C. Negatives:
   1. All negatives shall remain the property of photographer.
   2. The Contractor shall require that photographer maintain negatives or protected digital files for a period of two years from date of substantial completion of the project.
   3. Photographer shall agree to furnish additional prints to Owner and Engineer at commercial rates applicable at time of purchase. Photographer shall also agree to participate as required in any litigation requiring the photographer as an expert witness.

D. The Contractor shall pay all costs associated with the required photography and prints. Any parties requiring additional photography or prints shall pay the photographer directly.

E. All project photographs shall be a single weight, color image. All finishes shall be smooth surface and glossy and all prints shall be 8 inches x 10 inches.

F. Each print shall have clearly marked on the back, the name of the project, the orientation of view, the date and time of exposure, name and address of the photographer and the photographers numbered identification of exposure.

G. All project photographs shall be taken from locations to adequately illustrate conditions prior to construction, or conditions of construction and state of progress. The Contractor shall consult with the Engineer at each period of photography for instructions concerning views required.

1.04 VIDEO RECORDINGS

A. Video, recording shall be done along all routes that are scheduled for construction. Video, recording shall include full, recording of both sides of all streets and the entire width of easements plus 10 feet on each side on which construction is to be performed. All video recording shall be in full color.

B. A complete view, in sufficient detail with audio description of the exact location shall be provided.

C. The engineering plans shall be used as a reference for stationing in the audio portion of the recordings for easy location identification.

D. Two complete sets of video recordings shall be delivered to the Engineer on DVD for the permanent and exclusive use of the Engineer prior to the start of any construction on the project.

E. All video recordings shall contain the name of the project, the date and time of the video, recording, the name and address of the photographer and any other identifying information required.

F. Construction shall not start until preconstruction video recordings are completed, submitted and accepted by the Engineer. In addition, no progress payments shall be made until the preconstruction video recordings are accepted by the Engineer.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01410

TESTING AND TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Owner shall employ and pay for the services of an independent testing laboratory to perform testing specifically indicated on the Contract Documents or called out in the Specifications. Owner may elect to have materials and equipment tested for conformity with the Contract Documents at any time.
   1. Contractor shall cooperate fully with the laboratory to facilitate the execution of its required services.
   2. Employment of the laboratory shall in no way relieve the Contractor's obligations to perform the work of the Contract.

1.02 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:
   1. Release, revoke, alter or enlarge on requirements of Contract Documents.
   2. Approve or accept any portion of the Work.
   3. Perform any duties of the Contractor.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel; provide access to Work and/or to Manufacturer's operations.

B. Secure and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.

C. Provide to the laboratory the preliminary design mix proposed to be used for concrete, and other material mixes which require control by the testing laboratory.

D. Materials and equipment used in the performance of work under this Contract are subject to inspection and testing at the point of manufacture or fabrication. Standard specifications for quality and workmanship are indicated in the Contract Documents. The Engineer may require the Contractor to provide statements or certificates from the manufacturers and fabricators that the materials and equipment provided by them are manufactured or fabricated in full accordance with the standard specifications for quality and workmanship indicated in the Contract Documents. All costs of this testing and providing statements and certificates shall be a subsidiary obligation of the Contractor and no extra charge to the Owner shall be allowed on account of such testing and certification.

E. Furnish incidental labor and facilities:
   1. To provide access to work to be tested.
   2. To obtain and handle samples at the project site or at the source of the product to be tested.
   3. To facilitate inspections and tests.

4. For storage and curing of test samples.

F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.
   1. When tests or inspections cannot be performed due to insufficient notice, Contractor shall reimburse Owner for laboratory personnel and travel expenses incurred due to Contractor's negligence.

G. Employ and pay for the services of the same or a separate, equally qualified independent testing laboratory to perform additional inspections, sampling and testing required for the Contractor's convenience and as approved by the Engineer.

H. If the test results indicate the material or equipment complies with the Contract Documents, the Owner shall pay for the cost of the testing laboratory. If the tests and any subsequent retests indicate the materials and equipment fail to meet the requirements of the Contract Documents, the contractor shall pay for the laboratory costs directly to the testing firm or the total of such costs shall be deducted from any payments due the Contractor.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01510

TEMPORARY AND PERMANENT UTILITIES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall be responsible for furnishing all requisite temporary utilities, i.e., power, water, sanitation, etc. The Contractor shall obtain and pay for all permits required as well as pay for all temporary usages. The Contractor shall remove all temporary facilities upon completion of work.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. Comply with National Electric Code (NEC).

B. Comply with Federal, State and Local codes and regulations and with utility company requirements.

C. Comply with County Health Department regulations.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL

A. Materials for temporary utilities may be "used". Materials for electrical utilities shall be adequate in capacity for the required usage, shall not create unsafe conditions and shall not violate requirements of applicable codes and standards.

2.02 TEMPORARY ELECTRICITY AND LIGHTING

A. Arrange with the applicable utility company for temporary power supply. Provide service required for temporary power and lighting and pay all costs for permits, service and for power used.

2.03 TEMPORARY WATER

A. The Contractor shall arrange with Manatee County Utilities Customer Service office to provide water for construction purposes, i.e., meter, pay all costs for installation, maintenance and removal, and service charges for water used.

B. The Contractor shall protect piping and fitting against freezing.

2.04 TEMPORARY SANITARY FACILITIES

A. The Contractor shall provide sanitary facilities in compliance with all laws and regulations.

B. The Contractor shall service, clean and maintain facilities and enclosures.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall maintain and operate systems to assure continuous service.

B. The Contractor shall modify and extend systems as work progress requires.

3.02 REMOVAL

A. The Contractor shall completely remove temporary materials and equipment when their use is no longer required.

B. The Contractor shall clean and repair damage caused by temporary installations or use of temporary facilities.

END OF SECTION

SECTION 01580

PROJECT IDENTIFICATION AND SIGNS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnish, install and maintain County project identification signs.

B. Remove signs on completion of construction.

C. Allow no other signs to be displayed except for traffic control and safety.

1.02 PROJECT IDENTIFICATION SIGN (COUNTY)

A. One painted sign, of not less than 32 square feet (3 square meters) area, with painted graphic content to include:
   1. Title of Project.
   2. Name of Owner.
   3. Names and titles of authorities as directed by Owner.
   4. Prime Contractor.

B. Graphic design, style of lettering and colors: As approved by the Engineer and subject to approval of the Owner.

C. Erect on the site at a lighted location of high public visibility, adjacent to main entrance to site, as approved by the Engineer and the Owner

1.03 INFORMATIONAL SIGNS

A. Painted signs with painted lettering, or standard products.
   1. Size of signs and lettering: as required by regulatory agencies, or as appropriate to usage.
   2. Colors: as required by regulatory agencies, otherwise of uniform colors throughout project.

B. Erect at appropriate locations to provide required information.

1.04 QUALITY ASSURANCE

A. Sign Painter: Professional experience in type of work required.

B. Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

1.05 PUBLIC NOTIFICATION

A. Door Hangers: Manatee County Project Management shall generate and the General Contractor shall distribute door hangers to all residents who will be impacted by project construction.

1. Residents impacted include anyone who resides inside, or within 500 feet of project limits of construction.

B. Door Hangers shall be distributed prior to start of construction of the project. Hangers shall be affixed to doors of residents via elastic bands or tape.

EXAMPLE:

PLEASE PARDON THE INCONVENIENCE WHILE THE ROADWAY IS BEING RECONSTRUCTED IN YOUR NEIGHBORHOOD

This project consists of utility improvements and the reconstruction of ??? Boulevard from U.S. ??? to ??? Street West. The project is expected to begin in August, 200X and be completed in July 200X.

Location Map

WE HOPE TO KEEP ANY INCONVENIENCE TO A MINIMUM. HOWEVER, IF YOU HAVE ANY PROBLEMS, PLEASE CONTACT THE FOLLOWING:

A. Contractor
Contractor Address
Contractor Phone (Site Phone)

B. Project Inspector
Inspector Phone Number

C. Project Manager
PM Address
PM Phone No. & Ext.

AFTER HOURS EMERGENCY NUMBER – (941) 747-HELP
THANK YOU FOR YOUR UNDERSTANDING AND PATIENCE
MANATEE COUNTY GOVERNMENT – PROJECT MANAGEMENT DEPT.

PART 2 PRODUCTS

2.01 SIGN MATERIALS

A. Structure and Framing: May be new or used, wood or metal, in sound condition structurally adequate to work and suitable for specified finish.

B. Sign Surfaces: Exterior softwood plywood with medium density overlay, standard large sizes to minimize joints.
1. Thickness: As required by standards to span framing members, to provide even, smooth surface without waves or buckles.

C. Rough Hardware: Galvanized.

D. Paint: Exterior quality, as specified in the Contract Documents.

PART 3 EXECUTION

3.01 PROJECT IDENTIFICATION SIGN

A. Paint exposed surface or supports, framing and surface material; one (1) coat of primer and one (1) coat of exterior paint.

B. Paint graphics in styles, size and colors selected.

3.02 MAINTENANCE

A. The Contractor shall maintain signs and supports in a neat, clean condition; repair damages to structures, framing or sign.

3.03 REMOVAL

A. The Contractor shall remove signs, framing, supports and foundations at completion of project.

END OF SECTION

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SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Material and equipment incorporated into the work:
   1. Conform to applicable specifications and standards.
   2. Comply with size, make, type and quality specified, or as specifically approved in writing by the Engineer.
   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 gages, to be interchangeable.
      c. Two (2) or more items of the same kind shall be identical and manufactured by the same manufacturer.
      d. Products shall be suitable for service conditions.
      e. Equipment capacities, sizes and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing.
   4. Do not use material or equipment for any purpose other than that for which it is specified.
   5. All material and equipment incorporated into the project shall be new.

1.02 MANUFACTURER'S INSTRUCTIONS

A. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including two (2) copies to Engineer. Maintain one (1) set of complete instructions at the job site during installation and until completion.

B. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding. Do not proceed with work without clear instructions.

1.03 TRANSPORTATION AND HANDLING

A. Arrange deliveries of products in accordance with construction schedules, coordinate to avoid conflict with work and conditions at the site.
   1. Deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
   2. Immediately on delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved submittals and that products are properly protected and undamaged.

B. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

1.04 SUBSTITUTIONS AND PRODUCT OPTIONS

A. Contractor's Options:
   1. For products specified only by reference standard, select any product meeting that standard.
   2. For products specified by naming one or more products or manufacturers and "or equal", Contractor must submit a request for substitutions of any product or manufacturer not specifically named in a timely manner so as not to adversely affect the construction schedule.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01614

WIND DESIGN CRITERIA GENERAL SUMMARY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Wind design criteria.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Building code criteria: Design for wind in accordance with 2010 Florida Building Code, local amendments, and errata.
   2. Basic wind speed: 160 miles per hour.
   3. Exposure category: C.
   4. Topographic factor, K_{tz}: 1.0.
      a. Use anchor bolts, bolts, or welded studs for anchors for resisting wind forces. Anchor bolts used to resist wind forces shall have a standard hex bolt head. Do not use anchor bolts fabricated from rod stock with an L or J shape:
         1) Do not use concrete anchors, sleeve anchors, flush shells, chemical anchors, powder actuated fasteners, or other types of anchor unless indicated on the Drawings or accepted in writing by the Engineer.
         2) Wind forces must be resisted by direct bearing on the anchors used to resist wind forces. Do not use connections which use friction to resist wind forces.

1.03 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and wind design calculations where required by Specifications.

B. Calculations shall be signed and stamped by a Civil or Structural Engineer licensed in the state where the work will be installed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01620

STORAGE AND PROTECTION

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Provide secure storage and protection for products to be incorporated into the Work and maintenance and protection for products after installation and until completion of Work.

1.02 STORAGE

A. Store products immediately on delivery and protect until installed in the Work, in accordance with manufacturer's instructions, with seals and labels intact and legible.

B. Exterior Storage
   1. Provide substantial platform, blocking or skids to support fabricated products above ground to prevent soiling or staining.
      a. Cover products, subject to discoloration or deterioration from exposure to the elements, with impervious sheet coverings. Provide adequate ventilation to avoid condensation.
      b. Prevent mixing of refuse or chemically injurious materials or liquids.

C. Arrange storage in a manner to provide easy access for inspection.

1.03 MAINTENANCE OF STORAGE

A. Maintain periodic system of inspection of stored products on scheduled basis to assure that:
   1. State of storage facilities is adequate to provide required conditions.
   2. Required environmental conditions are maintained on continuous basis.
   3. Surfaces of products exposed to elements are not adversely affected. Any weathering of products, coatings and finishes is not acceptable under the requirements of these Contract Documents.

B. Mechanical and electrical equipment which require servicing during long term storage shall have complete manufacturer's instructions for servicing accompanying each item, with notice of enclosed instructions shown on exterior of package.
   1. Equipment shall not be shipped until approved by the Engineer. The intent of this requirement is to reduce on-site storage time prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one (1) month prior to installation without written authorization from the Engineer.
   2. All equipment having moving parts such as gears, electric motors, etc. and/or instruments shall be stored in a temperature and humidity controlled building approved by the Engineer until such time as the equipment is to be installed.
   3. All equipment shall be stored fully lubricated with oil, grease, etc. unless otherwise instructed by the manufacturer.

4. Moving parts shall be rotated a minimum of once weekly to insure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to insure that the equipment does not deteriorate from lack of use.
5. Lubricants shall be changed upon completion of installation and as frequently as required, thereafter during the period between installation and acceptance.
6. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

1.04 PROTECTION AFTER INSTALLATION

A. Provide protection of installed products to prevent damage from subsequent operations. Remove when no longer needed, prior to completion of Work.

B. Control traffic to prevent damage to equipment and surfaces.

C. Provide coverings to protect finished surfaces from damage.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Comply with requirements stated in Conditions of the Contract and in Specifications for administrative procedures in closing out the Work.

1.02 SUBSTANTIAL COMPLETION

A. The Contractor shall submit the following items when the Contractor considers the Work to be substantially complete:
   1. A written notice that the Work, or designated portion thereof, is substantially complete.
   2. A list of items to be completed or corrected.

B. Within a reasonable time after receipt of such notice, the Engineer and Owner shall make an inspection to determine the status of completion.

C. Project record documents and operations and maintenance manuals must be submitted before the project shall be considered substantially complete.

D. If the Engineer determines that the Work is not substantially complete:
   1. The Engineer shall notify the Contractor in writing, stating the reasons.
   2. The Contractor shall remedy the deficiencies in the Work and send a second written notice of substantial completion to the Engineer.
   3. The Engineer shall reinspect the Work.

E. When the Engineer finds that the Work is substantially complete:
   1. He shall prepare and deliver to the Owner a tentative Certificate of Substantial Completion (Manatee County Project Management Form PMD-8) with a tentative list of the items to be completed or corrected before final payment.
   2. The Engineer shall consider any objections made by the Owner as provided in Conditions of the Contract. When the Engineer considers the Work substantially complete, he will execute and deliver to the Owner and the Contractor a definite Certificate of Substantial Completion (Manatee County Project Management Form PMD-8) with a revised tentative list of items to be completed or corrected.

1.03 FINAL INSPECTION

A. When the Contractor considered the Work to be complete, he shall submit written certification stating that:
   1. The Contract Documents have been reviewed.
   2. The Work has been inspected for compliance with Contract Documents.
   3. The Work has been completed in accordance with Contract Documents.
   4. The equipment and systems have been tested in the presence of the Owner's representative and are operational.

5. The Work is completed and ready for final inspection.

B. The Engineer shall make an inspection to verify the status of completion after receipt of such certification.

C. If the Engineer determines that the Work is incomplete or defective:
   1. The Engineer shall promptly notify the Contractor in writing, listing the incomplete or defective Work.
   2. The Contractor shall take immediate steps to remedy the stated deficiencies and send a second written certification to Engineer that the Work is complete.
   3. The Engineer shall reinspect the Work.

D. Upon finding the Work to be acceptable under the Contract Documents, the Engineer shall request the Contractor to make closeout submittals.

E. For each additional inspection beyond a total of three (3) inspections for substantial and final completion due to the incompleteness of the Work, the Contractor shall reimburse the Owner for the Engineer's fees.

1.04 CONTRACTOR'S CLOSEOUT SUBMITTALS TO ENGINEER

A. Project Record Documents (prior to substantial completion).

B. Operation and maintenance manuals (prior to substantial completion).

C. Warranties and Bonds.

D. Evidence of Payment and Release of Liens: In accordance with requirements of General and Supplementary Conditions.

E. Certification letter from Florida Department of Transportation and Manatee County Department of Transportation, as applicable.

F. Certificate of Insurance for Products and Completed Operations.

G. Final Reconciliation, Warranty Period Declaration, and Contractor's Affidavit (Manatee County Project Management Form PMD-9).

1.05 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer.

B. Statement shall reflect all adjustments to the Contract Sum:
   1. The original Contract Sum.
   2. Additions and deductions resulting from:
      a. Previous Change Orders
      b. Unit Prices
      c. Penalties and Bonuses
      d. Deductions for Liquidated Damages
      e. Other Adjustments
   3. Total Contract Sum, as adjusted.
   4. Previous payments.
   5. Sum remaining due.

C. Project Management shall prepare a final Change Order, reflecting approved adjustments to the Contract Sum which were not previously made by Change Orders.

1.06 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment in accordance with procedures and requirements stated in the Conditions of the Contract.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01710

CLEANING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Execute cleaning during progress of the Work and at completion of the Work, as required by the General Conditions.

1.02 DISPOSAL REQUIREMENTS

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

PART 2 PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

A. Execute periodic cleaning to keep the Work, the site and adjacent properties free from accumulation of waste materials, rubbish and wind-blown debris, resulting from construction operations.

B. Provide on-site containers for the collection of waste materials, debris and rubbish.

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

3.02 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.03 FINAL CLEANING

A. Employ skilled workmen for final cleaning.

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

C. Prior to final completion or Owner occupancy, Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces and all work areas to verify that the entire Work is clean.

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Contractor shall maintain at the site for the Owner one (1) record copy of:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Engineer's field orders or written instructions.
   6. Approved shop drawings, working drawings and samples.
   7. Field test records.
   8. Construction photographs.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Store documents and samples in Contractor's field office apart from documents used for construction.
   1. Provide files and racks for storage of documents.
   2. Provide locked cabinet or secure storage space for storage of samples.

B. File documents and samples in accordance with CSI format.

C. Maintain documents in a clean, dry, legible, condition and in good order. Do not use record documents for construction purposes.

D. Make documents and samples available at all times for inspection by the Engineer.

1.03 MARKING DEVICES

A. Provide felt tip marking pens for recording information in the color code designated by the Engineer.

1.04 RECORDING

A. Label each document "PROJECT RECORD" in neat large printed letters.

B. Record information concurrently with construction progress.

C. Do not conceal any work until required information is recorded.

D. Drawings; Legibly mark to record actual construction:
   1. All underground piping with elevations and dimensions. Changes to piping location. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements. Actual installed pipe material, class, etc. Locations of drainage ditches, swales, water lines and force mains shall be shown every 200 feet (measured along the

centerline) or alternate lot lines, whichever is closer. Dimensions at these locations shall indicate distance from centerline of right-of-way to the facility.
2. Field changes of dimension and detail.
3. Changes made by Field Order or by Change Order.
4. Details not on original contract drawings.
5. Equipment and piping relocations.
6. Locations of all valves, fire hydrants, manholes, water and sewer services, water and force main fittings, underdrain cleanouts, catch basins, junction boxes and any other structures located in the right-of-way or easement, shall be located by elevation and by station and offset based on intersection P.I.'s and centerline of right-of-way. For facilities located on private roads, the dimensioning shall be from centerline of paving or another readily visible baseline.
7. Elevations shall be provided for all manhole rim and inverts; junction box rim and inverts; catch basin rim and inverts; and baffle, weir and invert elevations in control structures. Elevations shall also be provided at the PVI's and at every other lot line or 200 feet, whichever is less, of drainage swales and ditches. Bench marks and elevation datum shall be indicated.
8. Slopes for pipes and ditches shall be recalculated, based on actual field measured distances, elevations, pipe sizes, and type shown. Cross section of drainage ditches and swales shall be verified.
9. Centerline of roads shall be tied to right-of-way lines. Elevation of roadway centerline shall be given at PVI's and at all intersections.
10. Record drawings shall show bearings and distances for all right-of-way and easement lines, and property corners.
11. Sidewalks, fences and walls, if installed at the time of initial record drawing submittal, shall be located every 200 feet or alternate lot lines, whichever is closer. Dimensions shall include distance from the right-of-way line and the back of curb and lot line or easement line.
12. Sanitary sewer mainline wyes shall be located from the downstream manhole. These dimensions shall be provided by on-site inspections or televiewing of the sewer following installation.
13. Elevations shall be provided on the top of operating nuts for all water and force main valves.
14. Allowable tolerance shall be ± 6.0 inches for horizontal dimensions. Vertical dimensions such as the difference in elevations between manhole inverts shall have an allowable tolerance of ± 1/8 inch per 50 feet (or part thereof) of horizontal distance up to a maximum tolerance of ± 2 inch.
15. Properly prepared record drawings on mylar, together with two (2) copies, shall be certified by a design professional (Engineer and/or Surveyor registered in the State of Florida), employed by the Contractor, and submitted to the Owner/Engineer.

E. Specifications and Addenda; Legibly mark each Section to record:
1. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed.
2. Changes made by field order or by change order.

F. Shop Drawings (after final review and approval):
1. Five (5) sets of record drawings for each process equipment, piping, electrical system and instrumentation system.

1.05 SUBMITTAL

A. Prior to substantial completion and prior to starting the bacteria testing of water lines, deliver signed and sealed Record Documents and Record Drawings to the Engineer. These will be reviewed and verified by the inspector. If there are any required changes or additions, these shall be completed and the entire signed and sealed set resubmitted prior to final pay application.

B. The Contractor shall employ a Professional Engineer or Surveyor registered in the State of Florida to verify survey data and properly prepare record drawings. Record drawings shall be certified by the professional(s) (Engineer or Surveyor licensed in Florida), as stipulated by the Land Development Ordinance and submitted on signed and dated mylar drawings together with a recordable compact disk (CD-R).

C. The CD-R shall contain media in AutoCad Version 12 or later, or in any other CAD program compatible with AutoCad in DWG or DXF form. All fonts, line types, shape files or other pertinent information used in the drawing and not normally included in AutoCad shall be included on the media with a text file or attached noted as to its relevance and use.

D. Accompany submittal with transmittal letter, containing:
   1. Date.
   2. Project title and number.
   3. Contractor's name and address.
   4. Title and number of each Record Document.
   5. Signature of Contractor or his authorized representative.

   Note: The data required to properly prepare these Record Drawings shall be obtained at the site, at no cost to the County by the responsible design professional or his/her duly appointed representative. The appointed representative shall be a qualified employee of the responsible design professional or a qualified inspector retained by the responsible design professional on a project-by-project basis.

PART 2 STANDARDS

2.01 MINIMUM RECORD DRAWING STANDARDS FOR ALL RECORD DRAWINGS SUBMITTED TO MANATEE COUNTY

A. Record Drawings shall be submitted to at least the level of detail in the contract documents. It is anticipated that the original contract documents shall serve as at least a background for all record information. Original drawings in CAD format may be requested of the Engineer.

B. Drawings shall meet the criteria of paragraph 1.04 D above.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01730

OPERATING AND MAINTENANCE DATA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Compile product data and related information appropriate for Owner's maintenance and operation of products furnished under Contract.

B. Prepare operating and maintenance data as specified in this and as referenced in other pertinent sections of Specifications.

C. Instruct Owner's personnel in maintenance of products and equipment and systems.

D. Provide three (3) sets of operating and maintenance manuals for each piece of equipment provided within this Contract.

1.02 FORM OF SUBMITTALS

A. Prepare data in form of an instructional manual for use by Owner's personnel.

B. Format:
   1. Size: 8-1/2 inch x 11 inch
   2. Paper: 20 pound minimum, white, for typed pages
   3. Text: Manufacturer's printed data or neatly typewritten
   4. Drawings:
      a. Provide reinforced punched binder tab, bind in with text.
      b. Fold larger drawings to size of text pages.
   5. Provide fly-leaf for each separate product or each piece of operating equipment.
      a. Provide typed description of product and major component parts of equipment.
      b. Provide indexed tabs.
   6. Cover: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". List:
      a. Title of Project.
      b. Identity of separate structures as applicable.
      c. Identity of general subject matter covered in the manual.

C. Binders:
   1. Commercial quality three-ring binders with durable and cleanable plastic covers.
   2. Maximum ring size: 1 inch.
   3. When multiple binders are used, correlate the data into related consistent groupings.

1.03 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit three (3) copies of complete manual in final form.

B. Content for each unit of equipment and system, as appropriate:
   1. Description of unit and component parts.
      a. Function, normal operating characteristics and limiting conditions.
      b. Performance curves, engineering data and tests.
      c. Complete nomenclature and commercial number of replaceable parts.
   2. Operating Procedures:
      a. Start-up, break-in, routine and normal operating instructions.
      b. Regulation, control, stopping, shut-down and emergency instructions.
      c. Summer and winter operating instructions.
      d. Special operating instructions.
   3. Maintenance Procedures:
      a. Routine operations.
      b. Guide to "trouble-shooting".
      c. Disassembly, repair and reassembly.
      d. Alignment, adjusting and checking.
   4. Servicing and lubricating schedule.
      a. List of lubricants required.
   5. Manufacturer's printed operating and maintenance instructions.
   6. Description of sequence of operation by control manufacturer.
   7. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
      a. List of predicted parts subject to wear.
      b. Items recommended to be stocked as spare parts.
   8. As installed control diagrams by controls manufacturer.
   9. Each contractor's coordination drawings.
      a. As installed color-coded piping diagrams.
   10. Charts of valve tag numbers, with location and function of each valve.
   11. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.
   12. Other data as required under pertinent sections of specifications.

C. Content, for each electric and electronic system, as appropriate:
   1. Description of system and component parts.
      a. Function, normal operating characteristics and limiting conditions.
      b. Performance curves, engineering data and tests.
      c. Complete nomenclature and commercial number of replaceable parts.
   2. Circuit directories of panelboards.
      a. Electrical service.
      b. Controls.
      c. Communications.
   3. As-installed color-coded wiring diagrams.
   4. Operating procedures:
      a. Routine and normal operating instructions.
      b. Sequences required.
      c. Special operating instructions.
   5. Maintenance procedures:
      a. Routine operations.
      b. Guide to "trouble-shooting".
      c. Disassembly, repair and reassembly.
      d. Adjustment and checking.
   6. Manufacturer's printed operating and maintenance instructions.
   7. List of original manufacture's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.

8. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.

D. Prepare and include additional data when the need for such data becomes apparent during instruction on Owner's personnel.

E. Additional requirements for operating and maintenance data: Respective sections of Specifications.

1.04 SUBMITTAL SCHEDULE

A. Submit one (1) copy of completed data in final form fifteen (15) days prior to substantial completion.
   1. Copy will be returned after substantial completion, with comments (if any).

B. Submit two (2) copies of approved data in final form. Final acceptance will not be provided until the completed manual is received and approved.

1.05 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to final inspection or acceptance, fully instruct Owner's designated operating and maintenance personnel in operation, adjustment and maintenance of products, equipment and systems.

B. Operating and maintenance manual shall constitute the basis of instruction.
   1. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01740

WARRANTIES AND BONDS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Compile specified warranties and bonds.

B. Compile specified service and maintenance contracts.

C. Co-execute submittals when so specified.

D. Review submittals to verify compliance with Contract Documents.

E. Submit to Engineer for review and transmittal to Owner.

1.02 SUBMITTAL REQUIREMENTS

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

B. Number of original signed copies required: Two (2) each.

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

1.03 FORM OF SUBMITTALS

A. Prepare in duplicate packets.

B. Format:
   1. Size 8-1/2 inch x 11 inch punched sheets for standard 3-ring binder. Fold larger sheets to fit into binders.
   2. Cover: Identify each packet with typed or printed title "WARRANTIES AND BONDS". List:
      a. Title of Project.
      b. Name of Contractor.

C. Binders: Commercial quality, three-ring, with durable and cleanable plastic covers.

1.04 TIME OF SUBMITTALS

A. Make submittals within ten (10) days after date of substantial completion and prior to final request for payment.

B. For items of work, where acceptance is delayed materially beyond date of substantial completion, provide updated submittal within ten (10) days after acceptance, listing date of acceptance as start of warranty period.

1.05 SUBMITTALS REQUIRED

A. Submit warranties, bonds, service and maintenance contracts as specified in respective sections of Specifications.

B. Approval by the Owner of all documents required under this section is a pre-requisite to requesting a final inspection and final payment

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01756

TESTING, TRAINING, AND FACILITY START-UP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for equipment and system testing and facility start-up, including the following:
   1. Start-up plan.
   2. Performance testing.
   3. General start-up and testing procedures.
   4. Functional testing.
   5. Operational testing.
   6. Certificate of proper installation.
   7. Services of manufacturer's representatives.
   8. Training of OWNER's personnel.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 15050 - Basic Mechanical Materials and Methods
      b. Section 15958 - Mechanical Equipment Testing.

1.02 GENERAL TESTING, TRAINING, AND START-UP REQUIREMENTS

A. Contract requirements: Testing, training, and start-up are requisite to the satisfactory completion of the Contract.

B. Complete testing, training, and start-up within the Contract Times.

C. Allow realistic durations in the Progress Schedule for testing, training, and start-up activities.

D. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.

E. Provide competent, experienced technical representatives of equipment manufacturers for assembly, installation and testing guidance, and operator training.

1.03 START-UP PLAN

A. Submit start-up plan for each piece of equipment and each system not less than 3 weeks prior to planned initial start-up of equipment or system.

B. Provide detailed sub-network of Progress Schedule with the following activities identified:
   1. Manufacturer's services.
   2. Installation certifications.
   3. Operator training.
   4. Submission of Operation and Maintenance Manual.
   5. Functional testing.
   6. Performance testing.
   7. Operational testing.

C. Provide testing plan with test logs for each item of equipment and each system when specified. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.

D. Provide summary of shutdown requirements for existing systems which are necessary to complete start-up of new equipment and systems.

E. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

1.04 PERFORMANCE TESTING

A. Test equipment for proper performance at point of manufacture or assembly when specified.

B. When source quality control testing is specified:
   1. Demonstrate equipment meets specified performance requirements.
   2. Provide certified copies of test results.
   3. Do not ship equipment until certified copies have received written acceptance from ENGINEER. Written acceptance does not constitute final acceptance.
   4. Perform testing as specified in the equipment sections.

1.05 GENERAL START-UP AND TESTING PROCEDURES

A. Mechanical systems: As specified in the individual equipment Sections and Sections 15050, and 15958:
   1. Remove rust preventatives and oils applied to protect equipment during construction.
   2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.
   3. Flush fuel system and provide fuel for testing and start-up.
   4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
   5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
   6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
   7. Perform cold alignment and hot alignment to manufacturer's tolerances.

8. Adjust V-belt tension and variable pitch sheaves.
9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to insure no leakage, but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.
10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

B. Electrical systems:
1. Perform insulation resistance tests on wiring except 120 volt lighting, wiring, and control wiring inside electrical panels.
2. Perform continuity tests on grounding systems.
3. Test and set switchgear and circuit breaker relays for proper operation.
4. Perform direct current high potential tests on all cables that will operate at more than 2,000 volts. Obtain services of independent testing lab to perform tests.
5. Check motors for actual full load amperage draw. Compare to nameplate value.

C. Instrumentation systems:
1. Bench or field calibrate instruments and make required adjustments and control point settings.
2. Leak test pneumatic controls and instrument air piping.
3. Energize transmitting and control signal systems, verify proper operation, ranges, and settings.

1.06 FUNCTIONAL TESTING

A. Perform checkout and performance testing as specified in the individual equipment Sections.

B. Functionally test mechanical and electrical equipment, and instrumentation and controls systems for proper operation after general start-up and testing tasks have been completed.

C. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.

D. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation, and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.

E. Conduct continuous 8-hour test under full load conditions. Replace parts which operate improperly.

1.07 OPERATIONAL TESTING

A. After completion of operator training, conduct operational test of the entire facility. Demonstrate satisfactory operation of equipment and systems in actual operation.

B. Conduct operational test for continuous 7-day period.

C. OWNER will provide operations personnel, power, fuel, and other consumables for duration of test.

D. Immediately correct defects in material, workmanship, or equipment which became evident during operational test.

E. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified.

1.08 CERTIFICATE OF PROPER INSTALLATION

A. At completion of Functional Testing, furnish written report prepared and signed by manufacturer's authorized representative, certifying equipment:
   1. Has been properly installed, adjusted, aligned, and lubricated.
   2. Is free of any stresses imposed by connecting piping or anchor bolts.
   3. Is suitable for satisfactory full-time operation under full load conditions.
   4. Operates within the allowable limits for vibration.
   5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
   6. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.

B. Furnish written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:
   1. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.
   2. Control logic for equipment start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.
   3. Co-sign the reports along with the manufacturer's representative and subcontractors.

1.09 TRAINING OF OWNER'S PERSONNEL

A. Provide operations and maintenance training for items of mechanical, electrical, and instrumentation equipment. Utilize manufacturer's representatives to conduct training sessions.

B. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more than 2 sessions per week.

C. Provide Operation and Maintenance Manual for specific pieces of equipment or systems 1 month prior to training session for that piece of equipment or system.

D. Satisfactorily complete functional testing before beginning operator training.

E. Training sessions: Provide training sessions for equipment as specified in the individual equipment Sections.

F. The CONTRACTOR shall videotape all training sessions and provide a copy for the OWNER.

G. The CONTRACTOR shall designate and provide 1 or more persons to be responsible for coordinating and expediting his/her training duties. The person or persons so designated shall be present at all training coordination meetings with the OWNER.

H. The CONTRACTOR's coordinator shall coordinate the training periods with OWNER personnel and manufacturer's representatives, and shall submit a training schedule for each piece of equipment or system for which training is to be provided. Such training schedule shall be submitted not less than 21 calendar days prior to the time that the associated training is to be provided and shall be based on the current plan of operation.

1.10 RECORD KEEPING

A. Maintain and submit following records generated during start-up and testing phase of Project:
   1. Daily logs of equipment testing identifying all tests conducted and outcome.
   2. Logs of time spent by manufacturer's representatives performing services on the job site.
   3. Equipment lubrication records.
   4. Electrical phase, voltage, and amperage measurements.
   5. Insulation resistance measurements.
   6. Data sheets of control loop testing including testing and calibration of instrumentation devices and setpoints.

END OF SECTION

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SECTION 02485

SEEDING AND SODDING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials and equipment necessary to satisfactorily return all construction areas to their original conditions or better.

B. Work shall include furnishing and placing seed or sod, fertilizing, planting, watering and maintenance until acceptance by Engineer/Owner.

1.02 RELATED WORK NOT INCLUDED

A. Excavation, filling and grading required to establish elevation shown on the Drawings are included under other sections of these Specifications.

1.03 QUALITY ASSURANCE

A. It is the intent of this Specification that the Contractor is obliged to deliver a satisfactory stand of grass as specified. If necessary, the Contractor shall repeat any or all of the Work, including grading, fertilizing, watering and seeding or sodding at no additional cost to the Owner until a satisfactory stand is obtained. For purposes of grassing, a satisfactory stand of grass is herein defined as a full lawn cover over areas to be sodded or seeded, with grass free of weeds, alive and growing, leaving no bare spots larger than 3/4 square yard within a radius of eight (8) feet.

B. All previously grassed areas where pipelines are laid shall be sodded. All sodding and grassing shall be installed in accordance with these Specifications or as directed by the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fertilizer: The fertilizer shall be of the slow-release type meeting the following minimum requirements: 12 percent nitrogen, 8 percent phosphorus, 8 percent potassium; 40 percent other available materials derived from organic sources. At least 50 percent of the phosphoric acid shall be from normal super phosphate or an equivalent source which will provide a minimum of two units of sulfur. The amount of sulfur shall be indicated on the quantitive analysis card attached to each bag or other container. Fertilizer shall be uniform in composition, dry and free flowing delivered to sites in original unopened containers bearing manufacturer's statement or guarantee.

B. Seeding/Grassing: The Contractor shall grass all unpaved areas disturbed during construction which do not require sod. All grassing shall be completed in conformance with FDOT Specifications, Sections 570 and 981. The grassed areas

shall be mulched and fertilized in accordance with FDOT Specifications, except that no additional payment will be made for mulching, fertilizing and/or watering.

C. Sodding: Sod shall be provided as required on the construction drawings or at locations as directed by the Engineer in accordance with Florida Department of Transportation, Specifications Section 575 and 981. The Contractor shall furnish bahia grass sod or match existing sod. Placement and watering requirements shall be in accordance with FDOT Specifications Section 575, except that no additional payment will be made for placement and/or watering. This cost shall be included in the Contract price bid for sodding.

D. Topsoil: Topsoil stockpiled during excavation may be used as necessary. If additional topsoil is required to replace topsoil removed during construction, it shall be obtained off site at no additional cost to the Owner. Topsoil shall be fertile, natural surface soil, capable of producing all trees, plants and grassing specified herein.

E. Water: It is the Contractor's responsibility to supply all water to the site, as required during seeding and sodding operations and through the maintenance period and until the work is accepted. The Contractor shall make whatever arrangements that may be necessary to ensure an adequate supply of water to meet the needs for his work. He shall also furnish all necessary hose, equipment, attachments and accessories for the adequate irrigation of lawns and planted areas as may be required. Water shall be suitable for irrigation and free from ingredients harmful to plant life.

PART 3 EXECUTION

3.01 INSTALLATION

A. When the trench backfill has stabilized sufficiently, the Contractor shall commence work on lawns and grassed areas, including fine grading as necessary and as directed by the Engineer.

B. Finish Grading: Areas to be seeded or sodded shall be finish graded, raked, and debris removed. Soft spots and uneven grades shall be eliminated. The Engineer shall approve the finish grade of all areas to be seeded or sodded prior to seed or sod application.

C. Protection: Seeded and sodded areas shall be protected against traffic or other use by placing warning signs or erecting barricades as necessary. Any areas damaged prior to acceptance by the Owner shall be repaired by the Contractor as directed by the Engineer.

3.02 CLEANUP

A. Soil or similar materials spilled onto paved areas shall be removed promptly, keeping those areas as clean as possible at all times. Upon completion of seeding and sodding operations, all excess soil, stones and debris remaining shall be removed from the construction areas.

3.03 LANDSCAPE MAINTENANCE

A. Any existing landscape items damaged or altered during construction by the Contractor shall be restored or replaced as directed by the Engineer.

B. Maintain landscape work for a period of 90 days immediately following complete installation of work or until Owner accepts project. Watering, weeding, cultivating, restoration of grade, mowing and trimming, protection from insects and diseases, fertilizing and similar operations as needed to ensure normal growth and good health for live plant material shall be included at no additional cost to the Owner.

3.04 REPAIRS TO LAWN AREAS DISTURBED BY CONTRACTOR'S OPERATORS

A. Lawn areas planted under this Contract and all lawn areas damaged by the Contractor's operation shall be repaired at once by proper soil preparation, fertilizing and sodding, in accordance with these Specifications.

END OF SECTION

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SECTION 02640

VALVES AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.

B. All valves and appurtenances shall be of the size shown on the Drawings and, to the extent possible, all equipment of the same type on the Project shall be from one manufacturer.

C. All valves and appurtenances shall have the name of the manufacturer and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

D. All valves shall have a factory applied, fusion bonded epoxy coating on interior and exterior unless noted otherwise in the plans or this specification.

E. The equipment shall include, but not be limited to, the following:
   1. Pressure Sustaining and Check Valves
   2. Ball Valves for PVC Pipe
   3. Plug Valves
   4. Hose Bibs

1.02 DESCRIPTION OF SYSTEMS

A. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of potable water, reclaim water, wastewater, etc., depending upon the applications.

1.03 QUALIFICATIONS

A. All of the types of valves and appurtenances shall be products of well established, reputable firms who are fully experienced and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed and, installed in accordance with the best practices and methods and shall comply with these Specifications as applicable. Valves shall be as covered under mechanical devices in Section 8 of ANSI/NSF Standard 61.

1.04 SUBMITTALS

A. Submit to the Engineer within 30 days after execution of the contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.

B. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer for approval in accordance with the Specifications.

1.05 TOOLS

A. Special tools, if required for normal operation and maintenance shall be supplied with the equipment.

PART 2 PRODUCTS

2.01 PRESSURE SUSTAINING AND CHECK VALVE

A. Pressure sustaining and check valve shall be pilot operated diaphragm actuated valve with cast iron body, bronze trim, and 125-pound flanged ends. The valve shall be hydraulically operated, diaphragm type globe valve. The main valve shall have a single removable seat and a resilient disc, of rectangular cross section, surrounded on three and a half sides. The stainless steel stem shall be fully guided at both ends by a bearing in the valve cover, and an integral bearing in the valve seat. It shall be sleeved at both ends with delrin. No external packing glands are permitted and there shall be no pistons operating the main valve or any controls. The valve shall be equipped with isolation cocks to service the pilot system while permitting flow if necessary. Main valve and all pilot controls shall be manufactured in the United States of America. Valve shall be single chamber type, with seat cut to 5 degrees taper.

B. Valve shall maintain a minimum (adjustable) upstream pressure to a preset (adjustable) maximum. The pilot system shall consist of two direct acting, adjustable, spring loaded diaphragm valves.

C. Valve shall be cast iron (ASTM A48) with main valve trim of brass (QQB-B-626) and bronze (ASTM B61). The pilot control valves shall be cast brass (ASTM B62) with 303 stainless steel trim. All ferrous surfaces inside and outside shall have a 2-part epoxy coating. Valve shall be similar in all respects to CLA-VAL Company, Model 692G-01ABKG, as manufactured by CLA-VAL Company, , or similar pressure sustaining and check valve as manufactured by Golden Alderson; or approved equal.

2.02 BALL VALVES FOR PVC PIPE

A. Ball valves for PVC pipe shall be of PVC Type 1 with union, socket, threaded or flanged ends as required. Ball valves shall be full port, full flow, all plastic construction, 150 psi rated with teflon seat seals and T-handles. PVC ball valves shall be as manufactured by Celanese Piping Systems, Inc., Wallace and Tiernan, Inc., Plastiline, Inc., or approved equal.

B. All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

2.03 PLUG VALVES

A. All plug valves shall be eccentric plug valves capable of sustaining 150 psi in either direction without leaking.Exception: Single direction plug valves may be used if it is

clearly demonstrated they will never be required to resist pressure in both directions either in service or during pipe line testing.

B. Plug valves shall be tested in accordance with current AWWA Standard C-504-80 Section 5. Each valve shall be performance tested in accordance with paragraph 5.2 and shall be given a leakage test and hydrostatic test as described in paragraphs 5.3 and 5.4. The manufacturer shall furnish certified copies of reports covering proof of design testing as described in Section 5.5.

C. Plug valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connections as shown on the Plans. Flanged valves shall be faced and drilled to the ANSI 150 lb. standard. Mechanical joint ends shall be to the AWWA Standard C111-72. Bell ends shall be to the AWWA Standard C100-55 Class B. Screwed ends shall be to the NPT standard.

D. Plug valve bodies shall be of ASTM A126 Class B Semi-steel, 31,000 psi tensile strength minimum in compliance with AWWA Standard C507-73, Section 5.1 and AWWA Standard C504-70 Section 6.4. Port areas for valves 20-inches and smaller shall be 80 percent of full pipe area. Valves 24 inch and larger shall have a minimum port area between 80 and 100 percent of full nominal pipe area. All exposed nuts, bolts, springs, washers, etc. shall be zinc or cadmium plated. Resilient plug facings shall be of Hycar or Neoprene.

E. Plug valves shall be furnished with permanently lubricated stainless steel or oil-impregnated bronze upper and lower plug stem bushings. These bearings shall comply with current AWWA Standards.

2.04 HOSE BIBS

A. Hose bibs shall be 3/4" or 1" brass, polished chromium plated brass, with vacuum breaker as noted on the drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. All valves and appurtenances shall be installed in the location shown, true to alignment and rigidly supported. Any damage occurring to the above items before they are installed shall be repaired to the satisfaction of the Engineer.

B. After installation, all valves and appurtenances shall be tested at least two hours at the working pressure corresponding to the class of pipe, unless a different test pressure is specified. If any joint proves to be defective, it shall be repaired to the satisfaction of the Engineer.

C. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and he shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.

D. Pipe for use with flexible couplings shall have plain ends as specified in the respective pipe sections.

E. Flanged joints shall be made with high strength, low alloy Corten bolts, nuts and washers. Mechanical joints shall be made with mild corrosion resistant alloy steel bolts and nuts. All exposed bolts shall be painted the same color as the pipe. All buried bolts and nuts shall be heavily coated with two (2) coats of bituminous paint comparable to Inertol No. 66 Special Heavy.

F. Prior to assembly of split couplings, the grooves as well as other parts shall be thoroughly cleaned. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap or graphite paste, and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, the gasket shall be centered properly over the pipe ends with the lips against the pipes. The housing sections then shall be placed. After the bolts have been inserted, the nuts shall be tightened until the housing sections are firmly in contact, metal-to-metal, without excessive bolt tension.

G. Prior to the installation of sleeve-type couplings, the pipe ends shall be cleaned thoroughly for a distance of 8". Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6 inches from the end.

3.02 SHOP PAINTING

A. Ferrous surfaces of valves and appurtenances shall receive a coating of rust-inhibitive primer. All pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation.

3.03 FIELD PAINTING

A. All metal valves and appurtenances specified herein and exposed to view shall be painted.

3.04 INSPECTION AND TESTING

A. Completed pipe shall be subjected to hydrostatic pressure test for two (2) hours at 180 psi. All leaks shall be repaired and lines retested as approved by the Engineer. Prior to testing, the pipelines shall be supported in an approved manner to prevent movement during tests.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Cast-in-place concrete.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete.
   2. ACI Manual of Concrete Practice.

B. American Society for Testing and Materials (ASTM):
   1. C 31 - Practice for Making and Curing Concrete Test Specimens in the Field.
   2. C 33 - Specification for Concrete Aggregates.
   3. C 39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   4. C 40 - Test Method for Organic Impurities in Fine Aggregates for Concrete.
   5. C 42 – Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   6. C 88 - Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   7. C 94 - Specification for Ready-Mixed Concrete.
   8. C 114 - Test Methods for Chemical Analysis of Hydraulic Cement.
   9. C 117 - Test Method for Material Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing.
   10. C 123 - Test Method for Lightweight Particles in Aggregate.
   11. C 131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   12. C 136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   13. C 138 - Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
   14. C 142 - Test Method for Clay Lumps and Friable Particles in Aggregate.
   15. C 143 - Test Method for Slump of Hydraulic Cement Concrete.
   16. C 150 - Specification for Portland Cement.
   17. C 156 - Test Method for Water Retention by Concrete Curing Materials.
   18. C 157 - Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   19. C 171 - Specification for Sheet Materials for Curing Concrete.
   20. C 172 - Practice for Sampling Freshly Mixed Concrete.
   21. C 231 - Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   22. C 260 - Specification for Air-Entraining Admixtures for Concrete.
   23. C 289 - Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).

24. C 295 - Guide for Petrographic Examination of Aggregates for Concrete.
25. C 309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
26. C 311 - Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
27. C 494 - Specification for Chemical Admixtures for Concrete.
28. C 595 - Specification for Blended Hydraulic Cements.
29. C 618 - Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland-Cement Concrete.
30. C 1064 - Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
31. C 1017 - Specification for Chemical Admixtures for use in Producing Flowing Concrete.
32. D 75 - Practices for Sampling Aggregates.

C. NSF International (NSF)
   1. NSF Standard 61 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Alkali: Is defined to mean sum of sodium oxide and potassium oxide calculated as sodium oxide.

B. Hairline Crack: Crack with a crack width of less than 4 thousandths of an inch (0.004 inches).

1.04 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of portland cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.
      b. Proportion materials in a manner that will secure lowest water-cement ratio which is consistent with good workability, plastic, cohesive mixture, and one which is within specified slump range.
      c. Proportion fine and coarse aggregate in manner such as not to produce harshness in placing nor honeycombing in structures.
   2. Watertightness of Concrete Work: It is intent of this Section to secure for every part of the Work concrete and grout of homogeneous structure that, when hardened will have required strength, watertightness, and durability.
      a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.
      b. Construction, control and expansion joints have been positioned in structures as indicated on the Drawings, and curing methods have been specified, to reduce number and size of these expected cracks, due to normal expansion and contraction expected from specified concrete mixes.

c. Class A and Class B Concrete: Watertight: Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
d. Pressure inject visible cracks, other than hairline cracks and crazing, in following areas with epoxy as specified in Section 03931.
1) Floors and walls of water bearing structures.
2) Walls and overhead slabs of passageways or occupied spaces, outsides of which are exposed to weather or may be washed down and are not specified to receive separate waterproof membrane.
3) Other Items Not Specified to Receive Separate Waterproof Membrane: Slabs over water channels, wet wells, reservoirs, and other similar surfaces.
e. Walls or slabs, as specified above, that leak or sweat because of porosity or cracks too small for successful pressure grouting: Seal on water or weather side by coatings of surface sealant system, as specified in this Section.
f. Grouting and Sealing: Continue as specified above until structure is watertight and remains watertight for not less than one year after final acceptance or date of final repair, whichever occurs later in time.

3. Workmanship and Methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318 and ACI Manual of Concrete Practice.

1.05 SUBMITTALS

A. Product Data: Submit data completely describing products.

B. Information on Heating Equipment to Be Used for Cold Weather Concreting: Submit information on type of equipment to be used for heating materials and/or new concrete in process of curing during cold weather.

C. For conditions that promote rapid drying of freshly placed concrete such as low Humidity, high temperature, and wind: Submit corrective measures proposed for use prior to placing concrete.

D. Copies of Tests of Concrete Aggregates: Submit certified copies of commercial laboratory tests not more than 90 days old for samples of each aggregate proposed for use in concrete aggregates.
1. Fine Aggregate:
a. Clay lumps.
b. Reactivity.
c. Shale and chert.
d. Soundness.
e. Color.
f. Decantation.
2. Coarse Aggregate:
a. Clay lumps and friable particles.
b. Reactivity.
c. Shale and chert.
d. Soundness.
e. Abrasion loss.
f. Coal and lignite.

g. Materials finer than 200 sieve.

E. Sieve Analysis: Submit sieve analyses of fine and coarse aggregates being used at least every 3 weeks and at any time there is significant change in grading of materials.

F. Concrete Mixes: Submit full details, including mix design calculations for concrete mixes proposed for use for each class of concrete.
   1. Include information on correction of batching for varying moisture contents of fine aggregate.
   2. Submit source quality test records with mix design submittal.
      a. Include calculations for required average compression strength of concrete (f'_cr) based on source quality test records.

G. If There is Change in Aggregate Source, or Aggregate Quality from Same Source: Submit new set of design mixes covering each class of concrete.

H. Test Batch Test Data:
   1. Submit data for each test cylinder.
   2. Submit data that identifies mix and slump for each test cylinder.

I. Sequence of Concrete Placing: Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements.

J. Curing Compound: Submit complete data on proposed compound.

K. Repair of Defective Concrete: Submit mix design for grout.

L. Acceptance of Method of Concrete Repair: Make no repair until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.

M. If Either Fine or Coarse Aggregate Is Batched from More than One Bin: Submit analyses for each bin, and composite analysis made up from these, using proportions of materials to be used in mix.

N. Cement Mill Tests: Include alkali content, representative of each shipment of cement for verification of compliance with specified requirements.

O. Pozzolan Certificate of Compliance: Identify source of Pozzolan and certify compliance with requirements of ASTM C 618.

P. Admixtures: Manufacturer’s catalog cuts and product data indicating compliance with standards specified.
   1. If air entraining admixture requires test method other than ASTM C 231 to accurately determine air content, make special not of requirements in submittal.

Q. Information on mixing equipment.

R. CONTRACTOR’s report of field quality control testing for slump, temperature, unit weight, and air entrainment. Include designation numbers for associated compressive strength test cylinders with report.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:
   1. Deliver, store, and handle concrete materials in manner as to prevent damage and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.
   3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.

B. Acceptance at Site: Reject material containers or materials showing evidence of water or other damage.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Hot Weather Concreting:
      a. When Ambient Air Temperature Is above 90 Degrees Fahrenheit: Prior to placing concrete, cool forms and reinforcing steel to by water cooling to below 90 degrees Fahrenheit.
      b. Temperature of Concrete Mix at Time of Placement: Keep temperature below 90 degrees Fahrenheit by methods that do not impair quality of concrete.
   2. Cold Weather Concreting:
      a. Concrete placed below ambient air temperature of 45 degrees Fahrenheit and falling or below 40 degrees Fahrenheit: Make provision for heating water.
      b. If materials have been exposed to freezing temperatures to degree that any material is below 35 degrees Fahrenheit: Heat such materials.
      c. Heating Water, Cement, or Aggregate Materials:
         1) Do not heat in excess of 160 degrees Fahrenheit.
      d. Protection of Concrete in Forms:
         1) Protect by means of covering with tarpaulins, or other acceptable covering.
         2) Provide means for circulating warm moist air around forms in manner to maintain temperature of 50 degrees Fahrenheit for at least 5 days.
   3. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Take corrective measures to minimize rapid water loss from concrete.
   4. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature around concrete.

1.08 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in such manner as to complete any single placing operation to construction, contraction, or expansion joint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate:

1. General:
   a. Provide concrete aggregates that are sound, graded as specified, and free of deleterious material in excess of allowable amounts specified.
   b. Test for aggregate gradation in accordance with ASTM D 75 and C 136.
   c. Provide unit weight of fine and coarse aggregate to produce in place concrete with weight of:
      1) Not less than 140 pounds per cubic foot for normal weight concrete.
      2) Not more than 115 pounds per cubic foot for lightweight concrete.
2. Aggregate for Normal Weight Concrete
   a. Fine Aggregate:
      1) Provide fine aggregate conforming to ASTM C 33, except as modified in the following paragraphs.
      2) Deleterious Substances: Not in excess of following percentages by weight.

Item	Test Method	Percent
Shale or Chert	ASTM C 295	1
Clay Lumps	ASTM C 142	1

   b. Coarse Aggregate:
      1) General: Provide coarse aggregate conforming to the requirements of ASTM C 33, except as modified in the following paragraphs.
      2) Weight: Not exceeding 15 percent, for thin or elongated pieces having length greater than 5 times average thickness.
      3) Deleterious Substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

Item	Test Method	Percent
Shale or chert	ASTM C 295	1
Coal and lignite	ASTM C 123	1/4
Clay lumps and friable particles	ASTM C 142	1/4
Materials finer than Number 200 sieve	ASTM C 117	1/2*
* Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.		

      4) Grading:
         a) As specified in ASTM C 33, Size Number 57, unless otherwise specified or authorized in writing by the ENGINEER.
         b) Aggregate for Class CE Concrete for Encasement of Electrical Conduits: Graded as specified in ASTM C 33, Size Number 8.
3. Aggregate for Lightweight Concrete
   a. Fine Aggregate:
      1) Provide fine aggregate conforming to ASTM C330.

b. Coarse Aggregate:
    1) General: Provide coarse aggregate conforming to the requirements of ASTM C330.
    2) Grading: As specified in ASTM C330 for 3/4 inch to No. 4, unless otherwise specified or authorized in writing by the ENGINEER.

B. Portland Cement:
1. General: Conform to specifications and tests for ASTM C 150, Types II or III, Low Alkali, except as specified otherwise.
2. Low Alkali Portland: Have total alkali containing not more than 0.60 percent.
3. Exposed Concrete in Any Individual Structure: Use only one brand of portland cement.
4. Cement for Finishes: Provide cement from same source and of same type as concrete to be finished.

C. Admixtures:
1. General:
    a. Do not use admixtures of any type, except as specified, unless written authorization has been obtained from the ENGINEER.
    b. Admixtures shall be compatible with concrete constituents and with other admixtures. All admixtures in a given mix shall be products of the same manufacturer to ensure compatibility.
    c. Admixtures for concrete that will be in contact with potable water shall be non-toxic and shall not impart taste or odor to the water. Admixtures shall be listed under NSF 61 or carry other approval, that is acceptable to the ENGINEER, for use in contact with potable water
    d. Do not use admixtures containing chlorides calculated as chloride ion in excess of 0.5 percent by weight.
    e. Use in accordance with manufacturer's recommendations and add each admixture to concrete mix separately.
2. Air Entraining Admixture:
    a. Provide entrained air of evenly dispersed air bubbles at time of placement.
    b. Conform to ASTM C 260.
3. Fly Ash Pozzolan Admixture:
    a. Pozzolan:
        1) Conforming to requirements of ASTM C 618, Class F.
        2) Pozzolan may replace portland cement at ratio of 1.0 pound fly ash for each pound of portland cement replaced.
        3) Maximum of 20 percent by weight of minimum quantity of portland cement listed in Table A under paragraph 2.03D may be replaced with pozzolan.
        4) Do not use pozzolan as an admixture in concrete made with portland-pozzolan cement.
    b. Loss on Ignition for Pozzolan: Not exceed four percent.
4. Water Reducing Admixture:
    a. May be used at the CONTRACTOR's option.
    b. Conform to ASTM C 494, Type A.
    c. Not contain air entraining agents.
    d. Liquid form before adding to the concrete mix.
    e. No decrease in cement is permitted as result of use of water reducing admixture.
5. High-Range Water Reducer / Superplasticizer:

a. Conform to ASTM C 494, Type F or ASTM C 1017, Type I. Use shall produce non-segregating plasticized concrete with little bleeding and the physical properties of low water/cement ratio concrete. Admixture shall maintain treated concrete in a plasticized state for not less than 2 hours.

D. Water:
   1. Water for Concrete, Washing Aggregate, and Curing Concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
   2. Chlorides and Sulfate Ions:
      a. Water for Conventional Reinforced Concrete: Use water not containing more than 1,000 (mg/L) of chlorides calculated as chloride ion, nor more than 1,000 (mg/L) of sulfates calculated as sulfate ion.

E. Non-slip Abrasive:
   1. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate, homogenous, non-glazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
   2. Manufacturers: One of the following or equal:
      a. Exolon Company, Tonawanda, New York.
      b. Abrasive Materials, Incorporated, Hillsdale, Michigan.

F. Conduit Encasement Coloring Agent:
   1. Color: Red color concrete used for encasement of electrical ducts, conduits, similar type items.
   2. Manufacturers: One of the following or equal.
      a. Frank D. Davis Company, Red Oxide Number 1117.
      b. I. Reiss Company, Inc., equivalent product.
   3. Conduit Encasement Concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

G. Curing and Finishing Materials
   1. General:
      a. Materials shall be compatible with concrete and with other materials.
      b. Curing and finishing materials for concrete that will be in contact with potable water shall be non-toxic and shall not impart taste or odor to the water. Materials shall be listed under NSF 61 or carry other approval that is acceptable to ENGINEER for use in contact with potable water.
   2. Sprayed Membrane Curing Compound: Clear type with fugitive dye conforming to ASTM C 309, Type 1D.
   3. Evaporation Retardant:
      a. Manufacturers: One of the following or equal:
         1) Master Builders Technologies, Cleveland, Ohio, Confilm.
         2) Eucid Chemical Company, Cleveland, Ohio, Eucobar.
   4. Plastic Membrane Curing: Use polyethylene film conforming to ASTM C 171 unless otherwise noted.
      a. Color: White
      b. Thickness: Minimum 6 mils.
      c. Loss of Moisture: Not exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C 156.

2.02 EQUIPMENT

A. Mixing Concrete:
   1. Mixers may be of stationary plant, paver, or truck mixer type.
   2. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material.
   3. Mixing Equipment:
      a. Capable of combining aggregates, cement, and water within specified time into thoroughly mixed and uniform mass and of discharging mixture without segregation.
      b. Maintain concrete mixing plant and equipment in good working order and operated at loads, speeds, and timing recommended by manufacturer or as specified.
      c. Proportion cement and aggregate by weight.

B. Machine Mixing:
   1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.
   2. If bulk cement is used, weigh it on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
   3. Prevent cement from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
   4. Procedure of mixing cement with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
   5. Retempering of concrete (re-mixing of concrete that has started to take its initial set) will not be permitted.
   6. Discharge entire batch before recharging.
   7. Volume of Mixed Material Per Batch: Not exceed manufacturer's rated capacity of mixer.
   8. Mixers:
      a. Perform mixing in batch mixers of acceptable type.
      b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
      c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing.
         1) Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.

C. Transit-mixed Concrete:
   1. Mix and deliver in accordance with ASTM C 94.
   2. Total Elapsed Time Between Addition of Water at Batch Plant and Discharging Completed Mix: Not to exceed 90 minutes nor 300 revolutions of the mixing drum. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the ENGINEER.
   3. Temperature - Minimum and Maximum Allowable During Mixing and Transporting:
      a. Minimum: 55°F
      b. Maximum: 90°F

4. Equip each truck mixer with device interlocked so as to prevent discharge of concrete from drum before required number of turns and furnish such device that is capable of counting number of revolutions of drum.
5. Continuously revolve drum after it is once started until it has completely discharged its batch.
    a. Do not admit water until drum has started revolving.
    b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The CONTRACTOR will not be entitled to additional compensation because of such increase or decrease.

D. Other Types of Mixers: In case of other types of mixers, mixing shall be as follows:
1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than one cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.03 MIXES

A. Measurements of Materials:
1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the ENGINEER.
2. Furnish apparatus for weighing aggregates and cement that is suitably designed and constructed for this purpose.
3. Accuracy of Weighing Devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within one percent of desired amount of that material.
4. Measuring or Weighing Devices: Subject to review by the ENGINEER, and bear valid seal of the Sealer of Weights and Measures having jurisdiction.
5. Weighing Cement:
    a. Weigh cement separately.
    b. Cement in Unbroken Standard Packages (Sacks): Need not be weighed.
    c. Bulk Cement and Fractional Packages: Weigh such cement.
6. Mixing Water: Measured by volume or by weight.

B. Concrete Proportions and Consistency:
1. Concrete Consistency and Composition:
    a. Provide concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on surface.
    b. Prevent unnecessary or haphazard changes in consistency of concrete.
2. Ratio of Coarse Aggregate to Fine Aggregate: Not less than 1.0 nor more than 2.0 for all concrete Classes, with exception of Class CE.
3. Aggregate:
    a. Obtain aggregate from source that is capable of providing uniform quality, moisture content, and grading during any single day's operation.
4. Concrete Mix Water to Cement Ratio, Minimum Cement Content, and Slump Range: Conform to values specified in Table A in this Section.

5. Concrete Batch Weights: Control and adjust so as to secure maximum yield, and at all times maintain proportions of concrete mix within specified limits.
6. Mixture Modification: If required, by the ENGINEER, modify mixture within limits set forth in this Section.
7. Admixtures: Provide admixtures as specified in this Section.
    a. Air Entraining Admixture
        1) Add agent to batch in portion of mixing water.

C. Concrete Mixes:
1. Proportioning of Concrete Mix: Proportion mixes for required average ~~on~~ compressive strength (f'_cr) as defined in Subparagraph 2.04A2.
2. Mixes:
    a. Adjusting of Water: After acceptance, do not change mixes without acceptance by ENGINEER, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.
    b. Total Water Content of Each Concrete Class: Not exceed those specified in Table A in this Section.
    c. Checking Moisture Content of Fine Aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
3. Change in Mixes: Undertake new trial batch and test program as specified in this Section.

D. Classes of Concrete:
1. Provide concrete classes, referenced herein as Classes A, B, C and CE, and use where specified or indicated on the Drawings.
2. Class A Concrete: Normal weight concrete with minimum weight of 140 pounds per cubic foot. Use Class A concrete at all locations except those where Classes B, C and CE are specified or indicated on the Drawings.
3. Class B Concrete: Normal weight concrete with minimum weight of 140 pounds per cubic foot. Class B concrete may be substituted for Class A concrete, when high-early strength concrete is needed in areas specifically accepted by the ENGINEER and that do not require sulfate resistant concrete.
4. Class C Concrete: Normal weight concrete with minimum weight of 140 pounds per cubic foot. Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
5. Class CE Concrete: Normal weight concrete with minimum unit weight of 140 pounds per cubic foot. Use Class CE for electrical conduit encasements.
6. Class D Concrete: Lightweight concrete with maximum unit weight of 115 pounds per cubic foot. Use Class D for lightweight precast prestressed concrete roof framing including tees, inverted tee beams, rectangular roof beams.

"TABLE A" CONCRETE WITH AIR ENTRAINMENT						
Class	Specified Compressive Strength f'c at 28 Days (pounds per square inch)	Aggregate Type	Ratio of Maximum Net Water to Cementitious Materials	Minimum Cementitious Materials per Cubic Yard of Concrete (by weight - pounds)	Slump Range (Inches)	Entrained Air (Percent)
A (Type II cement)	4,500	Normal weight	0.42	564	2 to 4*	6±1.5
B (Type III cement)	4,500	Normal weight	0.42	564	2 to 4*	6±1.5
C	2,500	Normal weight	0.62	423	3 to 6	5±1
CE	2,500	Normal weight	0.62	564	3 to 6	5±1
D	5,000	Light weight	0.45	658	2 to 4	5±1
* NOTE: Slump for slabs, decks, walks, and beams shall be not more than 3-1/2 inches. Slump for drilled piers shall be 5 inches ±1 inch.						

7. Pumped Concrete: Provide pumped concrete that complies with all requirements of this Section.
8. Do not place concrete with slump outside limits indicated in Table A.
9. Classes:
    a. Classes A, C, and CE Concrete: Make with Type II low alkali cement.
    b. Class B Concrete: Make with Type III low alkali cement.
    c. Class D Concrete: Make with Type II or Type III low alkali cement.

E. Admixtures:
1. Air Entraining Admixture:
    a. Add agent to batch in portion of mixing water.
    b. Batch solution by means of mechanical batcher capable of accurate measurement.

2.04 SOURCE QUALITY CONTROL

A. Tests:
1. Concrete Mixes:
    a. Trial Batches
        1) After concrete mixes have been accepted by ENGINEER, have trial batches of the accepted Class A, Class B, and Class D concrete mix designs prepared by testing laboratory acceptable to the ENGINEER.
        2) Prepare trial batches for each class and slump range required within that class. Use cement and aggregates proposed to be used for the Work.

3) Trial Batches: Provide batches of sufficient quantity to determine slump, workability, consistency, and finishing characteristics, and to provide sufficient test cylinders.
4) Perform test batches and tests required to establish trial batches and acceptability of materials without change in Contract Price.
5) If trial batch tests do not meet specified requirements for slump, strength, workability, consistency, drying shrinkage, and finishing, change concrete mix design proportions and, if necessary, source of aggregate. Make additional trial batches and tests until an acceptable trial batch is produced that meets requirements of this Section.
6) Do not place concrete until the concrete mix design and trial batch have been accepted by ENGINEER.

b. Test Cylinders: Provide cylinders having six-inch diameter by 12-inch length and that are prepared in accordance with ASTM C 31 for tests specified in this Section.
1) Test 8 cylinders from each trial batch for compressive strength in accordance with ASTM C 39.
a) Test 4 cylinders at 7 days and 4 at 28 days.
b) Establish ratio between 7 day and 28 day strength for mix. Seven-day strength may be taken as satisfactory indication of 28-day strength provided effects on concrete of temperature and humidity between 7 day and 28 day are taken into account.
2) Average Compressive Strength of 4 Test Cylinders Tested At 28 Days shall be equal to or greater than required average compressive strength f'cr on which concrete mix design is based.

c. Required Average Compressive Strength:
1) Determine required average compressive strength (f'cr) for selection of concrete proportions for mix design, for each class of concrete, using calculated standard deviation and its corresponding specified compressive strength f'c, in accordance with ACI 318, Part 3, Chapter 5.
2) When test records of at least 30 consecutive tests that span period of not less than 45 calendar days are available, establish standard deviation as described in ACI 318, Part 3, Chapter 5 and modified herein.
3) Provide test records from which to calculate standard deviation that represent materials, quality control procedures, and conditions similar to materials, quality control procedures, and conditions expected to apply to concrete for the Work.
4) Provide changes in materials and proportions within test records that are more restricted than those for the Work.
5) Specified Compressive Strength (f'c) of Concrete Used in Test Records: Within 1,000 pounds per square inch of that specified for the Work.
6) When lacking adequate test records for calculation of standard deviation meeting requirements, determine required average compressive strength f'cr from following Table B.

TABLE B	
Specified Compressive Strength f'_c (pounds per square inch)	**Required Average Compressive Strength f'_cr (pounds per square inch)**
Less than 3,000	f'_c + 1,000
3,000 to 5,000	f'_c + 1,200

2. Pozzolan:
   a. Sampling and Testing:
      1) Sample and test pozzolan in accordance with ASTM C 311.
      2) In Computing Water to Cement Ratio And Cement Content Per Cubic Yard Of Concrete: Consider cement weight to be weight of portland cement plus 100 percent of weight of fly ash.
3. Aggregate:
   a. Testing of concrete aggregate is at CONTRACTOR's expense.
   b. Sieves:
      1) Use sieves with square openings for testing grading of aggregates.
      2) Sieve Analyses: If sieve analyses indicate significant change in materials, the ENGINEER may require that new mix design be submitted and accepted before further placing of concrete.
   c. Sample aggregate in accordance with ASTM D 75 and C 136.
   d. Fine Aggregate:
      1) Provide fine aggregate not containing strong alkali nor organic matter which gives color darker than standard color when tested in accordance with ASTM C 40.
      2) Provide aggregate having soundness complying with requirements of ASTM C 33 when tested in accordance with ASTM C 88.
      3) Provide aggregate complying with reactivity requirements of ASTM C 33 when tested in accordance with ASTM C 289.
   e. Coarse Aggregate:
      1) Soundness when tested in accordance with ASTM C 88: Have loss not greater than 10 percent when tested with sodium sulfate.
      2) Abrasion Loss: Not exceed 45 percent after 500 revolutions when tested in accordance with ASTM C 131.
      3) Reactivity: Not exceed limits specified in Appendix of ASTM C 33 when tested in accordance with ASTM C 289.
   f. Portland Cement:
      1) Determination Alkali Content: Determine by method set forth in ASTM C 114.

PART 3 EXECUTION

3.01 INSTALLATION

A. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, immediately after the concrete has been screeded, coat the surface of the concrete with a liquid evaporation retardant. Apply the evaporation retardant again after each work operation as necessary to prevent drying shrinkage cracks.

Conditions which result in rapid evaporation of moisture may include one or more of the following:

1. Low humidity.
2. Windy conditions.
3. High temperature.

B. Joints and Bonding:

1. As far as practicable construct concrete work as monolith.
2. Locations of contraction, construction, expansion, and other joints are indicated on the Drawings or as specified in this Section.
3. Construction Joints:
    a. Where construction joints are not indicated on the Drawings, provide slabs and walls with construction joints at intervals not greater than 30 feet.
    b. In order to preserve strength and watertightness of structures, make no other joints, except as authorized the ENGINEER.
    c. At construction joints, thoroughly clean concrete of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of heavy sandblasting, and wash surfaces just prior to succeeding concrete placement.
    d. At Horizontal Joints: Immediately prior to resuming concrete placing operations, thoroughly spread bed of grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over horizontal joint surfaces.
4. Keyways in Joints:
    a. Provide keyways in joints as indicated on the Drawings.
    b. Treat lumber keyway material with form release coating, applied in accordance with manufacturer's instructions.
5. Take special care to ensure that concrete is well consolidated around, below, and against waterstops and that waterstops are secured in proper position.
6. Cleaning of Construction Joints:
    a. Wash construction joints free of sawdust, chips, and other debris after forms are built and immediately before concrete or grout placement.
    b. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
    c. Provide cleanout hole at base of each wall and column for inspection and cleaning.
7. Expansion and Construction Joints
    a. Constructed where and as indicated on the Drawings.
    b. Waterstops, Expansion Joint Material, Synthetic Rubber Sealing Compound, and Other Similar Materials: As specified in Section 03150.
8. Repair of Concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first coat surface of set concrete with epoxy bonding agent.

C. Conveying and Placing Concrete:

1. Convey concrete from mixer to place of final deposit by methods that prevent separation or loss of materials.
2. Use chutes and equipment for pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without separation of materials.

3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of any day's placement.

D. Placing Concrete:
1. Place no concrete without prior authorization of the ENGINEER.
2. Do Not Place Concrete Until:
    a. Reinforcement is securely and properly fastened in its correct position and loose form ties at construction joints have been retightened.
    b. Dowels, bucks, sleeves, hangers, pipes, conduits, bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
    c. Forms have been cleaned and oiled as specified.
3. Placement of concrete in which initial set has occurred, or of retempered concrete, will not be permitted.
4. Place no concrete during rainstorms or high velocity winds.
5. Protect concrete placed immediately before rain to prevent water from coming in contact with such concrete or winds causing excessive drying.
6. Keep sufficient protective covering on hand at all times for protection of concrete.
7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested and accepted by the ENGINEER.
8. Notify the ENGINEER in writing of readiness, not just intention, to place concrete in any portion of the work.
    a. Provide this notification in such time in advance of operations as the ENGINEER deems necessary to make final inspection of preparations at location of proposed concrete placing.
    b. Place forms, steel, screeds, anchors, ties, and inserts in place before notification of readiness is given to the ENGINEER.
    c. Depositing Concrete:
        1) Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
        2) Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
        3) Do not drop concrete freely into place from height greater than 5 feet.
        4) Use tremies for placing concrete where drop is over 5 feet.
        5) Commence placement of concrete on slopes, at bottom of slope.
9. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
10. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached.
11. After placement begins, continue without significant interruption. Take precautions to prevent any delay from exceeding 20 minutes.
12. If concrete is to be placed over previously placed concrete and more than 20 minutes have elapsed, then spread layer of grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over surface before placing additional concrete.
13. Placement of Concrete for Slabs, Beams, or Walkways:
    a. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.

b. Allow set time of not less than one hour for shrinkage.

E. Consolidating Concrete:
1. Place concrete with aid of acceptable mechanical vibrators.
2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.
3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
   a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
   b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
   c. Place no concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
5. Take special care to place concrete solidly against forms so as to leave no voids.
6. Take every precaution to make concrete solid, compact, and smooth, and if for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the ENGINEER.

F. Footings and Slabs on Grade:
1. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the ENGINEER.
2. If necessary, sprinkle subgrade with water not less than 6 nor more than 20 hours in advance of placing concrete.
3. If it becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
4. Place no concrete if subgrade is muddy or soft.

G. Loading Concrete:
1. Green Concrete:
   a. No heavy loading of green concrete will be permitted.
   b. Green concrete is defined as concrete with less than 100 percent of the specified strength.
2. No backfill shall be placed against concrete walls until the concrete has reached the specified strength and the connecting slabs and beams have been cast and have reached the specified strength.
3. Use construction methods, sequencing, and allow time for concrete to reach adequate strength to prevent overstress of the concrete structure during construction.

H. Curing Concrete:
1. General:
   a. Cure concrete by methods specified in this Section.
   b. Cure concrete minimum of 7 days at average daily temperature not less than 50ºF. In no case shall temperature of curing concrete drop below 40ºF.
      1) Average daily temperature is calculated by summing hourly measurements of air temperature in the shade at the face of the concrete, and dividing the sum by 24. In calculating sum of the

temperatures recorded, any measurement less than 50ºF shall be recorded as 0ºF and included in the sum.

c. Cure concrete to be painted or cast against adjacent concrete (including construction joints) with water or plastic membrane.
d. Do not use curing compound on concrete surfaces that are to receive paint or upon which any material is to be bonded.
e. Water cure or plastic membrane cure concrete slabs that are specified to be sealed by concrete sealer or to receive grout topping.
f. Cure other concrete by water curing or sprayed curing membrane at the CONTRACTOR's option.
g. Floor slabs may be cured using plastic membrane curing.

2. Water Curing:
   a. Keep surfaces of concrete being water cured (including tops of walls) constantly and visibly moist day and night for period of not less than 7 days.
   b. Each day forms remain in place may count as 1 day of water curing.
   c. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
   d. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
   e. When steel forms are used, leave forms in place minimum 48 hours. Application of water for curing shall commence only after, but within 1 hour of, the time forms are removed.
3. Sprayed Membrane Curing:
   a. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
   b. If more than 1 hour elapses after removal of forms, do not use membrane curing compound, but apply water curing for full curing period.
   c. If surface requires repairing or painting, water cure such concrete surfaces.
   d. Curing Compound:
      1) Do not remove curing compound from concrete in less than 7 days.
      2) Curing compound may be removed only upon written request by the CONTRACTOR and acceptance by the ENGINEER, stating what measures are to be performed to adequately cure structures.
      3) Remove curing compound placed within construction joint silhouette by heavy sandblasting prior to placing any new concrete.
      4) Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound.
      5) Apply compound in at least 2 coats.
      6) Apply each coat in direction 90 degrees to preceding coat.
      7) Apply compound in sufficient quantity so that concrete has uniform appearance and that natural color is effectively and completely concealed at time of spraying.
      8) Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
      9) Thickness and Coverage of Compound: Provide compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
      10) The CONTRACTOR is cautioned that method of applying curing compound specified herein may require more compound than

normally suggested by manufacturer of compound and also more than is customary in the trade.

11) Apply amounts specified herein, regardless of manufacturer's recommendations or customary practice, if curing compound is used in place of water curing.
12) If the CONTRACTOR desires to use curing compound other than specified compound, coat sample areas of concrete wall with proposed compound and also similar adjacent area with specified compound in specified manner for comparison.
    a) If proposed sample is not equal or better, in opinion of the ENGINEER, in all features, proposed substitution will not be allowed.
13) Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

4. Plastic Membrane Curing:
    a. Polyethylene film may be used to cure slabs. Seal joints and edges with small sand berm.
    b. Install plastic membrane as soon as concrete is finished and can be walked on without damage.
    c. Keep concrete moist under plastic membrane.

3.02 CONCRETE FINISHING

A. Edges of Joints:
    1. Provide joints having edges as indicated on the Drawings.
    2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

3.03 FIELD QUALITY CONTROL

A. Testing Laboratory:
    1. OWNER will designate a testing laboratory for compression testing of field-cast concrete cylinders in accordance with ASTM C 39. Laboratory testing expenses will be paid by OWNER.

B. Testing
    1. During progress of construction, sample concrete in accordance with ASTM C 172 and make tests to determine whether concrete produced complies with project specifications.
    2. CONTRACTOR’s personnel to prepare test report including date and location of placement, name(s) of personnel performing tests, concrete batch delivery ticket number, concrete temperature, slump, unit weight, and air content.
    3. CONTRACTOR shall make, protect, and cure cylinders for compression strength testing in accordance with ASTM C 31.
        a. Label cylinders to indicate location of pour and cylinder numbers.
        b. Required number of cylinders for test set: Not less than 4 cylinder specimens, each 6 inches in diameter by 12 inches long. Two cylinders to be tested at 7 days, and two cylinders to be tested at 28 days.
        c. Required number of test sets:

1) Provide at least one test set for each class of concrete placed each day.
2) Provide at least on test set for each half-day's placement of each class of concrete.
3) Provide at least on test set for each 150 cubic yards of each class placed.

4. Additional testing performed by CONTRACTOR's ACI-certified personnel:
   a. Slump test in accordance with ASTM C 143.
      1) Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to do so by the ENGINEER.
   b. Temperature test in accordance with ASTM C 1064.
   c. Test for unit weight in accordance with ASTM C 138.
   d. Test for air content in accordance with ASTM C 231.
      1) If air entraining admixture used requires testing methods other than ASTM C 231 to accurately determine air content, report testing requirements to ENGINEER well in advance of concrete placement.
      2) Test percentage of entrained air at beginning of each placement, when requested by ENGINEER, and as often as necessary to maintain entrained air within specified range.

C. Enforcement of Specification Requirements
   1. Compressive Strength.
      a. Concrete is expected to reach higher compressive strength than that which is indicated in Table A as specified compressive strength f'c.
      b. Strength Level of Concrete: Will be considered acceptable if following conditions are satisfied.
         1) Average of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength f'c.
         2) No individual strength test (average of 2 cylinders) falls below specified compressive strength f'c by more than 500 pounds per square inch.
         3) Whenever one, or both, of 2 conditions stated above is not satisfied, provide additional curing of affected portion followed by cores taken in accordance with ASTM C 42 and ACI 318 and comply with the following requirements:
            a) If additional curing does not bring average of 3 cores taken in affected area to at least specified compressive strength f'c, designate such concrete in affected area as defective.
            b) The ENGINEER may require the CONTRACTOR to strengthen defective concrete by means of additional concrete, additional reinforcing steel, or replacement of defective concrete, all of the CONTRACTOR's expense.
   2. Slump, Temperature, and Air Entrainment.
      a. Do not use concrete that does not meet specification requirements in regards to slump, temperature, or air entrainment, but remove such concrete from project site.

3.04 ADJUSTING

A. Repair of Defective Concrete:
   1. Remove and replace or repair defective work.

2. Correct defective work as specified in this Article.
3. Do not patch, repair, or cover defective work without inspection by the ENGINEER.
4. Provide repairs having strength equal to or greater than specified concrete for areas involved.
    a. Chip out and key imperfections in the work and make them ready for repair.
5. Dry Pack Method:
    a. Dry Pack Method: Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt, and narrow slots cut for repair.
    b. Smooth Holes: Clean and roughen by heavy sandblasting before repair.
6. Mortar Method of Replacement: Use for following:
    a. Holes too wide to dry pack and too shallow for concrete replacement.
    b. Comparatively shallow depressions, large or small, which extend no deeper than reinforcement nearest surface.
7. Concrete Replacement:
    a. Use: When holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.
    b. Method of Repair for Surfaces of Set Concrete to Be Repaired: First coat with epoxy bonding agent.
8. Acceptable Method of Concrete Repair:
    a. Make no repair until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.

END OF SECTION

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SECTION 03926

CONCRETE REPAIR AND REHABILITATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to repair or rehabilitate all existing concrete members and surfaces identified in the Contract Documents.
   2. Repair all damage to new concrete construction as specified herein, except that where such repairs are specified in Section 03300, Cast-in-Place Concrete.

B. Coordination:
   1. Review installation procedures in the following Section and coordinate the installation of items that must be included with the repair and rehabilitation of concrete.

1.02 QUALITY CONTROL

A. Reference Standards: Comply with the applicable provisions and recommen-dations of the following, except as otherwise shown or specified:
   1. ASTM C 109, Test Method for Compressive Strength of Hydraulic Cement Mortars.
   2. ASTM C 157, Test Method for Length Change of Hardened Cement Mortar and Concrete.
   3. ASTM C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
   4. ASTM D 412, Test Methods for Vulcanized and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
   5. ASTM D 624, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   6. ASTM D 903, Test Method for Peel or Stripping Strength of Adhesive Bonds.
   7. ASTM G 109, Test Method for Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments.

B. Construction Tolerances: Construction tolerances shall be as specified in Section 03300, Cast-in-Place Concrete, except as specified herein and elsewhere in the Contract Documents.

1.03 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Submit manufacturer's product information and recommended placement procedures for all repair materials.

2. Submit Shop Drawings, when requested by ENGINEER, to show all methods for supporting existing structures, pipes, etc., during demolition and repair activities. Comply with the requirements of Section 01340.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver all materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and the following information.
      a. Name or title of material.
      b. Manufacturer's stock number and date of manufacture.
      c. Manufacturer's name.

B. Storage of Materials:
   1. Storage only acceptable project materials on project site.
   2. Store in a suitable location approved by ENGINEER. Keep area clean and accessible.
   3. Restrict storage to repair materials and related equipment.
   4. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970.

C. Handling of Materials:
   1. Handle materials carefully to prevent inclusion of foreign materials.
   2. Do not open containers or mix components until necessary preparatory Work has been completed and application Work will start immediately.

PART 2 PRODUCTS

2.01 REPAIR MORTAR

A. Repair mortar shall be a prepackaged cement based product specifically formulated for the repair of concrete surface defects. The repair mortar shall be a one-component, portland cement, fast setting, trowel-grade mortar. The repair mortar shall be enhanced with a penetrating corrosion inhibitor and shall have the following properties:

Physical Property	**Value**	**ASTM Standard**
Compressive Strength (minimum)		
at 1 day	2000 psi	C 109
at 28 days	6000 psi	C 109
Bond Strength (minimum)		
at 28 days	1800 psi	C 882*
* Modified for use with repair mortars.		

B. Where the least dimension of the placement in width or thickness, exceeds 1-inch, the repair mortar shall be extended by addition of aggregate as recommended by the manufacturer.

C. Product and Manufacturer: Provide one of the following:
   1. SikaRepair 222 or SikaRepair 223 , as manufactured by Sika Corporation.
   2. Or equal.

2.02 JOINT REPAIR SYSTEM

A. Joint Repair System: The joint repair system shall consist of two components, an epoxy resin adhesive and hypalon sheeting.
   1. Epoxy Resin Adhesive: Provide a two-component epoxy resin as follows:
      a. Component A shall be a modified epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents and pigments. It shall not contain butyl glycidyl ether.
      b. Component B shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents, pigments and accelerators.
   2. Hypalon Sheeting: Provide Hypalon sheeting as follows:
      a. Hypalon sheeting shall consist of Hypalon rubber. It shall be perforated along the bonding edge to provide a mechanical key. It shall have the ability to be vulcanized with hydrocarbon solvent to permit its adhesion to an epoxy resin adhesive.
      b. The sheeting shall be provided in 12-inch width with a thickness of 40 mils.
      c. The sheeting shall be able to be lapped or seamed by heat or by anaromatic hydrosolvent strip.
      d. The sheeting shall be supplied with a removable center expansion strip.
   3. Product and Manufacturer: Provide one of the following:
      a. Sikadur Combiflex, as manufactured by Sika Corporation.
      b. Or equal.

2.03 EXPOSED REBAR REPAIR/BONDING AGENT

A. Bonding agent shall be a three component epoxy modified cementitious product with an anti-corrosion ingredient.

B. Product and Manufacturer: Provide one of the following:
   1. Sika Armatec 110 EpoCem, as manufactured by Sika Corporation.
   2. Or equal.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which repair Work is to be installed, and notify ENGINEER, in writing, of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.02 GENERAL

A. Surface Preparation:
   1. The entire area to be repaired shall have all laitance, foreign material, and unsound concrete removed by chipping, abrasive blasting or hydroblasting.

Size and effort of equipment shall be limited such that sound concrete is not removed or damaged. The surface shall be further roughened as specified herein. Where non-shrink grout or repair mortar is used, any additional surface preparation steps recommended by the manufacturer shall be performed.

2. Where repair concrete, shotcrete, or cement grout is used, and a bonding agent is not required, or where the repair mortar or non-shrink grout manufacturer recommends a wet or saturated surface, water shall be delivered to the surface continuously for a minimum of four hours. Where large surface areas are to be repaired, fog spray nozzles mounted on stands shall be provided in sufficient numbers such that the entire surface to be repaired is in contact with the fog spray cloud. The concrete shall be prevented from drying until after the repair operation is completed or seven days, whichever is more. Unrepaired surfaces shall be rewetted by water spray on at least a daily basis. Should more than four days elapse without rewetting the unrepaired surfaces, the original saturating procedure shall be repeated. All standing water in areas to be repaired shall be removed prior to placement of repair material. Means to remove excess water from the structure shall be provided.
3. Where the repair material manufacturer recommends the use of an epoxy-bonding agent, the recommendations of both the repair material and bonding agent manufacturers shall be followed.

B. Care shall be taken to fully consolidate the repair material, completely filling all portions of the area to be filled.

C. The repair surface shall be brought into alignment with the adjacent existing surfaces to provide a uniform, even surface. The repair surface shall match adjacent existing surfaces in texture and shall receive any coatings or surface treatments which had been provided for the existing surface.

D. Curing:
   1. Curing of repair mortar shall be according to the manufacturer's recommendations except that the minimum cure period shall be seven days.
   2. Curing of other materials shall be according to Section 03300, Cast-in-Place Concrete.

3.03 TREATMENT OF SURFACE DEFECTS

A. Surface defects are depressions in a concrete surface which do not extend all the way through the member. The depressions can result from the removal of an embedded item, the removal of an intersecting concrete member, physical damage, unrepaired rock pockets created during original placement, or spalls from corroded reinforcing steel or other embeds.

B. Preparation:
   1. All loose, damaged concrete shall be removed by chipping to sound material.
   2. Where existing reinforcing bars are exposed, concrete shall be removed to a minimum of 1-inch all around the bars. If the existing bars are cut through, cracked, or the cross sectional area is reduced by more than 25 percent, the ENGINEER shall be notified immediately.
   3. The perimeter of the damaged area shall be score cut at a right angle to the concrete surface to a minimum depth of 0.5-inch and a maximum depth to not cut any existing reinforcing steel. Existing concrete shall be chipped up to the

score line so that the minimum thickness of repair mortar is 0.5-inch. “Feather Edges” will not be permitted.

C. Repair Material:
   1. Repair of surface defects in members, which are normally in contact with water or soil, or in the interior surfaces of enclosed chambers that contain water shall be made only with repair mortar.
   2. Repair of other surface defects may be by the application of repair mortar, repair concrete, shotcrete, or cement grout, as appropriate.

3.04 PATCHING OF HOLES IN CONCRETE

A. For holes larger than 48-inches, refer to the Drawings for reinforcement details.

3.05 REPAIR OF DETERIORATED CONCRETE

A. This Section pertains to concrete which has been damaged due to corrosion of reinforcing steel, physical damage due to abrasion, and damage due to chemical attack. The only material acceptable for surface repair is repair mortar as specified herein. Where the repaired surface is to be subsequently covered with a PVC liner material, the finishing details shall be coordinated with the requirements of installing the liner material.

B. Surface Preparation:
   1. All loose, broken, softened, and acid contaminated concrete shall be removed by abrasive blasting and chipping down to sound, uncontaminated concrete.
   2. When the removal of deteriorated concrete is completed, CONTRACTOR to notify the ENGINEER, in writing. Two weeks shall be scheduled for the ENGINEER to inspect the surface, perform testing for acid contamination, determine if additional concrete must be removed, and to develop any special repair details that may be required. Should it be determined that additional concrete must be removed to reach sound, uncontaminated material, another two week period shall be scheduled for further evaluation after the end of the additional removal.
   3. Additional surface preparation shall follow the recommendations of the repair mortar manufacturer.
   4. Isolated areas of exposed reinforcing bars shall be treated as required for repair of surface defects. If extensive areas of reinforcement are uncovered after removal of deteriorated concrete, repair methods shall be as determined by the ENGINEER.

C. Repair Mortar Placement:
   1. The procedures recommended by the manufacturer for the mixing and placement of the repair mortar shall be followed.
   2. After the initial mixing of the repair mortar, additional water shall not be added to change the consistency should the mix begin to stiffen.
   3. Apply bonding agent per manufacturer’s recommendations. Do not exceed open time before applying repair mortar. If temperature in area is greater than 95°F, contact manufacturer.
   4. Repair mortar shall be placed to a minimum thickness as recommended by the manufacturer, but not less than 0.50-inch. Where removal of deteriorated concrete results in a repair thickness of less than 0.5-inch to return to original concrete surface location in isolated areas totaling less than ten percent of the

total repair area, additional concrete shall be removed to obtain the 0.5-inch thickness. Where the area with repair thickness of less than 0.5-inch exceeds ten percent of the total repair area, notify the ENGINEER. In any case, repair mortar shall be added so that the minimum cover over existing reinforcing steel is 2-inches. Do not place repair mortar so as to create locally raised areas. Where there is a transition with wall surfaces which are not in need of repair, the repair mortar shall not be feathered at the transition. A score line shall be sawcut to not less than the minimum repair mortar depth and concrete chipped out to it to form the transition. Care shall be taken to not cut or otherwise damage any reinforcing steel.

5. The repair mortar shall be placed to an even, uniform plane to restore the member to its original surface. Tolerance for being out of plane shall be such that the gap between a 12-inch straight edge and the repair mortar surface does not exceed 0.125-inch and the gap between a 48-inch straight edge and the repair mortar surface does not exceed 0.25-inch. This shall apply to straight edges placed in any orientation at any location.

D. Finishing:
   1. The repair mortar shall receive a smooth, steel trowel finish.
   2. When completed, there shall be no sharp edges. All exterior corners, such as at penetrations, shall be made with a 1-inch radius. All interior corners shall be square except corners to receive PVC lining shall be made with a 2-inch repair mortar fillet.

E. Curing:
   1. Curing shall be performed as recommended by the repair mortar manufacturer, except that the cure period shall be at least 24 hours and shall be by means of a continuous fog spray. If the manufacturer recommends the use of a curing compound, no material shall be used that would interfere with the bond of the protective coating system or adhesive used for placing PVC lining, where required.

3.06 TREATMENT OF EXPANSION JOINT REPAIR

A. Surfaces to be repaired shall have all laitance, foreign material, and unsound concrete removed by chipping, abrasive blasting or hydroblasting.

B. Follow all other surface preparation and application specifications as recommended by manufacturer.

3.07 EXPOSED REBAR REPAIR

A. The entire area to be repaired shall have all corrosion, foreign materials, and unsound concrete by means of abrasive blasting or hydroblasting.

B. Surface shall be visually dry before application of the corrosion inhibitor. The corrosion inhibitor shall be placed liberally to achieve 100 sq ft/gal coverage in two or more coats by allowing it to soak into the substrate. The re-coat time between coats shall be a minimum of one hour. Apply by use of rollers, brushes, or hand-pressure spray equipment.

C. After the last coat of the corrosion inhibitor is applied, a minimum curing time of 24 hours is required.

D. For mortar coating, refer to Paragraph 3.05.C, Repair Mortar Placement, Paragraph 3.05.D, Finishing, and Paragraph 3.05.E, Curing.

3.08 FIELD QUALITY CONTROL

A. CONTRACTOR shall employ a testing laboratory to perform field quality control testing.

B. ENGINEER will direct the CONTRACTOR on the number of standard compression tests and specimens required as specified below, under the direct inspection by ENGINEER.

C. CONTRACTOR shall furnish all necessary assistance required by ENGINEER. Provide all labor, material and equipment required including rods, molds, thermometer, curing in a heated storage box, and all other incidentals required. Above will be subject to approval by ENGINEER. Furnish all necessary storage, curing, and transportation required by the testing.

D. Repair Concrete: Repair concrete shall be tested as required in Section 03300, Cast-in-Place Concrete.

END OF SECTION

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SECTION 03931

EPOXY INJECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Epoxy injection system.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 638 - Standard Test Method for Tensile Properties of Plastics.
   2. D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.
   3. D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.03 SUBMITTALS

A. Product data: Submit manufacturer's data completely describing epoxy injection system materials.

B. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers: One of the following or equal:
   1. BASF, MBT, Concresive Standard LVI.
   2. Sika Chemical Corp., Sikadur 35, Hi-Mod LV.

B. Epoxy:
   1. Provide epoxy materials that are new and use them within shelf-life limitations set forth by manufacturer.
   2. Water-insensitive 2-part type low viscosity epoxy adhesive material containing 100 percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified:

Physical Characteristic	Test Method	Required Results
Tensile Strength	ASTM D 638	8,000 pounds per square inch at 14 days.
Flexure Strength	ASTM D 790	11,000 pounds per square inch at 14 days.
Compressive Strength	ASTM D 695	11,000 pounds per square inch at 24 hours.
Bond Strength	--	Concrete shall fail before failure of epoxy.
Gel Time for 5 Mil Film	--	4 hours maximum.
Elongation	ASTM D 638	1 percent minimum at 14 days.

2.02 EQUIPMENT

A. Pump unit:
   1. Furnish unit to be used for injection that is positive displacement type with interlock to provide in-line mixing and metering system for 2 component epoxy.
   2. Furnish pressure hoses and injection nozzle of such design as to allow proper mixing of 2 components of epoxy.
   3. Presence of standby injection unit may be required.

2.03 MIXES

A. Epoxy injection system materials:
   1. Mix epoxy in accordance with manufacturer's installation instructions.
   2. Do not use solvents to thin epoxy system materials introduced into cracks or joints.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Epoxy injection system:
      a. General: Before processing, sweep or clean area in vicinity of crack location to receive epoxy and leave in generally clean condition.
      b. Joints to receive epoxy: Clean in manner such that joints are free from dirt, laitance, and other loose matter.

3.02 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Perform and conduct work of this Section in neat, orderly manner.

C. Epoxy injection system:
   1. Apply adequate surface seal to crack or joint to prevent escape of epoxy.
   2. Establish entry points at distance along seal not less than thickness of cracked member.
   3. Force epoxy into crack at first port with sufficient pressure to advance epoxy to adjacent port.

4. Seal original port and shift entry to port at which epoxy appears.
5. Continue this manner of port-to-port injection until each joint has been injected for its entire length.
6. For small amounts, or where excessive grout pressure developed by pump unit might further damage structure, premixed material and hand caulking gun may be used if acceptable to the ENGINEER.
7. Seal ports, including adjacent locations where epoxy seepage occurs, as necessary to prevent drips or run out.
8. After epoxy injection is complete, remove surface seal material and refinish concrete in area where epoxy was injected to match existing concrete.

END OF SECTION

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SECTION 09960

HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Field applied coatings.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. D 4262-83 - Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
   2. D 4263-83 - Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   3. D4285-83 - Test Method for Indicating Oil or Water in Compressed Air.
   4. D4541-93 - Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers.

B. NACE International, The Corrosion Society (NACE):
   1. RPO188-99 - Discontinuity (Holiday) Testing of Protective Coatings.

C. National Association of Pipe Fabricators (NAPF):
   1. NAPF 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.

D. NSF International (NSF):
   1. NSF 61 - Drinking Water System Components - Health Effects.

E. SSPC – Society for Protective Coatings:
   1. SSPC SP1 - Solvent Cleaning.
   2. SSPC SP2 - Hand Tool Cleaning.
   3. SSPC SP3 - Power Tool Cleaning.
   4. SSPC SP5 - White Metal Blast Cleaning.
   5. SSPC SP6 - Commercial Blast Cleaning.
   6. SSPC SP7 - Brush-Off Blast Cleaning.
   7. SSPC SP10 - Near-White Blast Cleaning.
   8. SSPC SP 11 - Power Tool Cleaning to Bare Metal.
   9. SSPC-SP 12 - High- and Ultrahigh-Pressure Water Jetting.

F. Underwriters' Laboratory (UL):
   1. UL 3P83 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Submerged Metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.

B. Submerged Concrete and Masonry Surfaces: Surfaces which are or will be:
   1. Underwater.
   2. In structures which normally contain water.
   3. Below tops of walls of water containing structures.

C. Exposed Surface: Any metal or concrete surface, indoors or outdoors that is exposed to view.

D. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils.

E. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.

F. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.

G. Where SSPC surface preparation standards are specified or implied for ductile iron pipe or fittings, the equivalent NAPF surface preparation standard shall be substituted for the SSPC standard.

1.04 PERFORMANCE REQUIREMENTS

A. Coating materials for concrete and metal surfaces shall be especially adapted for use in wastewater treatment plants.

B. Coating for final coats shall be fume resistant, compounded with pigment suitable for exposure to sewage gases, especially to hydrogen sulfide and to carbon dioxide.

C. Pigments shall be materials that do not darken, discolor, or fade due to action of sewage gases.

1.05 SUBMITTALS

A. Shop Drawings: Include schedule of where and for what use coating materials are proposed in accordance with requirements for Product Data.

B. Product Data: Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips.
   1. Regulatory Requirements: Submit data concerning the following:
      a. Volatile organic compound limitations.
      b. Coatings containing lead compounds and PCBs.
      c. Abrasives and abrasive blast cleaning techniques, and disposal.

C. Samples: Include 8-inch square drawdowns or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.

D. Certificates: Submit in accordance with requirements for Product Data.

E. Manufacturer's Instructions: Include the following:
   1. Special requirements for transportation and storage.

2. Mixing instructions.
3. Shelf life.
4. Pot life of material.
5. Precautions for applications free of defects.
6. Surface preparation.
7. Method of application.
8. Recommended number of coats.
9. Recommended dry film thickness (DFT) of each coat.
10. Recommended total dry film thickness (DFT).
11. Drying time of each coat, including prime coat.
12. Required prime coat.
13. Compatible and non-compatible prime coats.
14. Recommended thinners, when recommended.
15. Limits of ambient conditions during and after application.
16. Time allowed between coats (minimum and maximum).
17. Required protection from sun, wind and other conditions.
18. Touch-up requirements and limitations.

F. Manufacturer's Representative's Field Reports.

G. Operations and Maintenance Data:
1. Reports on visits to project site to view and approve surface preparation of structures to be coated.
2. Reports on visits to project site to observe and approve coating application procedures.
3. Reports on visits to coating plants to observe and approve surface preparation and coating application on items that are "shop coated."

H. Quality Assurance Submittals:
1. Quality Assurance plan.
2. Qualifications of coating applicator including List of Similar Projects.

I. Warranty
1. Warrant free of defects in material and workmanship for 3 years from the date of acceptance or date of first beneficial use by the OWNER.

1.06 QUALITY ASSURANCE

A. Applicator Qualifications:
1. Minimum of 5 years experience applying specified type or types of coatings under conditions similar to those of the Work.
   a. Provide qualifications of applicator and references listing five similar projects completed in the past two years.
2. Manufacturer approved applicator when manufacturer has approved applicator program.
3. Approved and licensed by polymorphic polyester resin manufacturer to apply polymorphic polyester resin coating system.
4. Approved and licensed by elastomeric polyurethane (100 percent solids) manufacturer to apply 100 percent solids elastomeric polyurethane system.
5. Applicator of off-site application of coal tar epoxy shall have successfully applied coal tar epoxy on similar surfaces in material, size, and complexity as on the Project.

B. Regulatory Requirements: Comply with governing agencies regulations by using coatings that do not exceed permissible volatile organic compound limits and do not contain lead.

C. Certification: Certify that applicable pigments are resistant to discoloration or deterioration when exposed to hydrogen sulfide and other sewage gases and product data fails to designate coating as "fume resistant."

D. Field Samples: Prepare and coat an area between corners or limits such as control or construction joints of each system. Approved field sample may be part of Work.

E. Compatibility of Coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

F. Services of Coating Manufacturers Representative: Make periodic visits to the project site to provide consultation and inspection services during surface preparation and application of coatings, and to make visits to coating plants to observe and approve surface preparation procedures and coating application of items to be “shop primed and coated”.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturers recommendations.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.

D. Store coatings in well-ventilated facility that provides protection form the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

1.08 PROJECT CONDITIONS

A. Surface Moisture Contents: Do not coat surfaces that exceed manufacturer specified moisture contents, or when not specified by the manufacturer, the following moisture contents:
   1. Masonry, Concrete and Concrete Block: 12 percent.

B. Do Not Apply Coatings:
   1. Under dusty conditions, unless tenting, covers, or other such protection is provided for structures to be coated.
   2. When light on surfaces measures less than 15 foot-candles.
   3. When ambient or surface temperature is less than 50 degrees Fahrenheit unless manufacturer allows a lower temperature.
   4. When relative humidity is higher than 85 percent.
   5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
   6. When surface temperature exceeds the manufacturer's recommendation.

7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
8. Apply clear finishes at minimum 65 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Special Coatings: One of the following or equal:
   1. Ameron: Ameron International, Brea, CA.
   2. Carboline: Carboline, St. Louis, MO.
   3. Devoe: Devoe Coatings, Louisville, KY.
   4. Dudick: Dudick, Inc., Streetsboro, OH.
   5. Sanchem: Sanchem, Chicago, IL.
   6. S-W: Sherwin-Williams Co., Cleveland, OH.
   7. Tnemec: Tnemec Co., Kansas City, MO.

B. Paints, Exterior Exposure: One of the following or equal:
   1. Modified Waterborne Acrylate: One of following or equal:
      a. Tnemec: Enviro-Crete.

2.02 PREPARATION AND PRETREATMENT MATERIALS

A. Metal Pretreatment: As manufactured by one of the following or equal:
   1. Ameron: Galvaprep.
   2. International: Galvaprep 5 or Alumiprep 33.
   3. S-W: P60G2, Wash Primer.
   4. Tnemec: Series N69 Hi-Build Epoxoline II

B. Surface Cleaner and Degreaser: As manufactured by one of the following or equal:
   1. Carboline Surface Cleaner No.3.
   2. Devoe: Devprep 88.
   3. S-W: Clean and Etch.

2.03 COATING MATERIALS

A. Waterborne acrylic emulsion: As manufactured by one of the following or equal:
   1. S-W: DTM Acrylic B66W1.
   2. Tnemec: Tneme-Cryl Series 6.

2.04 MIXES

A. Mix epoxy parts in accordance with manufacturer's instructions.

PART 3 EXECUTION

3.01 GENERAL PROTECTION

A. Protect adjacent surfaces from coatings and damage. Repair damage resulting from inadequate or unsuitable protection:

B. Protect adjacent surfaces not to be coated from spatter and droppings with drop cloths and other coverings.
   1. Mask off surfaces of items not to be coated or remove items from area.

C. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being coated and in particular, surfaces within storage and preparation area.

D. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.

E. Remove electrical plates, surface hardware, fittings and fastenings, prior to application of coating operations. Carefully store, clean and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

3.02 GENERAL PREPARATION

A. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements are specified in this Specification.

B. Protect following surfaces from abrasive blasting by masking, or other means:
   1. Threaded portions of valve and gate stems.
   2. Machined surfaces for sliding contact.
   3. Surfaces to be assembled against gaskets.
   4. Surfaces of shafting on which sprockets are to fit.
   5. Surfaces of shafting on which bearings are to fit.
   6. Machined surfaces of bronze trim, including those slide gates.
   7. Cadmium-plated items except cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment requiring abrasive blasting.
   8. Galvanized items, unless scheduled to be coated.

C. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.

D. PVC and FRP Surfaces:
   1. Prepare surfaces to be coated by light sanding and wipe-down with clean cloths, or by solvent cleaning in strict accordance with coating manufacturer's instructions.

E. Cleaning of Previously Coated Surfaces:
   1. Utilize cleaning agent to remove soluble salts such as chlorides and sulfates from concrete and metal surfaces.
      a. Cleaning Agent: Biodegradable non-flammable and containing no volatile organic compounds.
      b. Manufacturer: Chlor-Rid International, Inc., or accepted equal.
   2. Cleaning of surfaces utilizing the decontamination cleaning agent may be accomplished in conjunction with abrasive blast cleaning, high pressure, washing, or hand washing as approved by the coating manufacturer's representative and the ENGINEER.
   3. Test cleaned surfaces in accordance with the cleaning agent manufacturer's instructions to ensure all soluble salts have been removed. Additional cleaning shall be carried out as necessary.

4. Final surface preparation prior to application of new coating system shall be made in strict accordance with coating manufacturer's printed instructions

3.03 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Remove grilles, covers and access panels for mechanical and electrical system from location and coat separately.

B. Finish coat primed equipment with color selected by the ENGINEER.

C. Prime and coat insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with prefinished coating.

D. Replace identification markings on mechanical or electrical equipment when coated over or spattered.

E. Coat interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line.

F. Coat exposed conduit and electrical equipment occurring in finished areas with color and texture to match adjacent surfaces.

G. Coat both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them

H. Color code equipment, piping, conduit and exposed ductwork and apply color banding and identification, such as flow arrows, naming and numbering, in accordance with DIVISIONS 15 and 16.

3.04 GENERAL APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer's instructions.

B. Coat metal unless specified otherwise.
1. Aboveground piping to be coated shall be empty of contents during application of coatings.

C. Verify metal surface preparation immediately before applying coating in accordance with SSPC Pictorial Surface Preparation Standard.

D. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

E. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.

F. Prime shop primed metal surfaces. Spot prime exposed metal of shop primed surfaces before applying primer over entire surface.

G. Apply minimum number of specified coats.

H. Apply coats to thicknesses specified, especially at edges and corners.

I. Apply additional coats when necessary to achieve specified thicknesses.

J. Coat surfaces without drops, ridges, waves, holidays, laps, or brush marks.

K. Remove spatter and droppings after completion of coating.

L. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.

M. Dust coatings between coats. Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.

N. Apply coating by brush, roller, trowel, or spray, unless particular method of application is required by coating manufacturer's instructions or these Specifications.

O. Spray Application:
   1. Stripe coat edges by brush before beginning spray application, as necessary, to ensure specified coating thickness along edges.
   2. When using spray application, apply coating to thickness not greater than that recommended in coating manufacturer's instructions for brush coat application.
   3. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
   4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist or spray.

P. Drying and Recoating:
   1. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
   2. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
   3. Do not allow excessive drying time or exposure which may impair bond between coats.
   4. Recoat epoxies within time limits recommended by coating manufacturer.
   5. When time limits are exceeded, abrasive blast clean prior to applying another coat.
   6. When limitation on time between abrasive blasting and coating cannot be met before attachment of components to surfaces which cannot be abrasive blasted, coat components before attachment.
   7. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
   8. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
   9. Leave no holidays.
   10. Sand and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to naked eye.

3.05 WATERBORNE ACRYLIC EMULSION

A. Preparation:
   1. Remove all oil, grease, dirt, and other foreign material by Solvent Cleaning in accordance with SSPC SP-1.
   2. Lightly sand all surfaces and wipe thoroughly with clean cotton cloths before applying coating.

B. Application:
   Apply 2 or more coats to obtain a minimum dry film thickness (DFT) of 5.0 mils.

3.06 FIELD QUALITY CONTROL

A. Each coat will be inspected. Strip and remove defective coats, prepare surfaces and recoat. When approved, apply next coat.

B. Control and check dry film thicknesses and integrity of coatings.

C. Measure dry film thickness with calibrated thickness gauge.

D. Dry film thicknesses on ferrous-based substrates may be checked with Elcometer Type 1 Magnetic Pull-off gage or Positector 6000.

E. Verify coat integrity with low-voltage holiday detector. Allow ENGINEER to use detector for additional checking.

F. Check wet film thickness before coal tar epoxy coating cures on concrete or non-ferrous metal substrates.

G. Arrange for services of coating manufacturer's field representative to provide periodic field consultation and inspection services to ensure proper surface preparation of facilities and items to be coated, and to ensure proper application and curing.
   1. Notify ENGINEER 24 hours in advance of each visit by coating manufacturer's representative.
   2. Provide ENGINEER with a written report by coating manufacturer's representative within 48 hours following each visit.

3.07 SCHEDULE OF ITEMS NOT REQUIRING COATING

A. General: Unless specified otherwise, the following items do not require coating.
   1. Items that have received final coat at factory and not listed to receive coating in field.
   2. Aluminum (except where in contact with concrete), brass, bronze, copper, plastic, rubber, stainless steel, chrome, everdur, or lead.
   3. Buried or encased piping or conduit.
   4. Exterior Concrete.
   5. Galvanized roof decking, electrical conduits, pipe trays, cable trays, and other items.
      a. Areas on galvanized items or parts where galvanizing has been damaged during handling or construction shall be repaired as follows:

1) Clean damaged areas by SSPC SP-1, SP-2, SP-3, or SP-7 as required.
2) Apply two coats of a cold galvanizing zinc compound such as ZRC World Wide Inovatie Zinc Technologies of Mansfield, MA or accepted equal, in strict accordance with manufacturer's instructions.

6. Grease fittings.
7. Steel to be encased in concrete or masonry.

3.08 SCHEDULE OF SURFACES TO BE COATED IN THE FIELD

A. In general, apply coatings to steel, iron, galvanized surfaces, and wood surfaces unless specified or otherwise indicated on the Drawings. Coat concrete surfaces and anodized aluminum only when specified or indicated on the Drawings.

B. Following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Verify questionable surfaces.

C. Fiberglass and PVC pipe surfaces:
1. Waterborne acrylic emulsion.
a. PVC piping exposed to view.

END OF SECTION

SECTION 09984

COATINGS FOR CONCRETE SUBJECT TO HYDROGEN SULFIDE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Trowel-on aggregate filled chemical resistant coatings for concrete subject to hydrogen sulfide and acid attack from microbiological sources.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. C 307 - Test Method for Tensile Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.
   2. C 308 - Test Methods for Working and Setting Times of Chemical Resistant Resin Mortars.
   3. C 413 - Test Method for Absorption of Chemical-Resistant, Mortars, Grouts, and Monolithic Surfacing.
   4. C 579 - Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing.
   5. C 580 - Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
   6. D 4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gauges.
   7. D 4541 - Test method for pull off strength of coatings using portable adhesion testers.
   8. D 4787 - Standard Practice for continuity verification of liquid or sheet linings applied to concrete substrates.
   9. E 96 - Standard test methods for water vapor transmission of materials.

1.03 SUBMITTALS

A. Product Data.

B. Manufacturer's Instructions.

C. Manufacturer's Field Reports.

D. Warranties.

E. Qualifications of the coating applicator.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Qualified by manufacturer to apply:
   1. Coating applicators shall have a minimum of three (3) years experience in applying one of the specified coatings in the wastewater industry. The coating

applicator shall submit a successful “Performance History” for the application of the specified coating in the wastewater industry for the previous three (3) years. The Performance History shall have a minimum of three (3) references completed on the form. The Performance History shall be submitted to the OWNER after the bid opening for approval and verification. The coating applicator shall submit this Performance History on the form labeled “Performance history,” which is attached to these Specifications.

2. The coating applicator shall submit certification from the manufacturer of the specified product, stating that the applicator is certified to apply the coating specified herein.
3. The coating applicator shall submit a minimum of three (3) reference letters relating to the quality of workmanship performed on other wastewater projects for the specified coating.
4. Apply compatible underlayment and coating materials manufactured by same manufacturer.
5. Underlayment and coating materials shall be factory manufactured only. Jobsite manufactured or formulated products shall not be acceptable.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading: In accordance with Section 01600.

1.06 PROJECT OR SITE CONDITIONS

A. Environmental Requirements:
   1. Handle and Use Coatings at temperatures between 65 and 80 degrees Fahrenheit. At colder temperatures to 50 degrees Fahrenheit, expect longer curing times. At warmer temperatures to 90 degrees Fahrenheit, expect shorter working time.
   2. Avoid application under direct sunlight and rising surface temperatures to prevent blistering.
   3. Shade concrete for minimum 24 hours before applying coatings.

1.07 WARRANTY

A. Warrant to replace defective materials with new and correct defective workmanship for minimum 2 years.

PART 2 PRODUCTS

2.01 CHEMICAL RESISTANT COATINGS

A. Manufacturers: One of the following or equal:
   1. SewerGard 210 Saureisen, Pittsburgh, PA.
   2. Raven 405 Epoxy Lining, Raven Lining Systems, Tulsa, OK.

B. Characteristics: As follows:

Properties	Test	Results of Test
Absorption	ASTM C 413	Less than 0.03 percent
Application Time, Working Time at 70 degrees F.	ASTM C 308 modified	40 to 50 minutes
Application Time, Initial Set at 70 degrees F	ASTM C 308 modified	17 hours
Bond Strength to Dry or Damp Concrete Manhole	ASTM D 4541	Concrete failed
Compressive Strength	ASTM C 579	7,300 psi
Flexural Strength	ASTM C 580	4,900 psi
Modulus of Elasticity	ASTM C 580	2.75×10^{5} psi
Tensile Strength	ASTM C 307	2,000 psi
Thermal Expansion Coefficient		3.5×10^{-5} in/in/degree F
Permeance	ASTM E 96 Method A	6.88×10^{-9} perms

2.02 UNDERLAYMENTS

A. Manufacturers: One of the following or equal:
   1. Sauereisen, Pittsburgh, PA; F-120 Trowelable, F-120, Castable, and No. 209 Filler.

B. Characteristics: As follows for trowelable grade:

Properties	Results
Color	Tan
Compressive Strength at 5 Hours	1,000 psi
Compressive Strength at 24 Hours	3,000 psi
Density	135 pcf

2.03 MIXES

A. Trowelable Underlayment:
   1. Mix underlayment powder with potable water in clean mortar mixers.
   2. Mix ratio of 9:1 powder to 1 part clean and potable water by weight.
   3. Pour entire amount of potable water into mixing container and add powder slowly. Mix continuously to reduce potential for entrapped air. Mix slowly and thoroughly for minimum 10 minutes until achieving uniform consistency. Do not add more water.

B. Castable Underlayment: As recommended by manufacturer.

C. Filler Underlayment:
   1. Add contents of hardener to liquid and mix with slow speed paddle or Jiffy mixer for 1 minute until thoroughly blended.
   2. Add powder gradually while mixing with same slow speed mixer to obtain uniform consistency.

D. Coating:
   1. Thoroughly remix coating liquid by hand.
   2. Shake hardener thoroughly before opening.
   3. Pour liquid into clean, dry mixing containers.
   4. Add hardener and mix thoroughly for at least one minute using slow-speed drill with 5 inch Jiffy mixer.
   5. Add powder gradually while mixing with same slow-speed, paddle type or drill motor mixer to obtain uniform consistency.
   6. Discard mixture that has begun to set.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are free of dust, loose particles, oils, grease, chemical contaminants and previously applied paints or protective coatings.

3.02 PREPARATION

A. Chemically clean or scarify surfaces to remove conventional curing compounds and form oils or grease before abrasive blasting or hydro blasting.

B. Abrasive blast or hydro blast surfaces until surface has uniform texture resembling coarse sandpaper with exposed fine aggregate. The time between blasting and coating application shall not exceed two hours without re-blasting.

C. Remove foreign particles and attacked or unsound mortar from brick joints. Regrout loose brickwork with underlayment grout.

D. Stop active hydrostatic leaks. Repair structural defects, voids, and cracks.

E. When necessary to restore concrete surfaces, attach 2 by 2-inch by 10 or 12 gauge wire mesh to concrete. Apply castable or gunite grade underlayment to required thickness.

F. Fill voids, holes, rough, or irregular concrete to obtain uniform surfaces.
   1. When deeper than 1/2-inch, fill with castable or trowelable underlayment.
   2. When from 1/8 to 1/2-inch deep, fill with trowelable underlayment.
   3. When less than 1/8-inch deep, fill with filler underlayment. Spread mixed filler underlayment on plasterer's hawk upon completion of mixing. Apply with smooth plasterer's rubber float. Remove excess material with edge of float or squeegee. Allow for working time of 15 minutes.

G. Cure trowelable and castable underlayment for 5 hours, and filler underlayment for 3 hours, before applying coating.

H. Cure with fog spray, wet burlap, or coating manufacturer's approved curing compound.

I. Brush underlayment before initial set when coating will be applied 24 hours or more after application of underlayment.

J. Epoxy based underlayments do not require a moist cure.

3.03 APPLICATION

A. Trowel apply coating at minimum 1/8-inch thick. Use screed bars to control thickness on large surface areas.

B. Roll coating surface with short nap mohair paint rollers slightly dampened with water to obtain pinhole free surface.

C. Coordinate transition with plastic liner by lapping the coating over the plastic liner a minimum of six inches (6 in.). Areas of liner to be coated shall be roughened as recommended by the manufacturer to assure good adhesion of the coating.

3.04 CURING

A. Coating: Do not allow flowing water or chemicals on coating for minimum 24 hours at 70 degrees Fahrenheit. For temperatures below 70 degrees Fahrenheit, cure at minimum 48 hours before allowing flowing water or chemical exposure.

3.05 FIELD QUALITY CONTROL

A. During application, a wet film thickness gage meeting the ASTM D4414 shall be used to ensure a monolithic coating and uniform thickness.

B. Test coating for pinholes with holiday detector in accordance with ASTM D-4787 after coating has cured for 24 hours.

C. Testing shall be with a minimum test voltage of 100 volts per mil (where 1 mil = 1/1000-inch) of finished surface coat thickness. For example, a minimum of 12,500 volts shall be used for a surface coat of 1/8-inch (125 mils). Any imperfections found in the coating systems shall be ground down and refilled. The patch material shall be a contrasting color and shall be trowelable. Repaired areas shall be re-tested.

D. The CONTRACTOR shall perform repairs and re-testing at no additional cost to OWNER. Inspector shall observe and approve of all testing and retesting. In addition, the CONTRACTOR shall provide certification for each structure stating that the coating is free of holes or other imperfections.

E. Inspect coating with manufacturer and Owner at 9 and 23 months after Final Project Acceptance.

3.06 CLEANING

A. Any spilled or over-sprayed material must be cleaned-up prior to curing. After curing has occurred, clean up may be accomplished by chipping or blasting. All discarded materials shall be disposed of properly. Clean up and disposal of discarded material shall be at no additional cost to the OWNER.

3.07 SCHEDULE OF SURFACES TO BE COATED

A. Headworks influent channels floors, and walls.

END OF SECTION

SECTION 11321

CYCLONE SEPARATOR AND GRIT CLASSIFIER

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for providing one grit dewatering unit assembly, consisting of one cyclone grit concentrator mounted on a screw type grit classifier.
   1. Equipment Numbers:
      a. Cyclone No. 1 (GC-1011)
      b. Cyclone No. 2 (GC-1021)
      c. Grit Classifier No. 1 (GC-1012)
      d. Grit Classifier No. 2 (GC-1022)

B. Related Sections:
   1. Section 01614 - Wind Design Criteria.
   2. Section 01730 - Operating and Maintenance Data
   3. Section 01740 - Warranties and Bonds
   4. Section 15050 - Basic Mechanical Materials and Methods.
   5. Section 15958 - Mechanical Equipment Testing.
   6. Section 16405– Electric Motors.
   7. Division 16 - Electrical

C. All equipment shall conform to the requirements of Section 15050, Basic Mechanical Materials and Methods, except as modified herein.

D. Inclusion of a specific manufacturer’s name in the Specifications does not mean that the specified manufacturer’s standard product will be acceptable. Specified manufacturer’s or other manufacturer’s standard product shall be modified as required to meet the Specifications.

1.02 SUBMITTALS

A. Submit as specified in Section 15050.

B. Product Data.

C. Manufacturer's Installation Instructions.

D. Shop Drawings:
   1. General arrangement drawings showing the complete assembly, part numbers, and material list.
   2. Detailed Drawings: Include details on the grit dewatering unit, motors, gear drives, equipment, supports, and size and length of each support frame member.
   3. Performance Data: Include cyclone inlet flow rate and corresponding underflow rate at 5 psig, 10 psig, 15 psig, and 20 psig inlet pressures based on the specified vortex finder size. Also include cyclone capacity curves.

E. Calculations:
   1. Structural Calculations: Include the following to support structural adequacy of the grit dewatering unit prepared and signed by a registered professional structural engineer in the State of Florida.
      a. Structural anchoring to concrete foundation.
   2. Mechanical and Hydraulic Calculations:
      a. Demonstrate that dewatering unit's power train (screw, drive, and motor) is adequately sized for starting with settling tank fully loaded with grit.
   3. Screw shaft design and fatigue life.

F. Technician Qualifications Resume: Submit resume of technician to perform adjustments, inspections, start-up, observations of test operations, and training.

G. Performance Test Data.

H. Operating and Maintenance Manual:
   1. Submit operation and maintenance manuals in accordance with Section 01730.
   2. Include complete lubrication, maintenance, and operation instructions, including initial start-up instructions, and unloading and handling methods.

1.03 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:
   1. Minimum 10 years experience in production of equipment substantially similar to the specified equipment.
   2. Submit evidence of satisfactory operation of grit dewatering units similar to the specified grit dewatering units in at least five separate facilities in accordance with the following requirements:
      a. All grit dewatering units on the submitted installation list shall use the same design for critical components as specified for this project as follows:
         1) Cyclones.
         2) Grit classifiers.
         3) Service: Municipal wastewater in U.S. or Canada.
      b. Multiple grit dewatering units at a plant shall be considered as one installation toward meeting the experience requirements.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

C. The manufacturer of the grit classifiers shall assume complete responsibility for furnishing the cyclones and shall have sole-source responsibility for furnishing the complete assemblies and meeting the specified performance requirements.

1.04 WARRANTY

A. As specified in Section 01740

B. Warrant free of defects in material and workmanship for 3 years from the date of acceptance or date of first beneficial use by the OWNER.

1.05 SPARE PARTS AND SPECIAL TOOLS

A. Furnish the following spare parts:
   1. Cyclone:

Item	Quantity
Apex Liners	1
Vortex Finder	1
Replaceable Liners	1 set
Gaskets	1 set

   2. Classifier and Drive Unit:

Item	Quantity
Screw Lower Bearing Assembly	1
Cyclodrive Assembly	1
V-belts	1 set
Drive Bearings	1 set

B. Special Tools: Furnish any special tools required for maintenance and disassembly of furnished equipment.

C. Deliver spare parts and special tools in boxes labeled with contents, equipment to which spare parts belong, and name of CONTRACTOR.

D. CONTRACTOR, inspector, and OWNER's maintenance representative shall inventory and account for all tools and spare parts delivered to the site. Each party shall sign a turn over agreement. OWNER will then take possession and responsibility for items.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal, modified as needed to meet the Specification requirements:
   1. Cyclones
      a. Envirocare
      b. Sprirac
      c. Wemco
      d. Westech
   2. Grit Classifiers
      a. Envirocare
      b. Sprirac
      c. Wemco
      d. Westech

B. The ENGINEER has designed the piping, controls, and all other functions around Wemco equipment. The CONTRACTOR is responsible for any changes resulting from selecting another manufacture. This includes, but not limited to design changes to provide for variations in piping arrangements, controls, and electrical requirements.

C. The changes shall be made at no additional cost to the OWNER.

2.02 PERFORMANCE REQUIREMENTS

A. The complete grit dewatering unit shall include a cyclone type grit separator mounted on a grit classification mechanism as indicated on the Drawings. The combined unit, with the cyclone in service at the specified design feed flow rate, shall be capable of removing 90 percent size 150-mesh or greater particles having a specific gravity of 2.65 or greater, from the pumped grit slurry.

2.03 EQUIPMENT COMPONENTS

A. Cyclone:
   1. Design for highly abrasive applications.
   2. Sectional construction including inlet head, a separate cylindrical section, conical sections, vortex finder, and fixed apex valve.
   3. Inlet Head:
      a. Heavy-duty cast iron, ASTM A 48, Class 30 minimum.
      b. 10-inch diameter.
      c. Involute shape entry.
      d. Minimum 4-inch inlet and 6-inch outlet with adapter pieces to fit the piping layout shown on the Drawings.
   4. Provide cylindrical section to allow increased residence time for grit capture:
      a. 10-inch diameter.
      b. Fabricated steel, ASTM A 108.
   5. Completely line each cyclone section with an individual, independently replaceable neoprene or natural rubber liner.
   6. Vortex Finder: Ni-hard with a minimum hardness of 500 Brinell.
   7. Provide a hinge and quick disconnect clamp between the apex assembly and lower cone section to allow easy access for cleaning without disconnecting any piping.
   8. Design and furnish a structural supporting framework for the cyclones. Fabricate supports using Type 316L stainless steel.
   9. Design Criteria:
      a. Design Feed Flow Rate (each cyclone): 250 gpm.
      b. Maximum inlet pressure required at the design flow rate: 7.5 psig.
      c. Maximum allowable underflow from each cyclone at the design flow rate: 15 gpm.
   10. Performance Requirements:
      a. Design cyclone to remove not less than 95 percent of the 150-mesh grit having a specific gravity of 2.65 or greater from the pumped grit slurry stream.

B. Classifier:
   1. Design classifier to receive underflow discharge from one cyclone.

2. Design classifier to maintain necessary velocities to retain organic matter in suspension and remove the non-organic matter of a size retained on a 150-mesh screen.
3. Capable of removing substantially all 150-mesh grit having a specific gravity of 2.65 or greater from the cyclone underflow.
4. 12-inch straight side classifier with a screw-type grit conveyor.
5. Minimum classifier grit handling and raking capacity: 0.75 tons per hour at 12 rpm.
6. Design unit's power train (screw, drive, and motor) to be capable of starting with settling tank fully loaded with grit.
7. Settling Tank:
    a. Fabricated of Type 316L stainless steel plate (1/4-inch minimum) and reinforcements.
    b. Mounted on Type 316L stainless steel supports and self-supporting base at a slope of not more than 3.5 inches to 12 inches (vertical to horizontal).
    c. Design settling compartment where grit separation takes place with a minimum full water depth of 150 percent of the screw diameter.
    d. Minimum Pool Area: 8.3 square feet.
    e. Minimum Weir Length: 24 inches.
    f. Provide launder box to receive weir overflow. Equip launder box with a 2.5-inch pipe grooved-end fitting for connection to drain.
    g. Provide inlet boxes to receive the feed from the apex of each cyclone.
        1) Inlet boxes shall be of 316L stainless steel and provided with rubber liners. Feed boxes shall be reinforced minimum 3/8-inch stainless steel plate, and shall be lined with 1/2-inch soft, natural gum rubber to protect against abrasion, and to function as a splashguard. Radial flow diffusers shall not be acceptable.
        2) The classifier manufacturer shall ensure that the inlet boxes are designed to dissipate the energy from the cyclone underflow within the inlet box, so disruption of settling does not occur in the classifier. Evidence of satisfactory design from previous installations shall be provided with the Shop Drawings submittal.
        3) The inlet boxes shall be designed and located by the manufacturer to minimize short-circuiting to the overflow weir of the respective classifier and to handle maximum cyclone underflow discharge.
    h. Provide settling tank with a 2-inch grooved-end drain connection.
    i. Provide the classifier tank with a welded bar, running from the top of the tank to below the water level to provide a sluice channel, in order to prevent the buildup of grit opposite the raked material, to aid in drainage.
    j. The manufacturer shall furnish and install a valve cock with NPT nipple for the spiral sluice water (wash water).
    k. Provide settling tank with sectional, removable, gasketed, FRP or Type 316 stainless steel covers.
        1) Design covers to serve as protective guard over the full length of the rotating screw to protect personnel.
        2) Comply with all OSHA requirements.
        3) Bolt or clamp each cover section to classifier.
    l. Provide plexiglass view port, 6 inches by 4 inches, in the cover above the overflow weir to allow visual observation of weir area.
8. Grit Screw (Auger):
    a. 12-inch diameter.
    b. 50-percent pitch, single helical screw.

c. The screw shaft shall be minimum 3-inch nominal diameter pipe size, Schedule 80, and shall be of ASTM A 53, Grade B steel. Preformed 3/16-inch thick steel flight sections shall be continuously welded to the shaft and fitted with easily replaceable, abrasion-resistant wear shoes as specified.
    1) Wear shoes shall be of abrasion-resistant, Ni-hard or High Chrome cast iron, minimum Brinell of 550, and mounted on the flights by means of 316 or 304 stainless steel bolts and lock nuts.
    2) The wear shoes shall protrude at least 1 inch from the edge of the welded flight and extend to within 1/2 inch of the pipe shaft, and taper from 3/4 inch at the outer periphery to 3/16 inch at the shaft for maximum abrasion resistance and grit conveying capacity.

d. The pipe shaft of the screw shall be designed with a maximum stress of 3,000 psi and a fatigue life, at 98-percent reliability, of 20 years minimum. Calculations signed by a registered Professional Engineer showing compliance with these requirements shall be included with the Shop Drawing submittal.

e. Rigidly support the screw conveyor at both the upper and lower ends by special bearings, so that the screw conveyor is mounted above, and does not contact classifier tank. This mounting shall provide for a clearance between the screw conveyor and the tank bottom, so that a buildup of sand or grit will provide a bed for the screw, eliminating tank wear, and providing a drainage area for the conveyed grit.
    1) The upper end of the screw conveyor shall be connected to a cycloidal motion speed reducer by a flanged, rigid coupling. The cycloidal speed reducer shall be designed so that all torque is transmitted by rollers, and shall be capable of withstanding shock loads of not less than 500 percent of rated loading.
        a) The cyclodrive shall take radial and all thrust loads from the shaft, and at maximum load provide a minimum B-10 bearing life of 50,000 hours. Gear type speed reducers are not acceptable.
    2) The lower end of the screw shall be supported by a submerged bearing, housed in a water-tight cast iron housing, suitable for completely submerged operation in grit service.
        a) The bearing shall be designed to accept radial loads from the spiral screw conveyor.
        b) The cast iron housing shall be provided with stainless steel cap screws, fill, and drain plugs.
        c) The bearing shall use a sealed bronze sleeve-type bearing, running completely submerged in oil, and shall require only yearly inspection and oil change.
        d) The bearing shall be provided with permanent stellite seals to prevent the leakage of oil and infiltration of grit and other foreign particles into the housing. The seal shall be of the self-compensating type, consisting of two mating hardened steel alloy rings, each held in place by a rubber toric. The wearing surfaces of the rings shall be precision lapped to form an initial sealing band of approximately 1/32 inch in width. The seal shall be designed such that as seal rings wear through normal operation, the pressure from the rubber torics shall push the rings further against each other to form a broadened contact band.

e) Lower bearing designs incorporating conventional packing or requiring external flushing will not be acceptable.

f. The entire motor, cyclodrive, and screw conveyor and lower bearing assembly shall be designed so that the screw can be raised for inspection without the need to disassemble any components, or to drain the classifier tank.
   1) The complete drive assembly shall be pivoted at the shaft centerline so that the screw assembly can be raised for periodic inspection.
   2) The lower end of the assembly shall be attached to a manually operated hand wheel and screw-type lifting device designed to allow the entire assembly to be lifted above the maximum water level without the use of any special tools, or any dismantling of components.

g. Maximum Slope of Screw: 3.5 to 12 (vertical to horizontal).

9. Grit Screw Drive:
   a. Consists of a totally enclosed, ball bearing, constant-speed motor with V-belt drive to a cyclodrive-type speed reducer with oil-tight housing.
   b. Design grit screw drive with safety factor of 1.50, based on motor horsepower.
   c. Mount the screw drive unit on top of the screw trough.
   d. Directly connect the reducer output shaft to the upper end of the screw conveyor.
   e. Provide a pivot for the entire motor and reducer assembly at the shaft centerline so that the screw assembly can be raised.
   f. Provide a fiberglass or 316 stainless steel belt guard meeting all OSHA requirements.
   g. Maximum Screw Speed: 12 rpm.
10. Drive Motor:
   a. Induction, single-speed, continuous-duty, squirrel-cage type, designed, manufactured, and tested in accordance with NEMA MG1.
   b. The motor shall have a Class 1, Division 2, enclosure.
   c. Horsepower (minimum): 1
   d. Maximum Speed, rpm: 1,750.
   e. Volts: 460.
   f. Phase: Three.
   g. Frequency: 60.
   h. Enclosure: TEFC.
   i. Ambient Temperature (degrees Fahrenheit): 20-110.
   j. Service Factor: 1.15.
   k. Insulation: Class F.
   l. Temperature rise under full load: Not to exceed that for Class B insulation.
   m. Refer to Specification Section 16405 for additional requirements.
11. Dewatered Grit Discharge Connection: Minimum opening size 3 inches by 5.5 inches with stainless steel flanged end for connection to grit discharge chute.
12. Overall Dimensions:
   a. Overall length of the complete grit dewatering unit assembly including classifier, cyclone, gear reducer, and supports shall be not greater than 13 feet.
   b. Overall width of the complete grit dewatering unit assembly including classifier, cyclone, gear reducer, and supports shall be not greater than 4 feet.

2.04 ACCESSORIES

A. Zero Speed Switch:
   1. Provide each screw drive unit with a zero speed switch located and mounted per the grit dewatering unit manufacturer's recommendations.
   2. Zero speed sensor to be of the non-contacting type using a probe with an internal pre-amplifier and main electronic assembly. Probe shall be rated for Hazardous location. Do not install probe in direct sunlight. If needed, provide sunshield for probe.
   3. Use a magnetic pick-up welded on one of the spiral shoes or a reader plate on the end of the tail shaft to sense motion.
   4. Main electronic unit to operate on 120 volt, single-phase, 60 Hz power supply and shall be located and powered from the grit classifier control panel.
   5. House main electronic unit (probe) in a Class 1, Division 2 enclosure.
   6. Furnish and install all accessories required for a complete working system and coordinate requirements with the Electrical Drawings and Section 16050. MFA-4 shall be installed in the grit classifier control panel.
   7. As manufactured by Milltronics model MFA-4 motion failure alarm, or equal.

B. Emergency STOP Cable Switch:
   1. Furnish each grit dewatering unit with a cable-operated latching type emergency STOP safety switch.
   2. Hook safety switch to a cable running around the entire periphery of the classifier tank and provide accessories as required.
      a. Provide orange plastic coated safety cable and mount through eyebolts spaced no more than 10 feet.
   3. House main electronic unit in a Class 1, Division 2 enclosure.
   4. Safety switch as manufactured by Material Control, Inc.; or equal.
   5. Furnish and install all accessories required for a complete working system and coordinate requirements with the Electrical Drawings and Section 16050.

C. Lifting Lugs: Provide equipment and each disassemblable part weighing over 100 pounds with lifting lugs for easy handling.

D. Equipment Identification Plates: Securely mount a 16-gauge stainless steel identification plate on each grit dewatering unit in a readily visible location. The plate shall bear the 1/4-inch die-stamped equipment name and tag identification number listed in this Section or indicated on the Drawings.

E. Safety signage.

2.05 CONTROL SYSTEM

A. Grit Classifier Control Panels:
   1. The control panels shall be supplied by manufacture.
   2. One (1) control panel shall be supplied to house the controls for the grit classifier system. The control panel shall have a NEMA 4X, type 316 stainless steel enclosure and shall contain operating and adjustment controls including main breaker with external handle, motor circuit protectors, step-down control transformer (480V to 120V step-down), HOA selector switches, push buttons, emergency mushroom push buttons, and LED indicating lights, NEMA rated Full-voltage reversing starters with overloads, relays, and timers as required for a complete and fully operational grit classifier system. The power supply for

the grit classifier control panel shall be 480V, 3-phase, 60-Hz. Refer to Instrumentation drawings for the minimum input and output signals requirements.

B. Grit Classifier Controls: The following control devices/functions shall be provided for the grit classifier:
   1. At control panel:
      a. HAND-OFF-AUTO Selector Switch:
         1) HAND: Start the grit classifier.
         2) OFF: Inhibit the grit classifier from running.
         3) AUTO: Start the grit classifier when receiving a running signal from the grit pump and stop with 3 minutes (adjustable) time delay after grit pump stops.
      b. RESET Pushbutton: Resets alarm interlocks.
      c. Emergency STOP Latching Cable Switch: Stop grit classifier motor in all modes of operation and annunciate EMERGENCY STOP alarm at SCADA.
      d. Emergency STOP Pushbutton: Stop grit classifier motor and grit pump motor in all modes of operation and annunciate EMERGENCY STOP alarm at SCADA.
      e. Zero Speed Switch: Stop the classifier motor in all modes of operation when auger speed is ZERO.
   2. Process Control System (Plant PLC):
      a. No control of grit classifier through SCADA will be provided and only monitoring of the running and fail signals will be provided.
      b. SCADA shall monitor statuses and annunciate alarm conditions for each grit classifier.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as indicated on the Drawings and in strict accordance with the manufacturer's written instructions, shop drawings, and recommendations.

B. Prior to start-up, fill the clearance between the bottom of screw conveyor and the tank with a clean coarse sand to allow a porous bed for drain back and provide a conveying surface for the screw. Sand gradation to be per grit dewatering unit manufacturer's recommendation.

C. Prior to start-up, the equipment shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance.

3.02 FIELD QUALITY CONTROL

A. General:
   1. The Grit Classifier Supplier shall understand that carrying out the start-up and field-testing may depend on the plant shutdown, and water production. Any interruption for reasons not attributable to the Grit Classifier Supplier actions or the classifier operations will not affect the continuity of the start-up. The startup of the grit classifier systems, and the screw conveyor, most likely, will take place at the same time to ensure proper function of the instrumentation and

controls, including interlocks. Therefore, the Grit Classifier Supplier shall coordinate with the Screw Conveyor Supplier and General Contractor in carrying out the start-up.

B. Start-Up:
   1. The Grit Classifier Supplier shall submit a start-up test procedure and schedule (after training is completed) to the OWNER for approval. Start-up will begin only if the training has been completed and the start-up test procedure and schedule have been reviewed and approved by the OWNER. The Grit Classifier Supplier technical representative, the OWNER's trained personnel, and Construction Manager shall be present for the start-up testing.
   2. The Grit Classifier Supplier's technical representative shall be available on site for the tuning, monitoring, inspection and restarting of each classifier during the entire start-up procedure.
   3. The start-up procedure shall include the following:
      a. To begin the initial start-up, each classifier shall be tuned and adjusted to undergo operation. Faulty components found during initial inspection shall be repaired and replaced within 48 hours by the Grit Classifier Supplier, at no cost to the OWNER. Subsequent to the initial inspection, each classifier shall be operated for a minimum of 48 hours of continuous operation. If no malfunctions occur during the 48 hours of continuous operation, the initial start-up procedure shall be deemed complete.
      b. If malfunctions occur during 48 hours of continuous operation, the Grit Classifier Supplier shall start performing corrective action within 48 hours and restart the classifier for a minimum of 96 hours of additional continuous operation. If no problems are evident during the 96 hours of subsequent operation, the start-up procedure shall be deemed complete.
      c. If malfunctions occur during the 96 hours of subsequent continuous operation, the start-up period shall be terminated and the Grit Classifier Supplier shall perform corrective action within 48 hours prior to requesting additional start-up test. If an additional start-up procedure is necessary, it shall follow the procedure as specified above and be subject to the OWNER's approval. The satisfactory completion of the start-up procedure shall be at the sole discretion of the OWNER.

END OF SECTION

SECTION 14556

SHAFTED SCREW CONVEYORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: shafted screw conveyors.
   1. Equipment Number
      a. Conveyor No. 1 (SC-1013)
      b. Conveyor No. 2 (SC-1023)

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01310 – Construction Schedule and Project Restraints
      b. Section 01614 - Wind Design Criteria
      c. Section 01730 - Operating and Maintenance Data
      d. Section 01740 – Warranties and Bonds
      e. Section 15050 – Basic Mechanical Materials and Methods.
      f. Section 16010 – Basic Electrical Requirements
      g. Section 16050 – Basic Electrical Materials and Methods
      h. Section 16120 – Conductors
      i. Section 16405 – Electric Motors
      j. Section 16450 – Grounding

1.02 REFERENCES

A. American Gear Manufacturer's Association (AGMA).

B. American Institute of Steel Construction (AISC).

C. American Iron and Steel Institute (AISI).

D. American Welding Society (AWS).

E. National Electrical Manufacturer's Association (NEMA):
   1. 250 – Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA Type 4 enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. The 12-inch minimum conveyor shall be designed and manufactured to handle a continuous loading dewatered grit.
      a. Conveying capacity of the conveyor shall be 2 times the design loading without changing the design operating speed.
   2. Design calculations showing dead, live, and dynamic loadings are required.
      a. Calculations shall demonstrate that the design stress at 250 percent of the motor nameplate horsepower in the auger shall not exceed 30 percent of the F_y value in the extreme fiber of the flight material.
   3. The conveyor system shall consist of shafted screw conveyors as indicated on the Drawings, complete with drive, shafted screw, UHMW liner, grit ports for discharged from the bars screens, and grit classifiers**,** and drop chute to discharge in a continuous manner to bin.
      a. Sectional welded plate sections are not acceptable.
      b. The conveyor system shall be of the size and location as indicated on the Drawings.
      c. Manufacturer shall provide support mountings and discharge chutes for grit classifier, bar screen, and conveyor as indicated on the Drawings.
   4. The conveyor system shall be sized for a capacity of 30 cubic feet per hour. Maximum loading shall be 30 percent of trough filling.
   5. Basis of design:
      a. The Drawings have been prepared based upon the layout of the conveyor manufacturer listed in this specification section.
      b. If alternate equipment is proposed which requires modifications to the basis of design, then include in the lump sum bid all modifications and accessories as required to provide a complete and operable system.
      c. In addition, include in the lump sum bid all necessary structural, electrical, and mechanical modifications to the proposed system.

B. Supports:
   1. Provide structural supports.
      a. The support structure shall be designed and provided by the conveyor manufacturer.
   2. Provide full structural steel ground supports.
      a. The design of the support structure shall be integrated with the classifiers.
   3. All structural members shall be designed so that the unit stresses will not exceed AISC allowable stresses by more than 1/3 when subject to loading of twice the static load.

1.05 SUBMITTALS

A. General: Submit as specified in Section 15050.

B. Product data.

C. Sample of chute material.

D. Shop drawings: Include manufacturer's complete erection, installation, and adjustment instructions and recommendations, details of parts individually and severally, and detailed test procedures for field-testing.

E. Structural and mechanical calculations: prepared, signed, and sealed by Professional Engineer in the state of Florida.

F. Operating and Maintenance Manual:
   1. Submit operation and maintenance manuals in accordance with Section 01730.

G. Submit structural design calculations and all other product drawings and information required for a complete submittal.
   1. The structural calculations for the supports and anchoring of the unit and associated accessories as well any other structural supports as part of the system shall be done, signed, and stamped by a structural professional engineer in the state of Florida.

H. Video of factory test on DVD.

1.06 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Minimum 5 years experience in production of equipment substantially similar to the specified equipment.
   2. Submit evidence of satisfactory operation of shafted screw conveyor units similar to the specified units in at least five separate facilities in accordance with the following requirements:
      a. All shafted screw conveyor units on the submitted installation list shall use the same design for critical components as specified for this project.
      b. Service: Municipal wastewater in U.S. or Canada.
      c. Multiple screw conveyors units at a plant shall be considered as one installation toward meeting the experience requirements.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

1.07 WARRANTY

A. As specified in Section 01740

B. Liner Wear
   1. In addition to the equipment warranty required by the Contract Documents, each screw conveyor's trough liner shall not require replacement due to wear before 3,000 hours of operation or 18 months, after acceptance, whichever comes first. If any screw conveyor trough liner or segment thereof requires replacement due to wear, as evidenced within 3,000 hours of operation or 18 months after acceptance, whichever comes first, provide all labor and materials to replace the entire trough liner without additional cost to the OWNER.
   2. Liner failure shall be defined by a loss of 25 percent or more of liner depth over a length of more than 0.25 times the flight diameter at any point within the trough; or a failure of the liner attachment method at more than one point on a given conveyor.

C. Screw Wear

1. In addition to the equipment warranty required by the Contract Documents, the polyethylene screw shall not require replacement due to wear before 3,000 hours of operation or 18 months, after acceptance, whichever comes first. If any screw requires replacement due to wear, as evidenced within 3,000 hours of operation or 18 months after acceptance, whichever comes first, provide all labor and materials to replace the entire screw without additional cost to the OWNER.
2. Polyethylene screw wear failure shall be defined by a loss of 3/8-inch or more of the radius of a 12-inch polyethylene screw which equates to a 6.25% loss of diameter for all screws diameters.

1.08 SPARE PARTS AND SPECIAL TOOLS

A. Special Tools: Furnish any special tools required for maintenance and disassembly of furnished equipment. A minimum of two liner replacement tools shall be provided.

B. The following spare parts shall be provided:
1. Sufficient wear stripping to completely replace the wear strips on one conveyor
2. One complete set of tools and fasteners to make repairs
3. One complete set of all gaskets and seals for each sized chute provided
4. One replacement motor
5. Sufficient oil for reducer gear motors to provide two oil changes or an 18 month supply, whichever is greater

C. Deliver spare parts and special tools in boxes labeled with contents, equipment to which spare parts belong, and name of CONTRACTOR.

D. CONTRACTOR, inspector, and OWNER's maintenance representative shall inventory and account for all tools and spare parts delivered to the site. Each party shall sign a turn over agreement. OWNER will then take possession and responsibility for items.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Shafted screw conveyor: One of the following or equal:
1. Hydro-Dyne
2. Keller Angelillis

2.02 MATERIALS

A. Shafted screw conveyor: The shafted screw conveyor shall be new and of current manufacture, and shall be designed to transfer municipal dewatered grit as specified and shall be constructed in accordance with CEMA 350 standards.
1. Trough, chutes: 1/8-inch minimum Type 316 stainless steel.
2. Covers: 1/8-inch minimum Type 316 stainless steel.
3. Drive and end plates: 1/2-inch minimum Type 316 stainless steel, removable.
4. Screw flights: 12-inch polyethylene screw mounted on a 2.5-inch x 3/16-inch Type 316 stainless steel square tube.
5. Wear liner: Plastimeric, (UHMW) 1/2-inch thickness minimum, 2 color.
6. Hardware: Type 316 stainless steel.

7. Cover fasteners:
    a. Type 304 stainless steel hinges and toggle clamps.
    b. Hinges shall be located on the side of the conveyor closest to the wall or equipment.
8. Drive shaft: AISI 4150.

2.03 SCREW FLIGHT

A. 12-inch diameter polyethylene screw conveyor.

B. Spiral flighting for the shafted screw conveyors shall be full pitch, mounted on a 2.5-inch x 3/16-inch Type 316 stainless steel square tube. The drive and tail shaft shall be Type 316 stainless steel. The tail shaft shall run in a “Arguto” oil impregnated wooden bearing.

C. The shafted screw will run the full length of the trough transferring the grit from the classifiers and bar screen to the discharge chute.

2.04 TROUGH AND LINER

A. Construction: Materials shall be 1/8-inch minimum thick, Type 316 stainless steel, U-trough with neoprene gasketing at each trough flange and 1/8-inch gauge stainless steel cover.

B. Each trough section body shall be fabricated in single welded constructions for lengths up to 20 feet. Troughs greater than 20 feet in length shall be constructed for two or more sections bolted together at the trough joining the flanges.

C. Conveyor shall have standard removable trough end plates (both ends) with split-gland seal at the drive end.
    1. Provide zerk fitting for lubrication of seal.

D. Provide a 3-inch diameter drain at each end of the conveyor.

E. Conveyor trough shall have removable bolted cross braces.

F. Conveyor covers shall be hinged.
    1. Hinge shall be removable pin-style with a length at least 90 percent of the lid length.
    2. Cover shall come equipped with lid stops to prevent over-opening the cover.

G. Each lid shall have 2 stainless steel pull-action toggle clamps to keep the lid secure during operation.
    1. Each clamp shall be double-locking with a U-bolt arm adjustable up to 1/2 inch.
    2. The latch plate shall be mounted on the lid with the toggle body mounted below the lid on the trough.

H. The trough shall have a replaceable liner constructed of preformed 1/2-inch minimum ultra-high molecular weight polyethylene with anti-wear agents and retainer strips welded to the trough along the top of the liner.
    1. Fasteners shall not be used below the spiral centerline to hold the liner.

I. The liner shall be a single piece, formed and bonded with 2 layers, each a different color, to provide a visible indication when the liner is nearing the end of its useful life and there is only 1/8 inch remaining.

2.05 DRIVE UNITS

A. The drive units shall be a hollow shaft-mounted, roller-bearing gear motor rated a minimum AGMA Class II, single or double reduction or triple reduction.

B. Drive finish shall be severe duty washdown surface protection finish with stainless steel paint.

C. Provide a maximum 5-horsepower TEFC 230/460-volt, 60-hertz, 3-phase constant speed drive at discharge end of conveyor running at approximately 30 revolutions per minute. The motor shall have a Class 1, Division 2, explosion-proof enclosure.
   1. Provide NORD Gear Corporation Unicase, or equal, shaft-mounted drive with hollow shaft design.

D. V-belt-driven speed reducer or chain-driven reducers not permitted.

E. Motors shall be mounted at the end of the conveyors as indicated on the Drawings.

F. Refer to Specification Section 16405 for additional requirements.

2.06 CONTROLS AND ACCESSORIES

A. Control panel: A NEMA 4X type 316 stainless steel control panel shall be provided for conveyor system. The control panel shall contain operating and adjustment controls including main breaker with external handle, motor circuit protectors, branch breakers, step-down control transformer, on-off selector switches, push buttons, LED indicating lights, NEMA rated full voltage reversing starters, relays, elapsed time meters, and timers as required for a complete and fully operational conveyor system. Power supply for conveyor control panel shall be 480V, 3-phase, 60Hz. Refer to Instrumentation drawings for the minimum input and output signals requirements. Control panel shall have appropriate UL label and minimum of 25kAIC rating.

B. Emergency stop cables:
   1. Provide emergency stop cables on both sides of the conveyor with 2 switches per 50 feet minimum length of cable.
   2. Cable shall be orange plastic coated safety cable mounted through eyebolt spaced no more than 10 feet.

C. Non-Contacting-Type Zero-Motion Switches:
   1. Non-contacting-type zero-motion switches shall be provided and installed so they stop the operation of the drive motor when conveyor motion is not detected.
   2. Zero speed sensor to be of the non-contacting type using a probe with an internal pre-amplifier and main electronic assembly. Probe shall be rated for Hazardous location. Do not install probe in direct sunlight. If needed, provide sunshield for probe.
   3. Use a magnetic pick-up welded on one of the spiral shoes or a reader plate on the end of the tail shaft to sense motion.

4. Main electronic unit to operate on 120 volt, single-phase, 60 Hz power supply and shall be located and powered from conveyor control panel.
5. House main electronic unit (probe) in a Class 1, Division 2 enclosure.
6. Furnish and install all accessories required for a complete working system and coordinate requirements with the Electrical Drawings and Section 16050. MFA-4 shall be installed in the grit classifier control panel.
7. As manufactured by Milltronics model MFA-4 motion failure alarm, or equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. The overall dimensions of the shafted screw conveyors and appurtenances shall fit within the space shown on the Drawings. Verify dimensions and clearances and coordinate the installation of the shafted screw conveyors with the existing bar screen, drop chute, and new grit classifiers.related work included in other Sections. Verify equipment supports, structure dimensions and arrangement and notify the Engineer of any discrepancy before submitting shop and erection drawings for approval. Coordinate all interfaces of the shafted screw equipment with all related equipment specified in other related Sections. The shafted screw conveyors shall comprise complete coordinated systems including, but not limited to: the shafted screws, drives, troughs, supports, trough covers, liners, gear reducers, motors, discharge chutes, limit switches, motion sensors, and all appurtenances as shown on the Drawings or specified herein.

3.02 INSTALLATION

A. Install screw conveyors in accordance with manufacturer's recommendations.
   1. All field welds shall be passivated.

3.03 SHOP TESTING

A. Conveyors, in their entire length, shall be inspected and operated in the shop with the actual drive unit for the project.
   1. Unit shall be fully assembled with tack welds at the factory and test run for 15 minutes to check for equipment tolerances and proper operation.
   2. Conveyors shall be corrected as necessary.
   3. Prior to shipment, the tack welds will be broken apart and conveyors suitably prepared for shipment.
   4. A DVD video of the test shall be submitted to the ENGINEER for record purposes.

3.04 FIELD QUALITY CONTROL

A. General:
   1. The Screw Conveyor Supplier shall understand that carrying out the start-up and field-testing may depend on the plant shutdown, and water production. Any interruption for reasons not attributable to the Screw Conveyor Supplier actions or the conveyor operations will not affect the continuity of the start-up. The startup of the screw conveyor systems, and the grit classifiers, most likely, will take place at the same time to ensure proper function of the

instrumentation and controls, including interlocks. Therefore, the Screw Conveyor Supplier shall coordinate with the Grit Classifier Supplier and General Contractor in carrying out the start-up.

B. Start-Up:
   1. The Screw Conveyor Supplier shall submit a start-up test procedure and schedule (after training is completed) to the OWNER for approval. Start-up will begin only if the training has been completed and the start-up test procedure and schedule have been reviewed and approved by the OWNER. The Screw Conveyor Supplier technical representative, the OWNER's trained personnel, and Construction Manager shall be present for the start-up testing.
   2. The Screw Conveyor Supplier's technical representative shall be available on site for the tuning, monitoring, inspection and restarting of each conveyor during the entire start-up procedure.
   3. The start-up procedure shall include the following:
      a. To begin the initial start-up, each conveyor shall be tuned and adjusted to undergo operation. Faulty components found during initial inspection shall be repaired and replaced within 48 hours by the Screw Conveyor Supplier, at no cost to the OWNER. Subsequent to the initial inspection, each conveyor shall be operated for a minimum of 48 hours of continuous operation. If no malfunctions occur during the 48 hours of continuous operation, the initial start-up procedure shall be deemed complete.
      b. If malfunctions occur during 48 hours of continuous operation, the Screw Conveyor Supplier shall start performing corrective action within 48 hours and restart the conveyor for a minimum of 96 hours of additional continuous operation. If no problems are evident during the 96 hours of subsequent operation, the start-up procedure shall be deemed complete.
      c. If malfunctions occur during the 96 hours of subsequent continuous operation, the start-up period shall be terminated and the Screw Conveyor Supplier shall perform corrective action within 48 hours prior to requesting additional start-up test. If an additional start-up procedure is necessary, it shall follow the procedure as specified above and be subject to the OWNER's approval. The satisfactory completion of the start-up procedure shall be at the sole discretion of the OWNER.

END OF SECTION

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic design and performance requirements for mechanical equipment.

1.02 REFERENCES

A. American Gear Manufacturer's Association (AGMA) Standards:
   1. AGMA 2001-B88 - Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
   2. AGMA 6000-A88 - Specification for Measurement of Linear Vibration on Gear Units.
   3. AGMA 6010-E88 - Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives.
   4. AGMA 6019-E89 - Standard for Gear motors using Spur, Helical, Herringbone, Straight Bevel or Spiral Bevel Gears.
   5. AGMA 6025-C90 - Sound for Enclosed Helical, Herringbone, and Spiral Bevel Gear Drives.

B. American Society of Mechanical Engineers (ASME):
   1. ASME PTC 8.2 - Performance Test Code for Centrifugal Pumps.
   2. ASME PTC 10 - Performance Test Code - Compressors and Exhausters.
   3. ASME PTC 17 - Performance Test Code - Reciprocating Internal-Combustion Engines.
   4. ASME PTC 11 - Performance Test Code - Measurement of Shaft Horsepower - Instruments and Apparatus.

C. American Bearing Manufactures Association (ABMA) Standards:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

D. American Society for Testing and Materials (ASTM):
   1. A 36 - Standard Specification for Structural Steel.
   2. A 48 - Standard Specification for Gray Iron Castings.
   3. A 526 - Standard Specification for Steel Sheet, Zinc Coated by the Hot Dip Process, Commercial Quality.
   4. B 61 - Standard Specification for Steam or Valve Bronze Castings.
   5. B 62 - Standard specification for Composition Bronze or Ounce Metal Castings.
   6. E 527 - Standard Practice for Numbering Alloys and Metals (UNS).

E. Hydraulic Institute Standards (HI):
   1. HI 1.1-1.5 - Centrifugal Pumps - Nomenclature, Definitions, Application, and Operation.

2. HI 1.6 - Centrifugal Pump Tests.
3. HI 2.1-2.5 - Vertical Pumps - Nomenclature, Definitions, Application, and Operation.
4. HI 2.6 - Vertical Pump Tests.
5. HI 3.1-1.5 - Rotary Pumps - Nomenclature, Definitions, Application, and Operation.
6. HI 3.6 - Rotary Pump Tests.
7. HI 4.1-4.6 - Sealless Rotary Pumps - Nomenclature, Definitions, Application, Operation, and Test.
8. HI 5.1-1.6 - Sealless Centrifugal Pumps - Nomenclature, Definitions, Application, Operation, and Test.
9. HI 6.1-6.5 - Reciprocating Power Pumps - Nomenclature, Definitions, Application, and Operation.
10. HI 7.1-7.5 - Controlled Volume Pumps - Nomenclature, Definitions, Application, and Operation.
11. HI 9.1-9.5 - Pumps - General Guidelines for Types, Definitions, Application, and Sound Measurement.

F. American Petroleum Institute (API):
1. ANSI/API 682 - Shaft Sealing Systems for Centrifugal and Rotary Pumps.

1.03 DEFINITIONS

A. Special Tools: Tools that have been specifically made for use on unit of equipment for assembly, disassembly, repair, or maintenance.

B. Resonant Frequency: That frequency at which a small driving force produces an ever-larger vibration if no dampening exists.

C. Rotational Frequency: The revolutions per unit of time usually expressed as revolutions per minute.

D. Critical Frequency: Same as resonant frequency for the rotating elements or the installed machine and base.

E. Peak Vibration Velocity: The root mean square average of the peak velocity of the vibrational movement times the square root of 2 in inches per second.

F. Rotational Speed: Same as rotational frequency.

G. Maximum Excitation Frequency: The excitation frequency with the highest vibration velocity of several excitation frequencies that are a function of the design of a particular machine.

H. Critical Speed: Same as critical frequency.

I. Free Field Noise Level: Noise measured without any reflective surfaces (an idealized situation); sound pressure levels at 3 feet from the source unless specified otherwise.

J. Operating Weight: The weight of unit plus weight of fluids or solids normally contained in unit during operation.

1.04 SYSTEM DESCRIPTION

A. General:
   1. Provisions specified under each technical equipment specification prevail over and supersede conflicting provisions as specified in this Section.
   2. Provide equipment and parts that are suitable for stresses, which may occur during fabrication, transportation, erection, and operation.
   3. Provide equipment that has not been in service prior to delivery, except as required by tests.
   4. Like parts of duplicate units are to be interchangeable.
   5. When 2 or more units of equipment for the same purpose are required, provide products of same manufacturer.
   6. Equipment manufacturer's responsibility extends to selection and mounting of gear drive units, motors or other prime movers, accessories, and auxiliaries required for proper operation.
   7. When necessary, modify manufacturer's standard product to conform to specified requirements or requirements indicated on the Drawings and contained in Laws and Regulations.

B. Material Requirements:
   1. Materials: Suitable for superior corrosion resistance and for services under conditions normally encountered in similar installations.
   2. Dissimilar Metals: Separate contacting surfaces with dielectric material.

C. Power Transmission Systems:
   1. Power Transmission Equipment: V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints are to be rated for 24 hour-a-day continuous service or frequent stops-and-starts intermittent service, whichever is most severe, and sized with a minimum service factor of 1.5.
      a. Apply 1.5 service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
      b. Apply service factors higher than 1.5 when recommended for continuous 24 hour-per-day operation and shock loadings specified in AGMA 6010-E88, other applicable AGMA standards, or other applicable referenced standards.
      c. When manufacturer recommends service factor greater than 1.5, manufacturer's recommendation takes precedence.

D. Vibration:
   1. Resonant Frequency: Ensure there are no natural resonant torsional, radial, or axial frequencies within 25 percent above or below the operating rotational frequencies or multiples of the operating rotational frequencies that may be excited by the equipment design.
   2. Design, balance and align equipment to meet the vibration criteria specified in Section 15958.

E. Equipment Mounting and Anchoring:
   1. Mount equipment on cast iron or welded steel bases with structural steel support frames. Utilize continuous welds to seal seams and contact edges between steel members. Grind welds smooth.
   2. Provide bases and supports with machined support pads, dowels for alignment of mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits.
   3. Provide jacking screws in bases and supports for equipment weighing over 1,000 pounds.
   4. Anchorage of Equipment to Concrete: Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
   5. Provide bolt sleeves for anchor bolts for heavy equipment. Adjust bolts to final location and fill sleeve with non-shrink grout.
   6. Anchorage of Equipment to Metal Supports: Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.
   7. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load, and other loads as required for proper operation of equipment.

F. Equipment Units Weighing 50 Pounds or More: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.

1.05 SUBMITTALS

A. Product Data:
   1. For Each Item of Equipment:
      a. Design features.
      b. Load capacities.
      c. Efficiency ratings.
      d. Material designations by UNS alloy number or ASTM Specification and Grade.
      e. Data needed to verify compliance with the Specifications.
      f. Catalog data.
      g. Name plate data.
      h. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
   2. Gear Reduction Units:
      a. Engineering information per applicable AGMA standards.
      b. Gear mesh frequencies.

B. Shop Drawings:
   1. Drawings for Equipment:
      a. Drawings that include outline drawings, cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
   2. Outline drawings showing equipment, driver, driven equipment, pumps, seal, motor(s) or other specified drivers, variable frequency drive, shafting, U-joints, couplings, drive arrangement, gears, baseplate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
   3. Installation and checkout instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial start-up procedures.

4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer based controls.
5. Recommended or normal operating parameters such as temperatures and pressures.
6. Alarm and shutdown set points for all controls furnished.

C. Calculations:
1. Calculations and other information to substantiate equipment base plates, supports, bolts, anchor bolts, and other connections meet minimum design strength requirements.
2. Bearing L_{10} life calculations in accordance with ABMA 9 or ABMA 11 calculation methods for drivers, pumps, gears, shafts, motors, and other drive line components with bearings.
3. Calculations and other information to substantiate that operating rotational frequencies meet the requirements of this Section.
4. Torsional Analysis of Power Transmission Systems: When torsional analysis specified in the equipment Sections, provide:
   a. Sketch of system components identifying physical characteristics including mass, diameter, thickness, and stiffness.
   b. Results of analysis including first and second critical frequencies of system components and complete system.
5. Calculations shall be signed and stamped by a civil or structural engineer registered to practice in the state where the Project is located.

D. Quality Control Submittals:
1. Source quality control reports and certified test data as specified in Section 15958.
2. Submit factory test reports before shipment.
3. Certified static and dynamic balancing reports for rotating equipment.
4. Field quality control reports and test data as specified in Section 15958.
5. Start-Up Plan: Proposed plan for field-testing equipment.
6. Certificate of Proper Installation.
7. Submit material test reports a specified in the equipment sections.

E. Operation and Maintenance Manuals:
1. Submit prior to training of OWNER's personnel.
2. Make available at project site complete copy of manuals for use by field personnel and ENGINEER during start-up and testing of equipment.
3. Include manufacturer and model number of every bearing; include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.
4. Include motor rotor bar pass frequencies.

1.06 QUALITY ASSURANCE

A. Manufacturer's Field Service:
1. Furnish services of authorized representative specially trained in installation of equipment.
   a. Visit project site and perform tasks necessary to certify installation.
   b. Furnish Certificate of Proper Installation.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:
   1. Equipment: Pack in boxes, crates, or otherwise protect from damage and moisture, dust, or dirt during shipment, handling, and storage.
   2. Bearings: Separately pack or otherwise suitably protect during transport.
   3. Spare Parts: Deliver in boxes labeled with contents, equipment to which spare parts belong, and name of CONTRACTOR.

B. Storage:
   1. Equipment Having Bearings: Store in enclosed facilities. Rotate units at least once per month or more often as recommended by the manufacturer to protect rotating elements and bearings.
   2. Gear Boxes: Oil filled or sprayed with rust preventive protective coating.

C. Protection:
   1. Equipment: Protect equipment from deleterious exposure.
   2. Painted Surfaces: Protect against impact, abrasion, discoloration, and other damage.

1.08 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Equipment for project include:
      a. Installation in a wastewater treatment plant.
      b. Moderate quantities of commercial and industrial waste.
      c. Ambient Temperatures: 20 to 110 degrees Fahrenheit.
      d. Relative Humidities: 50 to 100 percent.
      e. Site Elevation: Approximately 15-20 feet above mean sea level.

1.09 SEQUENCING AND SCHEDULING

A. Equipment Anchoring: Obtain anchoring material and templates or setting drawings from equipment manufacturers in adequate time for anchors to be cast-in-place when concrete is placed.

B. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

C. General Start-Up and Testing of Equipment:
   1. Perform general start-up and testing procedures after operation and maintenance manuals for equipment have been received.
   2. Conduct functional testing of mechanical or electrical systems when each system is substantially complete and after general start-up and testing procedures have been successfully completed.
   3. Functional testing requirements as specified in Section 15958 and 16950 and the equipment sections.

1.10 MAINTENANCE

A. Special Tools:
   1. When specified, provide special tools required for operation and maintenance.

2. Mark or tag and list such tools in maintenance and operations instructions. Describe use of each tool.

B. Spare Belts:
   1. When spare belts are specified, furnish 1 spare belt for every different type and size of belt-driven unit.
      a. Where 2 or more belts are involved, furnish matched sets.
      b. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.
      c. Package in boxes labeled with identification of contents.

C. Spare Parts:
   1. Assume responsibility until turned over to OWNER.
   2. Store in enclosed facilities.
   3. Furnish itemized list and match identification tag attached to every part.
   4. List parts by generic title and identification number.
   5. Furnish name, address, and telephone number of supplier and spare parts warehouse.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ferrous Materials:
   1. Steel for Members used in Fabrication of Assemblies: ASTM A 36.
   2. Iron Castings: ASTM A 48, tough, close-grained gray iron, free from blowholes, flaws, and other imperfections.
   3. Galvanized Steel Sheet: ASTM A 526, minimum 0.0635 inch (16 gauge).
   4. Expanded Metal: ASTM A 36, 13 gauge, 1/2-inch flat pattern expanded metal.

B. Nonferrous Materials:
   1. Stainless Steel: Type 304 or 316 as specified. Provide L grade where welding required.
   2. Bronze in Contact with Liquid: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C83600, C92200 or C92700 in accordance with ASTM B 61, B 62, B 505, or B 584, when not specified otherwise.

C. Dielectric Materials for Separation of Dissimilar Metals:
   1. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials.

D. Anchors Bolts: As specified.

2.02 SHAFT COUPLINGS

A. General:
   1. Type and Ratings: Provide nonlubricated type, designed for not less than 50,000 hours of operating life.
   2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, and type of service.

3. Use: Use of couplings specified in this Section does not relieve CONTRACTOR of responsibility to provide precision alignment of driver-driven units as required by equipment manufacturer and alignment criteria specified elsewhere in this section.

B. Shaft Couplings - Close Coupled: Shaft couplings for close coupled electric motor driven equipment 1/2 horsepower or larger and subject to sudden torque reversals or shock loading:
   1. Manufacturers: One of the following or equal:
      a. T.B. Woods, Dura-Flex, L-Jaw C-Jaw or G-Jaw.
      b. Lovejoy, S-Flex.
   2. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
   3. Manufacture flexible component of coupling from synthetic rubber, or urethane.
   4. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
   5. Do not allow metal-to-metal contact between driver and driven equipment.
   6. Examples of loads where sudden torque reversals may be expected:
      a. Reciprocating pumps, blowers, and compressors.
      b. Conveyor belts.
      c. Reversing equipment.

C. Shaft Couplings - Direct Connected: Shaft couplings for direct connected electric motor driven equipment 1/2 horsepower or larger and subject to normal torque, non-reversing applications:
   1. Manufacturers: One of the following or equal:
      a. Falk, WA Torus.
      b. T.B. Woods, Dura-Flex, Sure-Flex or Form-Flex.
   2. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.
   3. Provide flexible connecting element of rubber and reinforcement fibers.
   4. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.

D. Spacer Couplings: Where cartridge type mechanical seals or non-split seals are specified, provide a spacer type coupling of sufficient length to remove the seal without disturbing the driver or driven equipment unless noted otherwise in the individual equipment specifications.

E. Specialized Couplings: Where requirements of equipment dictate specialized features, supply coupling recommended for service by manufacturer.

2.03 STUFFING BOX, SEAL CHAMBER, AND SHAFT SEALS

A. General:
   1. Unless otherwise noted in the equipment section, provide cartridge type, double mechanical shaft seals for pumps.
   2. Provide a stuffing box large enough for a double mechanical seal.
   3. Where packing is specified, provide stuffing box large enough to receive a double mechanical seal.
   4. Provide seal or packing flush connections, (3/4-inch size unless another size is indicated on the Drawings).

5. Provide and route leakage drain line to nearest equipment floor drain indicated on the Drawings.
6. For pumps with packing, design packing gland to allow adjustment and repacking without dismantling pump except to open up packing box.
7. Seal or packing flush requirements shall be in accordance with API Standard 682 requirements. Unless otherwise indicated, specified or required by the equipment and seal manufacturers, the following API flushing Plan arrangements shall be utilized as appropriate for the application:
    a. Single seal, clean water applications: Plan 11 (Discharge bypass to seal).
    b. Single seal, vertical pump applications: Plan 13 (Seal bypass to suction).
    c. Single seal, clean hot water (greater than 180 degrees Fahrenheit) applications: Plan 23 (Seal cooler and pumping ring).
    d. Single seal, solids, or contaminants containing water applications: Plan 32 (External seal water- see Carollo typical detail # M262).
    e. Double seal applications: Plan 54 (External seal water- see Carollo typical detail # M262).

B. Packing: When specified in the equipment section of the specifications, provide the following type of packing:
    1. Wastewater, water, and sludge applications:
        a. Asbestos free.
        b. PTFE (Teflon) free.
        c. Braided graphite.
        d. Manufacturers: One of the following or equal:
            1) Chesterton, 1400.
            2) John Crane Inc., equivalent product.
    2. Drinking water service:
        a. Approved by the FDA or NSF.
        b. Asbestos free.
        c. Material: Braided PTFE (Teflon).
        d. Manufacturers: One of the following or equal:
            1) Chesterton, 1725.
            2) John Crane, Inc., equivalent product.

C. Mechanical seals: Provide seal types specified in the equipment sections and as specified.
    1. Provide seal types meeting the following requirements:
        a. Balanced hydraulically.
        b. Spring: Stationary, out of pumping fluid, Hastelloy C; Type Elgiloy or 17-7 PH stainless steel for split seals.
        c. O-ring: Viton 747.
        d. Gland: Type 316L stainless steel.
        e. Set screws: Type 316L stainless steel.
        f. Faces: Reaction bonded, Silicon Carbide.
        g. Seal designed to withstand 300 pounds per square inch gauge minimum differential pressures in either direction; no requirement for seal buffer pressure to be maintained when pump is not operational even though process suction head may be present in pump.
    2. Cartridge type single mechanical: Manufacturers: One of the following or equal:
        a. Chesterton, S10.
        b. John Crane, 5610 Series.

3. Cartridge type double mechanical: Manufacturers: One of the following or equal:
    a. Chesterton, S20.
    b. John Crane, 5620 Series.
4. Split face single mechanical: Manufacturers: One of the following or equal:
    a. Chesterton, 442.
    b. John Crane, 3710.

2.04 GEAR REDUCTION UNITS

A. Type: Helical or herringbone, unless otherwise specified.

B. Design:
1. Made of alloys treated for hardness and for severe service.
2. AGMA Class II Service:
    a. Use more severe service condition when such is recommended by unit's manufacturer.
3. Cast iron housing with gears running in oil.
4. Anti-friction bearings.
5. Thermal horsepower rating based on maximum horsepower rating of prime mover not actual load.
6. Manufactured in accordance with applicable AGMA standards.

C. Planetary gear units are not to be used.

2.05 BEARINGS

A. Type: Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.

B. Oil Lubricated Bearings: Provide either pressure lubricating system or separate oil reservoir splash type system.
1. Size oil lubrication systems to safely absorb heat energy generated in bearings when equipment is operating under normal conditions and with the ambient temperature 15 degree Fahrenheit above the maximum ambient temperature specified elsewhere in this Section.
2. Provide an external oil cooler when required to satisfy the specified operating conditions. Provide air cooled system if a water cooling source is not indicated on the Drawings. Equip oil cooler with a filler pipe and external level gauge.

C. Grease Lubricated Bearings, Except Those Specified to Be Factory Sealed: Fit with easily accessible grease supply, flush, drain, and relief fittings.
1. Lubrication Lines and Fittings:
    a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
    b. Multiple Fitting Assemblies: Mount fittings together in easily accessible location.
    c. Use standard hydraulic type grease supply fittings.
        1) Manufacturers: One of the following or equal:
            a) Alenite.
            b) Zurk.

D. Ratings: Rated in accordance with ABMA 9 or ABMA 11 for L_{10} rating life of not less than 50,000 hours.

1. Higher ratings, when specified in other Sections, supersede preceding requirement.

2.06 SAFETY GUARDS

A. Drive Assemblies: Enclose sprockets, belts, drive chains, gearings, couplings, and other moving parts on drive assemblies in safety enclosures that are in compliance with applicable Laws and Regulations.

B. Shafts: Provide guards that protect personnel from rotating shafts or components within 7.5 feet of floors or operating platforms.

C. Guard Requirements:
   1. Allow visual inspection of moving parts without removal.
   2. Allow access to lubrication fittings.
   3. Prevent entrance of rain or dripping water for outdoor locations.
   4. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of one belt.

D. Materials:
   1. Sheet Metal: Carbon steel, 12 gauge minimum thickness, hot-dip galvanized after fabrication.
   2. Fasteners: Type 304 stainless steel.

2.07 SPRING VIBRATION ISOLATORS

A. Design Requirements:
   1. Telescopic top and bottom housing with vertical stabilizers to resist lateral and vertical forces.
   2. Use steel coil springs.

B. Performance Requirements: Minimum spring deflection of 1 inch under static load and capable of limiting transmissability to10 percent maximum at design operating load.

C. Manufacturers: One of the following or equal:
   1. California Dynamics Corporation, Type RJSD.
   2. Mason Industries, equivalent product.

D. Materials:
   1. Fabricate isolators using welded steel or shatterproof ductile iron in accordance with ASTM A 536 Grade CS-45-12.
   2. Spring Steel: ASTM A 125.

2.08 WARNING SIGNS

A. Provide for equipment that starts automatically or remotely.

B. Material and Size: Metal as specified.

C. Colors: Black lettering on yellow background.

D. Text: As specified.

2.09 FABRICATION

A. Nameplates:
   1. Engraved or stamped on Type 304 stainless steel and fastened to equipment at factory in an accessible and visible location.
   2. Indicate Following Information as Applicable:
      a. Manufacturer's name.
      b. Equipment model number and serial number.
      c. Maximum and Normal rotating speed.
      d. Horsepower.
      e. Rated capacity.
      f. Service class per applicable standards.
   3. Nameplates for Pumps: Include:
      a. Rated total dynamic head in feet of fluid.
      b. Rated flow in gallons per minute.
      c. Impeller, gear, screw, diaphragm, or piston size.
   4. Gear Reduction Units: Include:
      a. AGMA Class of service.
      b. Service factor.
      c. Input and output speeds.

B. Bolt Holes in Equipment Support Frames: Do not exceed bolt diameter by more than 25 percent, up to limiting maximum diameter oversize of 1/4 inch.

C. Shop Finishing:
   1. Provide factory and field coating as follows:
      a. Bases and Support Frames in Contact with Concrete or Other Material: Coat contacting surfaces with minimum of 2 coats of zinc chromate primer before installation or grouting.
      b. Shop Primer for Steel and Iron Surfaces, Unless Specified Otherwise:
         1) Manufacturers: One of the following or equal:
            a) Ameron, Amercoat 185 Universal Primer.
            b) Cook, 391-N-167 Barrier Coat.
            c) Kop-Coat, Pug Primer.
            d) Tnemec, 37-77 Chem-Prime.
            e) Valspar, 13-R-28 Chromox Primer.
      c. Coat machined, polished, and nonferrous surfaces which are not to be painted with rust-preventive compounds.
         1) Manufacturers: One of the following or equal:
            a) Houghton, Rust Veto 344.
            b) Rust-Oleum, R-9.
      d. Coating for Ferrous Metal Surfaces, Except Stainless Steel: High solids polyamine epoxy.
      e. Finish Painting of Motors: Shop finish paint with manufacturer's standard coating.

2.10 SOURCE QUALITY CONTROL

A. As specified in Section 15958 for testing requirements and the individual equipment sections of the Specifications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components for shipping damage, conformance to specifications, and proper torques and tightness of fasteners.

3.02 PREPARATION

A. Metal Work Embedded in Concrete:
   1. Accurately place and hold in correct position while concrete is being placed.
   2. Clean surface of metal in contact with concrete immediately before concrete is placed.

B. Concrete Surfaces Designated to Receive Grout:
   1. Heavy sandblast concrete surface in contact with grout.
   2. Clean surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bonding of grout.
   3. Concrete Saturation: Saturate concrete with water. Concrete shall be saturated surface damp at time grout is placed.

C. Field Measurements:
   1. Prior to fabrication of equipment, take measurements for installation of equipment and verify dimensions indicated on the Drawings. Ensure equipment and ancillary appurtenances fit within available space.

3.03 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions and recommendations.

B. Lubrication Lines and Fittings:
   1. Lines from Fittings to Point of Use: Support and protect.
   2. Fittings:
      a. Bring fittings to outside of equipment in manner such that they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
      b. Mount fittings together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
      c. Fittings for Underwater Bearings: Bring fittings above water surface and mount on edge of structure above.

C. Alignment of Drivers and Equipment:
   1. Where drive motors or other drivers are connected to driven equipment by flexible coupling, disconnect coupling halves and align driver and equipment after complete unit has been leveled on its foundation.
   2. Comply with procedures of appropriate Hydraulic Institute Standards, AGMA Standards, alignment tolerances of equipment manufacturers and the following requirements to bring components into angular and parallel alignment:
      a. Maximum Total Coupling Offset (not the per plane offset): Not to exceed 0.5 mils per inch of coupling length for spacer couplings based on coupling length (not dial separation).

b. Utilize jacking screws, wedges, or shims as recommended by the equipment manufacturer and as specified in the equipment sections.

3. Use reverse-indicator arrangement dial type or laser type alignment indicators: Mount indicators on the driver/coupling flange and equipment/coupling flange. Alignment instrumentation accuracy shall be sufficient to read angular and radial misalignment at 10 percent or less of the manufacturer's recommended acceptable misalignment.
4. Alignment and calculations shall include measurement and allowance for thermal growth, spacer coupling length, indicator separation and axial spacing tolerances of the coupling.
5. When alignment satisfies most stringent tolerance of system components, grout between base and foundation. Allow minimum 48 hours for grout to harden. After grout hardens, remove jacking screws, tighten anchor bolts and other connections, and recheck alignment. Correct alignment as required.
6. After operational testing is complete, dowel motor or drivers and driven equipment. Comply with manufacturer's instructions.

D. Special Techniques: Use applicable special tools and equipment, including precision machinist levels, dial indicators, and gauges as required in equipment installations.

E. Tolerances:
1. Completed Equipment Installations: Comply with requirements for intended use and specified vibration and noise tolerances.

F. Warning Signs: Mount securely with stainless fasteners at equipment that can be started automatically or from remote locations.

3.04 FIELD QUALITY CONTROL

A. Test equipment as specified in Section 15958 and the individual equipment Section of the Specifications.

3.05 MANUFACTURER'S REPRESENTATIVE

A. Field Checkout: Before field-testing and start-up, provide services of factory-trained field service representative to certify the equipment has been installed, aligned, and checked in accordance with the manufacturer’s instructions and the Specifications.

B. Testing: Provide services of factory trained representative to observe and advise the CONTRACTOR during field quality control testing.

C. Training: When training is specified, provide services of factory-trained representative to perform training as specified.

END OF SECTION

SECTION 15052

BASIC PIPING MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic piping materials and methods.

1.02 REFERENCES

A. American Society of Testing and Materials (ASTM):
   1. F 37 - Standard Test Methods for Sealability of Gasket Materials.

1.03 DEFINITIONS

A. Buried Pipe: Pipe that is buried in the soil, or cast in a concrete pipe encasement that is buried in the soil.

B. Exposed Pipe: Pipe that is located above ground, or pipe that is located inside a structure, supported by a structure, or case into a concrete structure.

C. Underground Piping: Piping actually buried in soil or cast in concrete.

D. Underwater Piping: Piping below tops of walls in basins or tanks containing water.

E. Wet Wall: Wall with water on at least 1 side.

1.04 SUBMITTALS

A. Product Data:
   1. Link -type seals.
   2. Gaskets.

PART 2 PRODUCTS

2.01 LINK TYPE SEALS

A. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
   2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
   3. Provide a nylon polymer pressure plate with 316 Stainless Steel hardware. Isolate pressure plate from contact with wall sleeve.

B. Manufacturers: One of the following or equal:
   1. Calpico, Incorporated.

2. Pipeline Seal and Insulator, Inc., Link-Seal.

2.02 GASKETS

A. Gaskets for Non-Steam Cleaned Ductile Iron and Steel Piping:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to or less than 250 degrees Fahrenheit, and raw sewage service.
   2. Gasket Material:
      a. Neoprene elastomer with minimum Shore A hardness value of 70.
      b. Reinforcement: Inserted 13-ounce nylon fabric cloth for pipes 20 inch or larger.
      c. Thickness: Minimum 3/32-inch thick for less than 10-inch pipe; minimum 1/8 inch thick for 10-inch and larger pipe.
   3. Manufacturers: One of the following or equal:
      a. Pipe less than 20 inches in diameter:
         1) Garlock, Style 7797.
         2) John Crane, similar product.
      b. Pipe 20 inches in diameter and larger:
         1) Garlock, Style 8798.
         2) John Crane, similar product.

B. Gaskets for Flanged Joints in Polyvinyl Chloride and Polyethylene Piping:
   1. Suitable for pressures equal to or less than 150-pounds per square inch gauge, with low flange bolt loadings, temperatures equal and less than 120 degrees Fahrenheit, and polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine including fluorochemicals and gaseous fluorine.
   2. Material: 0.125-inch thick Viton rubber.
   3. Manufacturers: One of the following or equal:
      a. Garlock.
      b. John Crane, similar product.

C. Gaskets for Flanged Joints in Ductile Iron or Steel Water Piping:
   1. Suitable for hot or cold water, pressures equal to or less than 150 pounds per square inch gauge, and temperatures equal to or less than 160 degrees Fahrenheit.
   2. Material:
      a. Neoprene elastomer, compressed, with non-asbestos fiber reinforcement.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Bluegard 3300.
      b. John Crane, similar product.

D. Gaskets for any other fluids or any other pressure or temperature conditions shall be suitable for the specific fluids and pressure and temperature conditions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Existing Conditions:

1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions that may affect construction of underground piping before starting excavation for new underground piping and appurtenances.
2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.02 INSTALLATION

A. General:
   1. Piping Drawings:
      a. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.
      b. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
         1) Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.
   2. Piping Alternatives:
      a. Provide piping as specified in this Section, unless indicated on the Drawings or specified otherwise.
      b. Alternative Pipe Ratings: Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price. Piping of different material may not be substituted in lieu of specified piping.
      c. Valves in Piping Sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.
      d. For flanged joints, where one of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.

B. Wall and Slab Penetrations:
   1. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, unless specified or otherwise indicated on the Drawings.
   2. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.
      a. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
      b. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
      c. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
      d. Seal spaces between pipes and sleeves with link-type seals when not otherwise specified or indicated on the Drawings.

e. Seal openings around piping running through interior walls and floors of chlorine rooms and chlorine storage rooms gastight with synthetic rubber sealing compound.

C. Exposed Piping:
1. Install exposed piping in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings.
a. Install piping runs plumb and level, unless otherwise indicated on the Drawings. Slope plumbing drain piping with a minimum of 1/4 inch per foot downward in the direction of flow. Slope digester gas piping to drip traps or low-point drains at a minimum of 1/2 inch per foot where condensate flows against the gas, or at a minimum of 1/4 inch per foot where condensate flows with gas.
2. Install exposed piping after installing equipment and after piping and fitting locations have been determined.
3. Support Piping
a. Do not transfer pipe loads and strain to equipment.
4. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
5. Assemble piping without distortion or stresses caused by misalignment.
a. Match and properly orient flanges, unions, flexible couplings, and other connections.
b. Do not subject piping to bending or other undue stresses when fitting piping. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
c. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
d. Alter piping assembly to fit, when proper fit is not obtained.
e. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

D. Buried Piping:
1. Bury piping with minimum 2-foot cover without air traps, unless otherwise indicated on the Drawings.
2. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.
3. Laying Piping:
a. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
b. Place piping with top or bottom markings with markings in proper position.
c. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
d. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
e. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.

E. Connections to Existing Piping:
   1. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings.
      a. Protect domestic water/potable water supplies from contamination.
         1) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
         2) Provide devices approved by OWNER of domestic water supply system to prevent flow from other sources into the domestic supply system.
   2. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
   3. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
   4. For flanged connections, provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

F. Connections to In-Service Piping:
   1. Where operation and maintenance of existing facilities require that a shutdown be made during hours other than normal working hours, perform the related work in coordination with the hours of actual shutdown.

G. Connections Between Ferrous and Nonferrous Metals:
   1. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
   2. Nonferrous metals include aluminum, copper, and copper alloys.

H. Flanged Connections Between Dissimilar Metals Such as Ductile Iron Pipe and Steel Pipe:
   1. Provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

3.03 CLEANING

A. Piping Cleaning:
   1. Upon completion of installation, clean piping interior of foreign matter and debris. Perform special cleaning when required by the Contract Documents.

3.04 PIPING SCHEDULE

A. Abbreviations:
   1. The following abbreviations used in the column of test method refer to the respective methods as specified in Section 15956.

AM	Air method
GR	Gravity method
HH	High head method
LH	Low head method
SC	Special case

2. Abbreviations to designate piping include the following:

ASPH	Asphaltic Base Coating
CE	Ceramic Epoxy
CI	Cast iron
CL	Class, followed by the designation
CM	Cement Mortar
CTE	Coal Tar Epoxy
DIP	Ductile iron piping
F	Flanged Joint
FBE	Fusion Bonded Epoxy
GA	Gauge, preceded by the designation
GE	Grooved end joint
HSE	High Solids Epoxy System
HSE/P	High Solids Epoxy and Polyurethane Coating System
MJ	Mechanical Joint
NPS	Nominal pipe size, followed by the number in inches
PJ	Push-On Joint
psi	pounds per square inch
psig	pounds per square inch gauge
PVC	Polyvinyl Chloride
SCH	Schedule, followed by the designation
SST	Stainless steel

PIPING SCHEDULE								
Pipe Service Abbrev.	**Service**	**Nominal Diameter (inches)**	**Materials**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**
GOF	Grit overflow	All	PVC	SCH 80	SW	50 psig/HH	None	None
GS	Grit slurry	All	PVC	SCH 80	SW	50 psig/HH	None	None
SW	Plant Service Water	1-3	PVC	SCH 80	SW	150 psig/HH	None	None
Notes: 1. All exposed piping shall be painted and/or coated in accordance with Section 09960.								

END OF SECTION

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SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Mechanical Identification including the following:
   1. Equipment nameplates.
   2. Pipe identification by color and legend.
   3. Underground Warning Tape
   4. Identification of equipment and components of systems with paint, brands, tags, and signboards.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit Following:
   1. Product data.
   2. Samples.
   3. Manufacturer's installation instructions.
   4. Submit following:
      a. Operation and Maintenance Data.
      b. Warranty.

PART 2 PRODUCTS

2.01 EQUIPMENT NAMEPLATES

A. Material and Fabrication:
   1. Stainless steel sheet engraved or stamped with text, holes drilled, or punch for fasteners.

B. Fasteners:
   1. Number 4 or larger oval head stainless steel screws or drive pins.

C. Text:
   1. Manufacturers name, equipment model number and serial number, identification tag number, and when appropriate, drive speed, motor horsepower with rated capacity, pump rated total dynamic head and impeller size.

2.02 PIPE IDENTIFICATION

A. Manufacturers:

1. One of the following or equal:
    a. Seton, Opti Code Pipe Markers.
    b. Lab Safety Supply.

B. Materials:
1. Pipe Markers: Self-adhesive vinyl, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; meet ANSI A13.1 requirements.
    a. Lettering:

Nominal Pipe Diameter	Lettering Size
Less than 1.5	1/2 inch
1.5 inches to 2 inches	3/4 inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

    b. Marker Colors:

Service	Lettering	Background
Flammables, chemicals, toxics	Black	Yellow
Water, nontoxic solutions or low hazard liquids	White	Green
Nonflammable or nontoxic gases	White	Blue
Fire quenching fluids (foam, fire water, CO_2 Halon)	White	Red

2. Coating: As specified in Section 09960.
3. Pipe Identification Tags: Aluminum or stainless steel with stamped-in 1/4 inch high identifying lettering.
4. Pipe Identification Tag Chains: Aluminum or stainless steel.
5. Snap-on Markers: Markers with 3/4 inch high letters for 3/4 to 4 inch pipe or covering, or 5 inch high letters for 5 inch or larger pipe or cover, as manufactured by one of following:
    a. Brady Bradysnap-On B-915.
    b. Seton Setmark.

2.03 UNDERGROUND WARNING TAPE

A. Manufacturer:
1. One of the following or equal:
    a. Seton Name Plate Company, Branford, CT.

B. Material:
1. Metallic detection tape; minimum 4 mil thick by 6 inches wide polyethylene film with wording, “Caution” with name of service followed by words, “Line Buried Below” repeated continuously along tape length, with alternate metallic and color strips. Colors as follows:

a. Water: Blue.
b. Telephone: Orange.
c. Sewer: Green.
d. Gas and Other Services: Yellow.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified.

3.02 PREPARATION

A. Prepare and coat surfaces as specified in Section 09960.

B. Prepare surface in accordance with product manufacturer's instructions.

3.03 PIPING IDENTIFICATION

A. Identify exposed piping, valves, and accessories, and piping, in accessible chases with lettering or tags designating service of each piping system with flow directional arrows and color code.

B. Color Code:
1. Coat piping scheduled to be color coded completely with specified colors.
2. Coat segments of pipe specified to be unpainted with specified coding color long enough to accommodate required lettering and arrows.

C. Coat piping specified to be coated to match adjacent surfaces, unless otherwise directed.

D. Lettering and Flow Direction Arrows:
1. Stencil lettering on painted bands or use snap-on markers on pipe to identify pipe. When stenciling, stencil 3/4 inch high letters on 3/4 through 4-inch pipe or coverings, or 5-inch high letters on 5-inch and larger pipe or coverings.
2. Provide lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee, and at intervals of not more than 50 feet in straight runs of pipe.

E. Where scheduled, space 6-inch wide bands along stainless steel pipe at 10-foot intervals and other pipe at 5-foot intervals.

F. Metal Tags:
1. Where outside diameter of pipe or pipe covering is 5/8 inch or smaller, provide metal pipe identification tags instead of lettering.
2. Fasten pipe identification tags to pipe with chain.
3. Where tags are used, color code pipe as scheduled.

G. Underground Warning Tape:

1. Place warning tape in pipe trench, 12 inches above the pipe.

3.04 APPLICATION

A. Identify piping with legend markers, directional arrow markers, and number markers; use self adhesive arrow roll tape to secure ends of piping markers and indicate flow direction.

B. Provide legend markers, directional arrow markers and number markers where piping passes through walls or floors, at piping intersections and at maximum 15 foot spacing on piping runs.

C. Provide piping marker letters and colors as scheduled.

D. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere.

END OF SECTION

SECTION 01005

GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE AND INTENT

A. Description
   1. The work to be done consists of the furnishing of all labor, materials and equipment, and the performance of all work included in this Contract.

B. Work Included
   1. The Contractor shall furnish all labor, superintendence, materials, plant, power, light, heat, fuel, water, tools, appliances, equipment, supplies, shop drawings, working drawings and other means of construction necessary or proper for performing and completing the work. He shall obtain and pay for all required permits necessary for the work, other than those permits such as FDEP permits. He shall perform and complete the work in the manner best calculated to promote rapid construction consistent with safety of life and property and to the satisfaction of the Engineer, and in strict accordance with the Contract Documents. The Contractor shall clean up the work and maintain it during and after construction, until accepted, and shall do all work and pay all costs incidental thereto. He shall repair or restore all structures and property that may be damaged or disturbed during performance of the work.
   2. The cost of incidental work described in these General Requirements, for which there are no specific Contract Items, shall be considered as part of the general cost of doing the work and shall be included in the prices for the various Contract Items. No additional payment will be made therefore.
   3. The Contractor shall provide and maintain such modern plant, tools, and equipment as may be necessary, in the opinion of the Engineer, to perform in a satisfactory and acceptable manner all the work required by this Contract. Only equipment of established reputation and proven efficiency shall be used. The Contractor shall be solely responsible for the adequacy of his workmanship, materials and equipment, prior approval of the Engineer notwithstanding.

C. Public Utility Installations and Structures
   1. Public utility installations and structures shall be understood to include all poles, tracks, pipes, wires, conduits, house service connections, vaults, manholes and all other appurtenances and facilities pertaining thereto whether owned or controlled by the Owner, other governmental bodies or privately owned by individuals, firms or corporations, used to serve the public with transportation, traffic control, gas, electricity, telephone, sewage, drainage, water or other public or private property which may be affected by the work shall be deemed included hereunder.
   2. The Contractor shall protect all public utility installations and structures from damage during the work. Access across any buried public utility installation or structure shall be made only in such locations and by means approved by the Engineer. The Contractor shall so arrange his operations as to avoid any damage to these facilities. All required protective devices and construction shall be provided by the Contractor at his expense. All existing public utilities

damaged by the Contractor which are shown on the Plans or have been located in the field by the utility shall be repaired by the Contractor, at his expense, as approved by the Engineer. No separate payment shall be made for such protection or repairs to public utility installations or structures.

3. Public utility installations or structures owned or controlled by the Owner or other governmental body, which are required by this contract to be removed, relocated, replaced or rebuilt by the Contractor not identified in any separate bid item shall be considered as a part of the general cost of doing the work and shall be included in the prices bid for the various contract items. No separate payment shall be made therefore.
4. Where public utility installations or structures owned or controlled by the Owner or other governmental body are encountered during the course of the work, and are not indicated on the Plans or in the Specifications, and when, in the opinion of the Engineer, removal, relocation, replacement or rebuilding is necessary to complete the work under this Contract, such work shall be accomplished by the utility having jurisdiction, or such work may be ordered, in writing by the Engineer, for the contractor to accomplish. If such work is accomplished by the utility having jurisdiction, it will be carried out expeditiously and the Contractor shall give full cooperation to permit the utility to complete the removal, relocation, replacement or rebuilding as required. If such work is accomplished by the Contractor, it will be in accordance with the General and Supplemental General Conditions.
5. The Contractor shall give written notice to Owner and other governmental utility departments and other owners of public utilities of the location of his proposed construction operations, at least forty-eight hours in advance of breaking ground in any area or on any unit of the work. This can be accomplished by making the appropriate contact with the Sunshine State One-Call of Florida, Inc. Call Center ("Call Sunshine") and per all requirements provided for in the Florida Underground Facilities Damage Prevention and Safety Act (Florida Statutes, Title XXXIII, Chapter 556).
6. The maintenance, repair, removal, relocation or rebuilding of public utility installations and structures, when accomplished by the Contractor as herein provided, shall be done by methods approved by the Engineer.

1.02 PLANS AND SPECIFICATIONS

A. Plans
   1. When obtaining data and information from the Plans, figures shall be used in preference to scaled dimensions, and large scale drawings in preference to small scale drawings.

B. Copies Furnished to Contractor
   1. The Contractor shall furnish each of the subcontractors, manufacturers, and material men such copies of the Contract Documents as may be required for their work. Additional copies of the Plans and Specifications, when requested, may be furnished to the Contractor at cost of reproduction.

C. Supplementary Drawings
   1. When, in the opinion of the Engineer, it becomes necessary to explain more fully the work to be done or to illustrate the work further or to show any changes which may be required, drawings known as Supplementary Drawings, with specifications pertaining thereto, will be prepared by the Engineer and five paper prints thereof will be given to the Contractor.

D. Contractor to Check Plans and Data
   1. The Contractor shall verify all dimensions, quantities and details shown on the Plans, Supplementary Drawings, Schedules, Specifications or other data received from the Engineer, and shall notify him of all errors, omissions, conflicts, and discrepancies found therein. Failure to discover or correct errors, conflicts or discrepancies shall not relieve the Contractor of full responsibility for unsatisfactory work, faulty construction or improper operation resulting there from nor from rectifying such conditions at his own expense. He will not be allowed to take advantage of any errors or omissions, as full instructions will be furnished by the Engineer, should such errors or omissions be discovered. All schedules are given for the convenience of the Engineer and the Contractor and are not guaranteed to be complete. The Contractor shall assume all responsibility for the making of estimates of the size, kind, and quality of materials and equipment included in work to be done under the Contract.

E. Specifications
   1. The Technical Specifications consist of three parts: General, Products and Execution. The General Section contains General Requirements which govern the work. Products and Execution modify and supplement these by detailed requirements for the work and shall always govern whenever there appears to be a conflict.

F. Intent
   1. All work called for in the Specifications applicable to this Contract, but not shown on the Plans in their present form, or vice versa, shall be of like effect as if shown or mentioned in both. Work not specified in either the Plans or in the Specifications, but involved in carrying out their intent or in the complete and proper execution of the work, is required and shall be performed by the Contractor as though it were specifically delineated or described.
   2. The apparent silence of the Specifications as to any detail, or the apparent omission from them of a detailed description concerning any work to be done and materials to be furnished, shall be regarded as meaning that only the best general practice is to prevail and that only material and workmanship of the best quality is to be used, and interpretation of these Specifications shall be made upon that basis.
   3. The inclusion of the Related Requirements (or work specified elsewhere) in the General part of the specifications is only for the convenience of the Contractor, and shall not be interpreted as a complete list of related Specification Sections.

1.03 MATERIALS AND EQUIPMENT

A. Manufacturer
   1. The names of proposed manufacturers, material men, suppliers and dealers who are to furnish materials, fixtures, equipment, appliances or other fittings shall be submitted to the Engineer for approval. Such approval must be obtained before shop drawings will be checked. No manufacturer will be approved for any materials to be furnished under this Contract unless he shall be of good reputation and have a plant of ample capacity. He shall, upon the request of the Engineer, be required to submit evidence that he has manufactured a similar product to the one specified and that it has been previously used for a like purpose for a sufficient length of time to demonstrate its satisfactory performance.

2. All transactions with the manufacturers or subcontractors shall be through the Contractor, unless the Contractor shall request, in writing to the Engineer, that the manufacturer or subcontractor deal directly with the Engineer. Any such transactions shall not in any way release the Contractor from his full responsibility under this Contract.
3. Any two or more pieces or material or equipment of the same kind, type or classification, and being used for identical types of services, shall be made by the same manufacturer.

B. Delivery
1. The Contractor shall deliver materials in ample quantities to insure the most speedy and uninterrupted progress of the work so as to complete the work within the allotted time. The Contractor shall also coordinate deliveries in order to avoid delay in, or impediment of, the progress of the work of any related Contractor.

C. Tools and Accessories
1. The Contractor shall, unless otherwise stated in the Contract Documents, furnish with each type, kind or size of equipment, one complete set of suitably marked high grade special tools and appliances which may be needed to adjust, operate, maintain or repair the equipment. Such tools and appliances shall be furnished in approved painted steel cases, properly labeled and equipped with good grade cylinder locks and duplicate keys.
2. Spare parts shall be furnished as specified.
3. Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, weight and principal rating data.

D. Installation of Equipment.
1. The Contractor shall have on hand sufficient proper equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character.
2. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Plans, unless directed otherwise by the Engineer during installation. All equipment shall be correctly aligned, leveled and adjusted for satisfactory operation and shall be installed so that proper and necessary connections can be made readily between the various units.
3. The Contractor shall furnish, install and protect all necessary anchor and attachment bolts and all other appurtenances needed for the installation of the devices included in the equipment specified. Anchor bolts shall be as approved by the Engineer and made of ample size and strength for the purpose intended. Substantial templates and working drawings for installation shall be furnished.
4. The Contractor shall, at his own expense, furnish all materials and labor for, and shall properly bed in non-shrink grout, each piece of equipment on its supporting base that rests on masonry foundations.
5. Grout shall completely fill the space between the equipment base and the foundation. All metal surfaces coming in contact with concrete or grout shall receive a coat of coal tar epoxy equal to Koppers 300M.

E. Service of Manufacturer's Engineer

1. The Contract prices for equipment shall include the cost of furnishing (as required by equipment specifications sections) a competent and experienced engineer or superintendent who shall represent the manufacturer and shall assist the Contractor, when required, to install, adjust, test and place in operation the equipment in conformity with the Contract Documents. After the equipment is placed in permanent operation by the Owner, such engineer or superintendent shall make all adjustments and tests required by the Engineer to prove that such equipment is in proper and satisfactory operating condition, and shall instruct such personnel as may be designated by the Owner in the proper operation and maintenance of such equipment.

1.04 INSPECTION AND TESTING

A. General
   1. Inspection and testing of materials will be performed by the Owner unless otherwise specified.
   2. For tests specified to be made by the Contractor, the testing personnel shall make the necessary inspections and tests and the reports thereof shall be in such form as will facilitate checking to determine compliance with the Contract Documents. Three (3) copies of the reports shall be submitted and authoritative certification thereof must be furnished to the Engineer as a prerequisite for the acceptance of any material or equipment.
   3. If, in the making of any test of any material or equipment, it is ascertained by the Engineer that the material or equipment does not comply with the Contract, the Contractor will be notified thereof and he will be directed to refrain from delivering said material or equipment, or to remove it promptly from the site or from the work and replace it with acceptable material, without cost to the Owner.
   4. Tests of electrical and mechanical equipment and appliances shall be conducted in accordance with recognized test codes of the ANSI, ASME, or the IEEE, except as may otherwise be stated herein.
   5. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

B. Costs
   1. All inspection and testing of materials furnished under this Contract will be performed by the Owner or duly authorized inspection engineers or inspections bureaus without cost to the Contractor, unless otherwise expressly specified.
   2. The cost of shop and field tests of equipment and of certain other tests specifically called for in the Contract Documents shall be borne by the Contractor and such costs shall be deemed to be included in the Contract price.
   3. Materials and equipment submitted by the Contractor as the equivalent to those specifically named in the Contract may be tested by the Owner for compliance. The Contractor shall reimburse the Owner for the expenditures incurred in making such tests on materials and equipment which are rejected for non-compliance.

C. Inspections of Materials
   1. The Contractor shall give notice in writing to the Engineer, at least two weeks in advance of his intention to commence the manufacture or preparation of

materials especially manufactured or prepared for use in or as part of the permanent construction. Such notice shall contain a request for inspection, the date of commencement and the expected date of completion of the manufacture of preparation of materials. Upon receipt of such notice, the Engineer will arrange to have a representative present at such times during the manufacture as may be necessary to inspect the materials or he will notify the Contractor that the inspection will be made at a point other than the point of manufacture, or he will notify the Contractor that inspection will be waived. The Contractor must comply with these provisions before shipping any material. Such inspection shall not release the Contractor from the responsibility for furnishing materials meeting the requirements of the Contract Documents.

D. Certificate of Manufacture
   1. When inspection is waived or when the Engineer so requires, the Contractor shall furnish to him authoritative evidence in the form of Certificates of Manufacture that the materials to be used in the work have been manufactured and tested in conformity with the Contract Documents. These certificates shall be notarized and shall include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

E. Shop Tests of Operating Equipment
   1. Each piece of equipment for which pressure, duty, capacity, rating, efficiency, performance, function or special requirements are specified shall be tested in the shop of the maker in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents. No such equipment shall be shipped to the work until the Engineer notifies the Contractor, in writing, that the results of such tests are acceptable.
   2. Five copies of the manufacturer's actual test data and interpreted results thereof, accompanied by a certificate of authenticity sworn to by a responsible official of the manufacturing company, shall be forwarded to the Engineer for approval.
   3. The cost of shop tests and of furnishing manufacturer's preliminary and shop test data of operating equipment shall be borne by the Contractor.

F. Preliminary Field Tests
   1. As soon as conditions permit, the Contractor shall furnish all labor, materials, and instruments and shall make preliminary field tests of equipment. If the preliminary field tests disclose any equipment furnished under this Contract which does not comply with the requirements of the Contract Documents, the Contractor shall, prior to the acceptance tests, make all changes, adjustments and replacements required. The furnishing Contractor shall assist in the preliminary field tests as applicable.

G. Final Field Tests
   1. Upon completion of the work and prior to final payment, all equipment and piping installed under this Contract shall be subjected to acceptance tests as specified or required to prove compliance with the Contract Documents.

   2. The Contractor shall furnish labor, fuel, energy, water and all other materials, equipment and instruments necessary for all acceptance tests, at no additional cost to the Owner. The Supplier shall assist in the final field tests as applicable.

H. Failure of Tests
   1. Any defects in the materials and equipment or their failure to meet the tests, guarantees or requirements of the Contract Documents shall be promptly corrected by the Contractor. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the Contract shall be final and conclusive. If the Contractor fails to make these corrections or if the improved materials and equipment, when tested, shall again fail to meet the guarantees of specified requirements, the Owner, notwithstanding its partial payment for work, and materials and equipment, may reject the materials and equipment and may order the Contractor to remove them from the site at his own expense.
   2. In case the Owner rejects any materials and equipment, then the Contractor shall replace the rejected materials and equipment within a reasonable time. If he fails to do so, the Owner may, after the expiration of a period of thirty (30) calendar days after giving him notice in writing, proceed to replace such rejected materials and equipment, and the cost thereof shall be deducted from any compensation due or which may become due the Contractor under his Contract.

I. Final Inspection
   1. During such final inspections, the work shall be clean and free from water. In no case will the final pay application be prepared until the Contractor has complied with all requirements set forth and the Engineer has made his final inspection of the entire work and is satisfied that the entire work is properly and satisfactorily constructed in accordance with the requirements of the Contract Document.

1.05 TEMPORARY STRUCTURES

A. Temporary Fences
   1. If, during the course of the work, it is necessary to remove or disturb any fence or part thereof, the Contractor shall, at his own expense, if so ordered by the Engineer, provide a suitable temporary fence which shall be maintained until the permanent fence is replaced. The Engineer shall be solely responsible for the determination of the necessity for providing a temporary fence and the type of temporary fence to be used.

1.06 TEMPORARY SERVICES

A. First Aid
   1. The Contractor shall keep upon the site, at each location where work is in progress, a completely equipped first aid kit and shall provide ready access thereto at all times when people are employed on the work.

1.07 LINES AND GRADES

A. Grade
   1. All work under this Contract shall be constructed in accordance with the lines and grades shown on the Plans, or as given by the Owner/Engineer. The full responsibility for keeping alignment and grade shall rest upon the Contractor.

B. Safeguarding Marks

1. The Contractor shall safeguard all points, stakes, grade marks, monuments and bench marks made or established on the work, bear the cost of reestablishing them if disturbed, and bear the entire expense of rectifying work improperly installed due to not maintaining or protecting or to removing without authorization such established points, stakes and marks.
2. The Contractor shall safeguard all existing and known property corners, monuments and marks adjacent to but not related to the work and, if required, shall bear the cost of reestablishing them if disturbed or destroyed.

C. Datum Plane
1. All elevations indicated or specified refer to the Mean Sea Level Datum of the NGVD 1929 Datum and/or NAVD 1988.

1.08 ADJACENT STRUCTURES AND LANDSCAPING

A. Responsibility
1. The Contractor shall also be entirely responsible and liable for all damage or injury as a result of his operations to all other adjacent public and private property, structures of any kind and appurtenances thereto met with during the progress of the work. The cost of protection, replacement in their original locations and conditions or payment of damages for injuries to such adjacent public and private property and structures affected by the work, whether or not shown on the Plans, and the removal, relocation and reconstruction of such items called for on the Plans or specified shall be included in the various Contract Items and no separate payments will be made therefore. Where such public and private property, structures of any kind and appurtenances thereto are not shown on the Plans and when, in the opinion of the Engineer, additional work is deemed necessary to avoid interference with the work, payment therefore will be made as provided for in the General Conditions.
2. Contractor is expressly advised that the protection of buildings, structures, tunnels, tanks, pipelines, etc. and related work adjacent and in the vicinity of his operations, wherever they may be, is solely his responsibility. Conditional inspection of buildings or structures in the immediate vicinity of the project which may reasonably be expected to be affected by the Work shall be performed by and be the responsibility of the Contractor.
3. Contractor shall, before starting operations, make an examination of the interior and exterior of the adjacent structures, buildings, facilities, etc., and record by notes, measurements, photographs, etc., conditions which might be aggravated by open excavation and construction. Repairs or replacement of all conditions disturbed by the construction shall be made to the satisfaction of the Owner and to the satisfaction of the Engineer. This does not preclude conforming to the requirements of the insurance underwriters. Copies of surveys, photographs, reports, etc., shall be given to the Engineer.
4. Prior to the beginning of any excavations, the Contractor shall advise the Engineer of all buildings or structures on which he intends to perform work or which performance of the project work will affect.

B. Protection of Trees
1. All trees and shrubs shall be adequately protected by the Contractor with boxes and otherwise and in accordance with ordinances governing the protection of trees. No excavated materials shall be placed so as to injure such trees or shrubs. Trees or shrubs destroyed by negligence of the Contractor or

his employees shall be replaced by him with new stock of similar size and age, at the proper season and at the sole expense of the Contractor.

2. Beneath trees or other surface structures, where possible, pipelines may be built in short tunnels, backfilled with excavated materials, except as otherwise specified, or the trees or structures carefully supported and protected from damage.
3. The Owner may order the Contractor, for the convenience of the Owner, to remove trees along the line or trench excavation. If so ordered, the Owner will obtain any permits required for removal of trees. Such tree removal ordered shall be paid for under the appropriate Contract Items.

C. Lawn Areas

1. Lawn areas shall be left in as good condition as before the starting of the work. Where sod is to be removed, it shall be carefully removed, and later replaced, or the area where sod has been removed shall be restored with new sod in the manner described in the Workmanship and Materials Paragraph in Section 02485, Seeding & Sodding.

D. Restoration of Fences

1. Any fence, or part thereof, that is damaged or removed during the course of the work shall be replaced or repaired by the Contractor and shall be left in as good a condition as before the starting of the work. The manner in which the fence is repaired or replaced and the materials used in such work shall be subject to the approval of the Engineer. The cost of all labor, materials, equipment, and work for the replacement or repair of any fence shall be deemed included in the appropriate Contract Item or items, or if no specific Item is provided therefore, as part of the overhead cost of the work, and no additional payment will be made therefore.

1.09 PROTECTION OF WORK AND PUBLIC

A. Barriers and Lights

1. During the prosecution of the work, the Contractor shall put up and maintain at all times such barriers and lights as will effectually prevent accidents. The Contractor shall provide suitable barricades, red lights, "danger" or "caution" or "street closed" signs and watchmen at all places where the work causes obstructions to the normal traffic or constitutes in any way a hazard to the public, in accordance with state and local requirements.

B. Smoke Prevention

1. A strict compliance with ordinances regulating the production and emission of smoke will be required. No open fires will be permitted.

C. Noise

1. The Contractor shall eliminate noise to as great an extent as practicable at all times. Air compressing plants shall be equipped with silencers and the exhaust of all engines or other power equipment shall be provided with mufflers. In the vicinity of hospitals and schools, special care shall be used to avoid noise or other nuisances. The Contractor shall strictly observe all local regulations and ordinances covering noise control.
2. Except in the event of an emergency, no work shall be done between the hours of 7:00 P.M. and 7:00 A.M., or on weekends. If the proper and efficient prosecution of the work requires operations during the night or weekends, the

written permission of the Owner shall be obtained before starting such items of the work.

D. Access to Public Services
   1. Neither the materials excavated nor the materials or plant used in the construction of the work shall be so placed as to prevent free access to all fire hydrants, valves or manholes.

E. Dust prevention
   1. The Contractor shall prevent dust nuisance from his operations or from traffic by keeping the roads and/or construction areas sprinkled with water at all times.

1.10 CUTTING AND PATCHING

A. The Contractor shall do all cutting, fitting or patching of his portion of the work that may be required to make the several parts thereof join and coordinate in a manner satisfactory to the Engineer and in accordance with the Plans and Specifications. The work must be done by competent workmen skilled in the trade required by the restoration.

1.11 CLEANING

A. During Construction
   1. During construction of the work, the Contractor shall, at all times, keep the site of the work and adjacent premises as free from material, debris and rubbish as is practicable and shall remove the same from any portion of the site if, in the opinion of the Engineer, such material, debris, or rubbish constitutes a nuisance or is objectionable.
   2. The Contractor shall remove from the site all of his surplus materials and temporary structures when no further need therefore develops.

B. Final Cleaning
   1. At the conclusion of the work, all equipment, tools, temporary structures and materials belonging to the Contractor shall be promptly taken away, and he shall remove and promptly dispose of all water, dirt, rubbish or any other foreign substances.
   2. The Contractor shall thoroughly clean all equipment and materials installed by him and shall deliver such materials and equipment undamaged in a bright, clean, polished and new operating condition.

1.12 MISCELLANEOUS

A. Protection Against Siltation and Bank Erosion
   1. The Contractor shall arrange his operations to minimize siltation and bank erosion on construction sites and on existing or proposed water courses and drainage ditches.
   2. The Contractor, at his own expense, shall remove any siltation deposits and correct any erosion problems as directed by the Engineer which results from his construction operations.

B. Protection of Wetland Areas

1. The Contractor shall properly dispose of all surplus material, including soil, in accordance with Local, State and Federal regulations. Under no circumstances shall surplus material be disposed of in wetland areas as defined by the Florida Department of Environmental Protection or Southwest Florida Water Management District.

C. Existing Facilities
   1. The work shall be so conducted to maintain existing facilities in operation insofar as is possible. Requirements and schedules of operations for maintaining existing facilities in service during construction shall be as described in the Special Provisions.

D. Use of Chemicals
   1. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, must show approval of either EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with instructions.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS/REQUIREMENTS INCLUDED

A. The work included in this contract consists of the following:
   1. Demolition of the concrete channel liner system, conveyors, grit cyclones and classifiers, area lighting, and electrical and I&C conduits.
   2. Inspection of concrete channels and covers to establish limits of repair.
   3. New coatings/liner system for concrete channels.
   4. Concrete and steel rehabilitation and repair.
   5. New screenings conveyors and grit cyclones and classifiers.
   6. New electrical and I&C wiring and conduits from existing power source for new
   7. Equipment and new lighting

B. The Contractor shall furnish all shop drawings, working drawings, labor, materials, equipment, tools, services and incidentals necessary to complete all work required by these Specifications and as shown on the Contract Drawings.

C. The Contractor shall perform the work complete, in place and ready for continuous service and shall include any repairs, replacements, and/or restoration required as a result of damages caused prior to acceptance by the Owner.

D. The Contractor shall furnish and install all materials, equipment and labor which is reasonably and properly inferable and necessary for the proper completion of the work, whether specifically indicated in the Contract Documents or not.

1.02 CONTRACTS

A. Construct all the Work under a single contract.

1.03 WORK SEQUENCE

A. Headworks Shutdown:
   1. Only one influent channel can be out of service for rehabilitation at a time.
   2. Contractor shall complete all work on one influent channel before beginning construction on the other influent channel. All work on the first influent channel, including the concrete and steel repairs, new coating, cyclone, grit classifier, conveyor, startup and testing, shall be completed prior to beginning work on the second channel.
   3. Coordinate with plant staff on sequence of headworks shutdown requirements.

B. All work done under this Contract shall be done with a minimum of inconvenience to the users of the system or facility. The Contractor shall coordinate his work with private property owners such that existing utility services are maintained to all users to the maximum extent possible.

C. The Contractor shall, if necessary and feasible, construct the work in stages to accommodate the Owner's use of the premises during the construction period; coordinate the construction schedule and operations with the Owner's Representative.

D. The Contractor shall, where feasible, construct the Work in stages to provide for public convenience and not close off public use of any facility until completion of construction to provide alternative usage.

1.04 CONSTRUCTION AREAS

A. The Contractor shall: Limit his use of the construction areas for work and for storage, to allow for:
   1. Work by other Contractors.
   2. Owner's Use.
   3. Public Use.

B. Coordinate use of work site under direction of Engineer or Owner's Representative.

C. Assume full responsibility for the protection and safekeeping of products under this Contract, stored on the site.

D. Move any stored products under the Contractor's control, which interfere with operations of the Owner or separate contractor.

E. Obtain and pay for the use of additional storage of work areas needed for Contractor operations.

1.05 OWNER OCCUPANCY

A. It is assumed that portions of the Work will be completed prior to completion of the entire Work. Upon completion of construction of each individual facility, including testing, if the Owner, at its sole discretion, desires to accept the individual facility, the Contractor will be issued a dated certificate of completion and acceptance for each individual facility. The Owner will assume ownership and begin operation of the individual facility on that date and the three-year guaranty period shall commence on that date. The Owner has the option of not accepting the entire work as a whole until it is completed, tested and approved by the Engineer and Owner.

1.06 PARTIAL OWNER OCCUPANCY

A. The Contractor shall schedule his operations for completion of portions of the Work, as designated, for the Owner's occupancy prior to substantial completion of the entire work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01015

CONTROL OF WORK

PART 1 GENERAL

1.01 WORK PROGRESS

A. The Contractor shall furnish personnel and equipment which will be efficient, appropriate and adequately sized to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the time stipulated in the Contract. If at any time such personnel appears to the Engineer to be inefficient, inappropriate, or insufficient for securing the quality of work required for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character, or increase the personnel and equipment and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

1.02 PRIVATE LAND

A. The Contractor shall not enter or occupy private land outside of easements, except by permission of the affected property owner.

1.03 WORK LOCATIONS

A. Work shall be located substantially as indicated on the drawings, but the Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons.

1.04 OPEN EXCAVATIONS

A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access to private property during construction shall be removed when no longer required. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of open trench, prohibiting stacking excavated material in the street and requiring that the trench shall not remain open overnight.

B. The Contractor shall take precautions to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles which could be dangerous to the public shall be barricaded and well lighted at all times when construction is not in progress.

1.05 DISTRIBUTION SYSTEMS AND SERVICES

A. The Contractor shall avoid interruptions to water, telephone, cable TV, sewer, gas, or other related utility services. He shall notify the Engineer and the appropriate agency well in advance of any requirement for dewatering, isolating, or relocating a section of a utility, so that necessary arrangements may be made.

B. If it appears that utility service will be interrupted for an extended period, the Engineer may order the Contractor to provide temporary service lines at the Contractor's expense. Inconvenience of the users shall be kept to the minimum, consistent with existing conditions. The safety and integrity of the systems are of prime importance in scheduling work.

1.06 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

A. The Contractor shall assume full responsibility for the protection of all buildings, structures and utilities, public or private, including poles, signs, services to building utilities, gas pipes, water pipes, hydrants, sewers, drains and electric and telephone cables and other similar facilities, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operation shall be repaired by the Contractor at his expense.

B. The Contractor shall bear full responsibility for obtaining locations of all underground structures and utilities (including existing water services, drain lines and sewers). Services to buildings shall be maintained and all costs or charges resulting from damage thereto shall be paid by the Contractor.

C. Protection and temporary removal and replacement of existing utilities and structures as described in this Section shall be a part of the work under the Contract and all costs in connection therewith shall be included in the unit prices established in the Bid.

D. If, in the opinion of the Engineer, permanent relocation of a utility owned by the Owner is required, he may direct the Contractor, in writing, to perform the work. Work so ordered will be paid for at the Contract unit prices, if applicable, or as extra work as classified in the General Conditions. If relocation of a privately owned utility is required, the Owner will notify the utility to perform the work as expeditiously as possible. The Contractor shall fully cooperate with the Owner and utility and shall have no claim for delay due to such relocation. The Contractor shall notify public utility companies in writing at least 48 hours (excluding Saturdays, Sundays and legal holidays) before excavating near their utilities.

1.07 TEST PITS

A. Test pits for the purpose of locating underground pipeline or structures in advance of the construction shall be excavated and backfilled by the Contractor immediately after the utility location and the surface shall be restored in a manner equal or better than the original condition. No separate payment will be made.

1.08 CARE AND PROTECTION OF PROPERTY

A. The Contractor shall be responsible for the preservation of all public and private property and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition equal or better to that existing before the damage was done, or he shall make good the damage in another manner acceptable to the Engineer.

B. All sidewalks which are disturbed by the Contractor's operations shall be restored to their original or better condition by the use of similar or comparable materials. All curbing shall be restored in a condition equal to the original construction and in accordance with the best modern practice.

C. Along the location of this work, all fences, walks, bushes, trees, shrubbery and other physical features shall be protected and restored in a thoroughly workmanlike manner unless otherwise shown on the drawings. Fences and other features removed by the Contractor shall be replaced in the location indicated by the Engineer as soon as conditions permit. All grass areas beyond the limits of construction which have been damaged by the Contractor shall be regraded and sodded to equal or exceed original conditions.

D. Trees close to the work which drawings do not specify to be removed, shall be boxed or otherwise protected against injury. The Contractor shall trim all branches that are liable to damage because of his operations, but in no case shall any tree be cut or removed without prior notification to the Engineer. All injuries to bark, trunk, limbs and roots of trees shall be repaired by dressing, cutting and painting according to approved methods, using only approved tools and materials.

E. The protection, removal and replacement of existing physical features along the line of work shall be a part of the work under the Contract and all costs in connection therewith shall be included in the unit and/or lump sum prices established under the items in the Bid.

1.09 MAINTENANCE OF TRAFFIC

A. Open pits, trenches, unpaved streets, debris, or other obstructions due to construction that will prevent the normal flow of traffic during an extended construction stoppage, for any reason, shall be minimized. In the event an extended construction stoppage is found to be necessary, Contractor shall, at his own expense, provide normal traffic flow during extended construction stoppage. Extended stoppage will be defined by the Engineer.

B. All excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, he shall repair the road surface, provide temporary roadways, erect wheel guards or fences, or take other safety measures which are satisfactory to the Engineer and Owner.

C. Detours around construction areas will be subject to the approval of the Owner and the Engineer. Where detours are permitted, the contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic

is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured, will be strictly controlled by the Owner.

1.10 WATER FOR CONSTRUCTION PURPOSES

A. In locations where public water supply is available, the Contractor may purchase water for all construction purposes.

B. The Contractor shall be responsible for paying for all water tap fees incurred for the purpose of obtaining a potable water service or temporary use meter.

1.11 MAINTENANCE OF FLOW

A. The Contractor shall, at his own cost, provide for the flow of sewers, drains and water courses interrupted during the progress of the work and shall immediately cart away and remove all offensive matter. The entire procedure of maintaining existing flow shall be fully discussed with the Engineer and Owner well in advance of the interruption of any flow.

1.12 CLEANUP

A. During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. He shall dispose of all residue resulting from the construction work and at the conclusion of the work, he shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures and any other refuse remaining from the construction operations and shall leave the entire site of the work in a neat and orderly condition.

1.13 COOPERATION WITHIN THIS CONTRACT

A. All firms or person authorized to perform any work under this Contract shall cooperate with the General Contractor and his subcontractors or trades and shall assist in incorporating the work of other trades where necessary or required.

B. Cutting and patching, drilling and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

1.14 PROTECTION OF CONSTRUCTION AND EQUIPMENT

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

B. All structures shall be protected in a manner approved by the Engineer. Should any of the floors or other parts of the structures become heaved, cracked, or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor, at his own expense and to the satisfaction of the Engineer. If, in the final inspection of the work, any defects, faults, or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. Further, the Contractor shall be fully responsible for the

satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the warranty period described in the Contract.

C. Further, the Contractor shall take all necessary precautions to prevent damage to any structure due to water pressure during and after construction and until such structure is accepted and taken over by the Owner.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01030

SPECIAL PROJECT PROCEDURES

PART 1 GENERAL

1.01 PERMITS

A. Upon notice of award, the Contractor shall immediately apply for all applicable permits not previously obtained by the Owner to do the work from the appropriate governmental agency or agencies. No work shall commence until all applicable permits have been obtained and copies delivered to the Engineer. The costs for obtaining all permits shall be borne by the Contractor.

1.02 CONNECTIONS TO EXISTING SYSTEM

A. The Contractor shall perform all work necessary to locate, excavate, and prepare for connections to the terminus of the existing systems all as shown on the Drawings or where directed by the Owner/Engineer. The cost for this work and for the actual connection to the existing systems shall be included in the price bid for the project and shall not result in any additional cost to the Owner. The termination point for each contract shall be as shown on the Contract Drawings.

1.03 RELOCATIONS

A. The Contractor shall be responsible for the coordination of the relocation of structures, including but not limited to light poles, power poles, signs, sign poles, fences, piping, conduits and drains that interfere with the positioning of the work as set out on the Drawings. No relocation of the items under this Contract shall be done without approval from the Engineer.

1.04 EXISTING UNDERGROUND PIPING, STRUCTURES AND UTILITIES

A. The attention of the Contractor is drawn to the fact that during excavation, the possibility exists of the Contractor encountering various water, sewer, gas, telephone, electrical, or other utility lines not shown on the Drawings. The Contractor shall exercise extreme care before and during excavation to locate and flag these lines as to avoid damage to the existing lines. Cost for relocation of all existing lines shall be included in the price bid for the project. Should damage occur to an existing line, the Contractor shall bear the cost of all repairs.

B. It is the responsibility of the Contractor to ensure that all utility or other poles, the stability of which may be endangered by the close proximity of excavation, are temporarily stayed in position while work proceeds in the vicinity of the pole and that the utility or other companies concerned be given reasonable advance notice of any such excavation by the Contractor.

C. The existing utility locations are shown without express or implied representation, assurance, or guarantee that they are complete or correct or that they represent a true picture of underground piping to be encountered. The Contractor shall be responsible for notifying the various utility companies to locate their respective

utilities in advance of construction in conformance with all requirements provided for in the Florida Underground Facilities Damage Prevention and Safety Act (Florida Statutes, Title XXXIII, Chapter 556).

D. The existing piping and utilities that interfere with new construction shall be rerouted as shown, specified, or required. Before any piping and utilities not shown on the Drawings are disturbed, the Contractor shall notify the Engineer of the location of the pipeline or utility and shall reroute or relocate the pipeline or utility as directed. Cost for relocation of existing pipelines or utilities shall be included in the price bid for the project.

E. The Contractor shall exercise care in any excavation to locate all existing piping and utilities. All utilities which do not interfere with complete work shall be carefully protected against damage. Any existing utilities damaged in any way by the Contractor shall be restored or replaced by the Contractor at his expense as directed by the Engineer and/or the owner of the utility.

F. It is intended that wherever existing utilities such as water, sewer, gas, telephone, electrical, or other service lines must be crossed, deflection of the pipe within recommended limits and cover shall be used to satisfactorily clear the obstruction unless otherwise indicated in the Drawings. However, when in the opinion of the Engineer this procedure is not feasible, he may direct the use of fittings for a utilities crossing as detailed on the Drawings. No deflections will be allowed in gravity sanitary sewer lines or in existing storm sewer lines.

1.05 SUSPENSION OF WORK DUE TO WEATHER

A. Refer to FDOT Standards and Specifications Book, Section 8.

1.06 HURRICANE PREPAREDNESS PLAN

A. Within 30 days of the date of Notice to Proceed, the Contractor shall submit to the Engineer and Owner a Hurricane Preparedness Plan. The plan should outline the necessary measures which the Contractor proposes to perform at no additional cost to the Owner in case of a hurricane warning.

B. In the event of inclement weather, or whenever Engineer shall direct, Contractor shall insure that he and his Subcontractors shall carefully protect work and materials against damage or injury from the weather. If, in the opinion of the Engineer, any portion of work or materials is damaged due to the failure on the part of the Contractor or Subcontractors to protect the work, such work and materials shall be removed and replaced at the expense of the Contractor.

1.07 POWER SUPPLY

A. Electricity as may be required for construction and permanent power supply shall be secured and purchased by the Contractor.

1.08 SALVAGE

A. Any existing equipment or material, including, but not limited to, valves, pipes, fittings, couplings, etc., which is removed or replaced as a result of construction under this project may be designated as salvage by the Engineer or Owner and if so

shall be protected for a reasonable time until picked up by the Owner. Any equipment or material not worthy of salvaging, as directed by the Engineer, shall be disposed of by the Contractor at no additional cost.

1.09 DEWATERING

A. The Contractor shall do all groundwater pumping necessary to prevent flotation of any part of the work during construction operations with his own equipment.

B. The Contractor shall pump out water and wastewater which may seep or leak into the excavations for the duration of the Contract and with his own equipment. He shall dispose of this water in an appropriate manner.

1.10 ADDITIONAL PROVISIONS

A. Before commencing work on any of the existing pipelines, structures or equipment, the Contractor shall notify the Engineer, in writing, at least (ten) 10 calendar days in advance of the date he proposes to commence such work.

B. The Contractor shall provide, at his own expense, all necessary temporary facilities for access to and for protection of, all existing facilities. The Owner's personnel must have ready access at all times to the existing facilities. The Contractor is responsible for all damage to existing structures, equipment and facilities caused by his construction operations and must repair all such damage when and as ordered by the Engineer.

1.11 CONSTRUCTION CONDITIONS

A. The Contractor shall strictly adhere to the specific requirements of the governmental unit(s) and/or agency(ies) having jurisdiction over the work. Wherever there is a difference in the requirements of a jurisdictional body and these Specifications, the more stringent shall apply.

1.12 PUBLIC NUISANCE

A. The Contractor shall not create a public nuisance including but not limited to encroachment on adjacent lands, flooding of adjacent lands, excessive noise or dust.

B. Sound levels must meet Manatee County Ordinance #87-34, (which amends Ordinance 81-3, The Manatee County Noise Control Ordinance). Sound levels in excess of such ordinance are sufficient cause to have the work halted until equipment can be quieted to these levels. Work stoppage by the Engineer or County for excessive noise shall not relieve the Contractor of the other portions of this specification including, but not limited to contract time and contract price.

C. No extra charge may be made for time lost due to work stoppage resulting from the creation of a public nuisance.

1.13 WARRANTIES

A. All material supplied under these Specifications shall be warranted by the Contractor and the manufacturers for a period of three (3) years. Warranty period shall commence on the date of Owner acceptance.

B. The material shall be warranted to be free from defects in workmanship, design and materials. If any part of the system should fail during the warranty period, it shall be replaced at no expense to the Owner.

C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. The Contractor shall be responsible for obtaining warranties from each of the respective suppliers or manufacturers for all the material specified under these contract specifications,

D. In the event that the manufacturer is unwilling to provide a three (3) year warranty commencing at the time of Owner acceptance, the Contractor shall obtain from the manufacturer a four (4) year warranty starting at the time of equipment delivery to the job site. This four (4) year warranty shall not relieve the Contractor of the three (3) year warranty starting at the time of Owner acceptance of the equipment.

1.14 FUEL STORAGE & FILLING

A. If the contractor is storing fuel on site, or doing his own fuel filling of portable equipment (other than hand-held equipment), he is responsible for any required response, clean-up or reporting required, at no additional cost to the county.

B. The Contractor shall prepare and submit a fuel storage/spill abatement plan prior to start of construction if required.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01045

CUTTING AND PATCHING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall be responsible for all cutting, fitting and patching, including excavation and backfill, required to complete the work or to:
   1. Make its several parts fit together properly.
   2. Uncover portions of the work to provide for installation of ill-timed work.
   3. Remove and replace defective work.
   4. Remove and replace work not conforming to requirements of Contract Documents.
   5. Provide penetrations of non-structural surfaces for installation of piping and electrical conduit.

PART 2 PRODUCTS

2.01 MATERIALS

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

PART 3 EXECUTION

3.01 INSPECTION

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

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

C. Report unsatisfactory or questionable conditions to Engineer. Do not proceed with work until Engineer has provided further instructions.

3.02 PREPARATION

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

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

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

3.03 PERFORMANCE

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

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

C. Fit and adjust products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

D. Restore work which has been cut or removed; install new products to provide completed work in accordance with the requirements of the Contract Documents.

E. Replace surfaces airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

F. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes.

END OF SECTION

SECTION 01050

FIELD ENGINEERING AND SURVEYING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall provide and pay for field surveying service required for the project.

B. The Contractor shall furnish and set all necessary stakes to establish the lines and grades as shown on the Contract Drawings and layout each portion of the Work of the Contract.
   1. All survey work required in execution of Project.
   2. All costs of construction layout shall be included in the unit and lump sum prices contained in the respective divisions of the Contract Bid Form.
   3. Civil, structural or other professional engineering services specified or required to execute Contractor's construction methods.

1.02 QUALIFICATION OF SURVEYOR AND ENGINEER

A. All construction staking shall be conducted by or under the supervision of a Florida Registered Professional Surveyor and Mapper approved by the Owner. The Contractor shall be responsible for the layout of all such lines and grades, which will be subject to verification by the Engineer.

1.03 SURVEY REFERENCE POINTS

A. Locate and protect all survey monumentation, property corners and project control points prior to starting work and preserve all permanent reference points during construction. All costs associated with the replacement of all survey monumentation, property corners and project control points shall be borne by the Contractor.

B. Make no changes or relocations without prior written notice to Engineer.

C. Report to Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

D. Require surveyor to replace project control points which may be lost or destroyed.

E. Establish replacements based on original survey control.

1.04 PROJECT SURVEY REQUIREMENTS

A. The Contractor shall establish temporary bench marks as needed, referenced to data established by survey control points.

1.05 RECORDS

A. Maintain a complete, accurate log of all control and survey work as it progresses.

B. The Contractor shall employ a Professional Engineer or Surveyor registered in the State of Florida to verify survey data and properly prepare record drawings per Section 01720.

1.06 SUBMITTALS

A. Submit name and address of Professional Surveyor and Mapper to Engineer for Owner's approval.

B. Submit certificate signed by the Professional Surveyor and Mapper certifying that elevations and locations of improvements are in conformance, or nonconformance, with Contract Documents.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01090

REFERENCE STANDARDS

PART 1 GENERAL

1.01 REQUIREMENTS

Abbreviations and acronyms used in Contract Documents to identify reference standards.

A. Application: When a standard is specified by reference, comply with requirements and recommendations stated in that standard, except when requirements are modified by the Contract Documents, or applicable codes established stricter standards.

B. Publication Date: The most recent publication in effect on the date of issue of Contract Documents, except when a specific publication date is specified.

1.02 ABBREVIATIONS, NAMES AND ADDRESSES OR ORGANIZATIONS

Obtain copies of reference standards direct from publication source, when needed for proper performance of work, or when required for submittal by Contract Documents.

AA	Aluminum Association 818 Connecticut Avenue, N.W. Washington, DC 20006
AASHTO	American Association of State Highway and Transportation Officials 444 North Capital Street, N.W. Washington, DC 20001
ACI	American Concrete Institute Box 19150 Reford Station Detroit, MI 48219
AI	Asphalt Institute Asphalt Institute Building College Park, MD 20740
AISC	American Institute of Steel Construction 1221 Avenue of the Americas New York, NY 10020
AISI	American Iron and Steel Institute 1000 16th Street NW Washington, DC 20036

ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 179l Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
AWS	American Welding Society 2501 N.W. 7th Street Miami, FL 33125
CRSI	Concrete Reinforcing Steel Institute 180 North LaSalle Street, Suite 2110 Chicago, IL 60601
FDEP	Florida Department of Environmental Protection 3900 Commonwealth Blvd. Tallahassee, Florida 32399
FDOT	Florida Department of Transportation Standards Specifications for Road and Bridge Construction Maps & Publication Sales - Mail Station 12 605 Suwannee St. Tallahassee, FL 32399-0450
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Bldg. 197 Washington, DC 20407
MCUOD	Manatee County Utility Operations Department 4410 66th St. W. Bradenton, FL 34210
MLSFA	Metal Lath/Steel Framing Association 221 North LaSalle Street Chicago, IL 60601

MMA	Monorail Manufacturer's Association 1326 Freeport Road Pittsburgh, PA 15238
NAAMM	National Association of Architectural Metal Manufacturers 221 North LaSalle Street Chicago, IL 60601
NEMA	National Electrical Manufacturer's Assoc. 2101 L Street N.W. Washington, DC 20037
OHSA	Occupational Safety and Health Assoc. 5807 Breckenridge Pkwy., Suite A Tampa, FL 33610-4249
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 20076
PCI	Prestressed Concrete Institute 20 North Wacker Drive Chicago, IL 60606
SDI	Steel Door Institute 712 Lakewood Center North Cleveland, OH 44107
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association 8224 Old Court House Road Vienna, VA 22180
SSPC	Steel Structures Painting Council 402 24th Street, Suite 600 Pittsburgh, PA 15213
SWFWMD	Southwest Florida Water Management District 2379 Broad Street Brooksville, FL 34604-6899
UL	Underwriter's Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01150

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SCOPE

A. The scope of this section of the Contract Documents is to further define the items included in each Bid Item in the Bid Form section of the Contract Documents. Payment will be made based on the specified items included in the description in this section for each bid item.

B. All contract prices included in the Bid Form section will be full compensation for all shop drawings, working drawings, labor, materials, tools, equipment, and incidentals necessary to complete the construction as shown on the Drawings and/or as specified in the Contract Documents to be performed under this Contract. Actual quantities of each item bid on a unit price basis will be determined upon completion of the construction in the manner set up for each item in this section of the Specifications. Payment for all items listed in the Bid Form will constitute full compensation for all work shown and/or specified to be performed under this Contract.

1.02 ESTIMATED QUANTITIES

A. The quantities shown are approximate and are given only as a basis of calculation upon which the award of the Contract is to be made. The Owner/Engineer does not assume any responsibility for the final quantities, nor shall the Contractor claim misunderstanding because of such estimate of quantities. Final payment will be made only for satisfactorily completed quantity of each item.

1.03 WORK OUTSIDE AUTHORIZED LIMITS

A. No payment will be made for work constructed outside the authorized limits of work.

1.04 MEASUREMENT STANDARDS

A. Unless otherwise specified for the particular items involved, all measurements of distance shall be taken horizontally or vertically.

1.05 AREA MEASUREMENTS

A. In the measurement of items to be paid for based on area of finished work, the lengths, and/or widths to be used in the calculations shall be the final dimensions measured along the surface of the completed work within the neat lines shown or designated.

1.06 LUMP SUM ITEMS

A. Where payment for items is shown to be paid for on a lump sum basis, no separate payment will be made for any item of work required to complete the lump sum items.

Lump sum contracts shall be complete, tested and fully operable prior to request for final payment. Contractor may be required to provide a breakdown of the lump sum totals.

1.07 UNIT PRICE ITEM

A. Separate payment will be made for the items of work described herein and listed on the Bid Form. Any related work not specifically listed, but required for satisfactory completion of the work shall be considered to be included in the scope of the appropriate listed work items.

B. No separate payment will be made for the following items and the cost of such work shall be included in the applicable pay items of work. Final payments shall not be requested by the Contractor or made by the Owner until as-built (record) drawings have been submitted and approved by the Engineer.
   1. Shop Drawings, Working Drawings.
   2. Clearing, grubbing, and grading except as hereinafter specified.
   3. Trench excavation, including necessary pavement removal and rock removal, except as otherwise specified.
   4. Dewatering and disposal of surplus water.
   5. Structural fill, backfill, and grading.
   6. Replacement of unpaved roadways, and shrubbery plots.
   7. Cleanup and miscellaneous work.
   8. Foundation and borrow materials, except as hereinafter specified.
   9. Testing and placing system in operation.
   10. Any material and equipment required to be installed and utilized for the tests.
   11. Pipe, structures, pavement replacement, asphalt and shell driveways, and/or appurtenances included within the limits of lump sum work, unless otherwise shown.
   12. Maintaining the existing quality of service during construction.
   13. Maintaining or detouring of traffic.
   14. Appurtenant work as required for a complete and operable system.
   15. Seeding and hydromulching.
   16. As-built Record Drawings.

BID ITEM NO. 1- MOBILIZATION/DEMOBILIZATION

Measurement and payment for this Bid Item shall include full compensation for the required 100 percent (100%) Performance Bond, 100 Percent (100%) Payment Bond, all required insurance for the project and the Contractor's mobilization and demobilization costs as shown in the Bid Form.

Payment for mobilization shall not exceed 10 percent (10%) of the total Contract cost unless the Contractor can prove to the Owner that his actual mobilization cost exceeds 10 percent (10%).

BID ITEM NO 2 - CONVEYORS

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the removal and replacement of two screening conveyors, and installation of associated piping and valves; and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this lump sum bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 3 – CLASSIFIERS AND PIPING

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the removal and replacement of two classifiers and cyclones; removal and replacement of plant service water and grit slurry piping and valves; and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this lump sum bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 4 – INFLUENT CHANNEL

Payment for all work under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the removal and replacement of the concrete channel liner; furnishing, placing and installing the miscellaneous concrete or repair material; and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Payment shall represent full compensation for all labor, materials, and equipment necessary to complete the work, ready for approval and acceptance by the Engineer/Owner.

BID ITEM NO. 5 – EPOXY INJECTION FOR CONCRETE CRACK REPAIR

Payment for all work under this Bid Item shall be made at the applicable Contract unit price bid per linear foot of concrete crack repair as shown on the Bid Form for furnishing and injection of the installing the miscellaneous concrete, measured in place. Any crack repair necessary for replacing defective work or damaged caused by the Contractor shall be at the expense of the Contractor. Epoxy injection specifically included under any other Bid Item will not be measured or paid for under this Bid Item.

Measurement for the epoxy injection shall be per actual linear foot of crack repaired as shown on the Contract Drawings or as ordered by the Engineer in writing. For payment purposes, depth of crack shall be assumed to be a uniform 2-inch over the measured linear foot of crack repaired. Payment shall represent full compensation for all labor, materials, and equipment for mixing and injection of the epoxy, and all incidentals necessary to complete the concrete work, ready for approval and acceptance by the Engineer/Owner.

BID ITEM NO 6 – ANTI-SLIP SAFETY TREADS FOR STAIRS

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the new anti-slip safety threads on stairs, and all other materials and equipment necessary for a complete and fully operable system, as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this lump sum bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 7 – ELECTRICAL AND INSTRUMENTATION

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the Electrical and Instrumentation work including new conduit and wiring; new area lighting; removal and replacement of classifier and conveyor control panels, modification of existing MCC (motor control center), and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this lump sum bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO. 8 - DISCRETIONARY WORK

Payment for all work under this Bid Item and listed in the Bid Form shall be made only at the Owner's discretion in order to satisfactorily complete the project in accordance with the Plans and Specifications.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01152

REQUESTS FOR PAYMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Submit Applications for Payment to the Project Manager or as directed at the preconstruction meeting, in accordance with the schedule established by Conditions of the Contract and Agreement between Owner and Contractor.

1.02 FORMAT AND DATA REQUIRED

A. Submit payment requests in the form provided by the Owner with itemized data typed in accordance with the Bid Form.

B. Provide construction photographs in accordance with Contract Documents.

1.03 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

A. When the Owner or the Engineer requires substantiating data, Contractor shall submit suitable information with a cover letter.

B. Submit one copy of data and cover letter for each copy of application.

1.04 PREPARATION OF APPLICATION FOR FINAL PAYMENT

A. Fill in application form as specified for progress payments.

1.05 SUBMITTAL PROCEDURE

A. Submit applications for payment at the times stipulated in the Agreement.

B. Number: Three (3) copies of each application; all signed and certified by the Contractor.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01153

CHANGE ORDER PROCEDURES

PART 1 GENERAL

1.01 DEFINITION

A. Change Order: Major change in contract scope or time that must be approved by the Board.

B. Administrative Change Adjustment: Minor change order under 10% of project cost or 20% time, does not have to be Board approved.

C. Field Directive Change: Change to contract quantity that does not require a change of scope or time extension.

1.02 REQUIREMENTS INCLUDED

A. The Contractor shall promptly implement change order procedures:
   1. Provide full written data required to evaluate changes.
   2. Maintain detailed records of work done on a time-and-material/force account basis.
   3. Provide full documentation to Engineer on request.

B. The Contractor shall designate a member of the Contractor's organization who:
   1. Is authorized to accept changes to the Work.
   2. Is responsible for informing others in the Contractor's employ of the authorized changes into the Work.

C. The Board of County Commissioners executes all Change Orders.

1.03 PRELIMINARY PROCEDURES

A. Project Manager may initiate changes by submitting a Request to Contractor. Request will include:
   1. Detailed description of the change, products, costs and location of the change in the Project.
   2. Supplementary or revised Drawings and Specifications.
   3. The projected time extension for making the change.
   4. A specified period of time during which the requested price will be considered valid.
   5. Such request is for information only and is not an instruction to execute the changes, nor to stop work in progress.

B. Contractor may initiate changes by submitting a written notice to the Project Manager, containing:
   1. Description of the proposed changes.
   2. Statement of the reason for making the changes.
   3. Statement of the effect on the Contract Sum and the Contract Time.
   4. Statement of the effect on the work of separate contractors.

5. Documentation supporting any change in Contract Sum or Contract Time, as appropriate.

1.04 FIELD DIRECTIVE CHANGE

A. In lieu of a Change Order, the Project Manager may issue a Field Directive change for the Contractor to proceed with additional work within the original intent of the Project.

B. Field Directive change will describe changes in the work, with attachments of backup information to define details of the change.

C. Contractor must sign and date the Field Directive change to indicate agreement with the terms therein.

1.05 DOCUMENTATION OF PROPOSALS AND CLAIMS

A. Support each quotation for a lump sum proposal and for each unit price which has not previously been established, with sufficient substantiating data to allow the Engineer/Owner to evaluate the quotation.

B. On request, provide additional data to support time and cost computations:
   1. Labor required.
   2. Equipment required.
   3. Products required.
      a. Recommended source of purchase and unit cost.
      b. Quantities required.
   4. Taxes, insurance and bonds.
   5. Credit for work deleted from Contract, similarly documented.
   6. Overhead and profit.
   7. Justification for any change in Contract Time.

C. Support each claim for additional costs and for work done on a time-and-material/force account basis, with documentation as required for a lump-sum proposal, plus additional information.
   1. Name of the Owner's authorized agent who ordered the work and date of the order.
   2. Date and time the work was performed and by whom.
   3. Time record, summary of hours work and hourly rates paid.
   4. Receipts and invoices for:
      a. Equipment used, listing dates and time of use.
      b. Products used, listing of quantities.
      c. Subcontracts.

1.06 PREPARATION OF CHANGE ORDERS

A. Project Manager will prepare each Change Order.

B. Change Order will describe changes in the Work, both additions and deletions, with attachments as necessary to define details of the change.

C. Change Order will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.

1.07 LUMP SUM/FIXED PRICE CHANGE ORDER

A. Project Manager initiates the form, including a description of the changes involved and attachments based upon documents and proposals submitted by the Contractor, or requests from the Owner, or both.

B. Once the form has been completed, all copies should be sent to Contractor for approval. After approval by Contractor, all copies should be sent to Owner for approval. The Owner will distribute executed copies after approval by the Board of County Commissioners.

1.08 UNIT PRICE CHANGE ORDER

A. Contents of Change Orders will be based on, either:
   1. Owner's definition of the scope of the required changes.
   2. Contractor's Proposal for a change, as approved by the Owner.
   3. Survey of completed work.

B. The amounts of the unit prices to be:
   1. Those stated in the Agreement.
   2. Those mutually agreed upon between Owner and Contractor.

1.09 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/CONSTRUCTION CHANGE AUTHORIZATION

A. At completion of the change, Contractor shall submit itemized accounting and supporting data as provided in the Article "Documentation of Proposals and Claims" of this Section.

B. Engineer will determine the allowable cost of such work, as provided in General Conditions and Supplementary Conditions.

C. Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time.

D. Owner and Contractor will sign and date the Change Order to indicate their agreement therewith.

1.10 CORRELATION WITH CONTRACTOR'S SUBMITTALS

A. Periodically revise Schedule of Values and Application for Payment forms to record each change as a separate item of work, and to record the adjusted Contract Sum.

B. Periodically revise the Construction Schedule to reflect each change in Contract Time. Revise sub schedules to show changes for other items of work affected by the changes.

C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01200

PROJECT MEETINGS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Owner or Engineer shall schedule the pre-construction meeting, periodic progress meetings and special meetings, if required, throughout progress of work.

B. Representatives of contractors, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.

C. The Contractor shall attend meetings to ascertain that work is expedited consistent with Contract Documents and construction schedules.

1.02 PRE-CONSTRUCTION MEETING

A. Attendance:
   1. Owner's Engineer.
   2. Owner's Project Manager
   3. Contractor.
   4. Resident Project Representative.
   5. Related Labor Contractor's Superintendent.
   6. Major Subcontractors.
   7. Major Suppliers.
   8. Others as appropriate.

B. Suggested Agenda:
   1. Distribution and discussion of:
      a. List of major subcontractors.
      b. Projected Construction Schedules.
      c. Coordination of Utilities
   2. Critical work sequencing.
   3. Project Coordination.
      a. Designation of responsible personnel.
      b. Emergency contact persons with phone numbers.
   4. Procedures and processing of:
      a. Field decisions.
      b. Submittals.
      c. Change Orders.
      d. Applications for Payment.
   5. Procedures for maintaining Record Documents.
   6. Use of premises:
      a. Office, work and storage areas.
      b. Owner's REQUIREMENTS.
   7. Temporary utilities.
   8. Housekeeping procedures.
   9. Liquidated damages.
   10. Equal Opportunity Requirements.
   11. Laboratory testing.
   12. Project / Job meetings: Progress meeting, other special topics as needed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01310

CONSTRUCTION SCHEDULE & PROJECT RESTRAINTS

PART 1 GENERAL

1.01 GENERAL

A. Construction under this contract must be coordinated with the Owner and accomplished in a logical order to maintain utilization and flow through existing facilities and public properties and rights-of-way and to allow construction to be completed within the time allowed by Contract Documents and in the manner set forth in the Contract.

1.02 CONSTRUCTION SCHEDULING GENERAL PROVISIONS

A. No work shall be done between 7:00 p.m. and 7:00 a.m. nor on weekends or legal holidays without written permission of the Owner. However, emergency work may be done without prior permission.

B. Night work may be established by the Contractor as regular procedure with the written permission of the Owner. Such permission, however, may be revoked at any time by the Owner if the Contractor fails to maintain adequate equipment and supervision for the proper execution and control of the work at night.

C. Due to potential health hazards and requirements of the State of Florida and the U.S. Environmental Protection Agency, existing facilities must be maintained in operation.

D. The Contractor shall be fully responsible for providing all temporary piping, plumbing, electrical hook-ups, lighting, temporary structure, or other materials, equipment and systems required to maintain the existing facility's operations. All details of temporary piping and temporary construction are not necessarily shown on the Drawings or covered in the Specifications. However, this does not relieve the Contractor of the responsibility to insure that construction will not interrupt proper facility operations.

E. The Contractor shall designate an authorized representative of his firm who shall be responsible for development and maintenance of the schedule and of progress and payment reports. This representative of the Contractor shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the commitments of the Contractor's schedule.

1.03 PROGRESS OF THE WORK

A. The work shall be executed with such progress as may be required to prevent any delay to the general completion of the work. The work shall be executed at such times and in or on such parts of the project and with such forces, materials and equipment to assure completion of the work in the time established by the Contract and in the manner set forth in the Contract.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The Contractor shall submit a critical path schedule as described herein.

B. The planning, scheduling, management and execution of the work is the sole responsibility of the Contractor. The progress schedule requirement is established to allow Engineer to review Contractor's planning, scheduling, management and execution of the work; to assist Engineer in evaluating work progress and make progress payments and to allow other contractors to cooperate and coordinate their activities with those of the Contractor.

2.02 FORM OF SCHEDULES

A. Prepare schedules using the latest version of Microsoft Project, or other Owner approved software, in the form of a horizontal bar chart diagram. The diagram shall be time-scaled and sequenced by work areas. Horizontal time scale shall identify the first work day of each week.

B. Activities shall be at least as detailed as the Schedule of Values. Activity durations shall be in whole working days. In addition, man-days shall be shown for each activity or tabulated in an accompanying report.

C. Diagrams shall be neat and legible and submitted on sheets at least 8-1/2 inches by 11 inches suitable for reproduction. Scale and spacing shall allow space for notations and future revisions.

2.03 CONTENT OF SCHEDULES

A. Each monthly schedule shall be based on data as of the last day of the current pay period.

B. Description for each activity shall be brief, but convey the scope of work described.

C. Activities shall identify all items of work that must be accomplished to achieve substantial completion, such as items pertaining to Contractor's installation and testing activities; items pertaining to the approval of regulatory agencies; contractor's time required for submittals, fabrication and deliveries; the time required by Engineer to review all submittals as set forth in the Contract Documents; items of work required of Owner to support pre-operational, startup and final testing; time required for the relocation of utilities. Activities shall also identify interface milestones with the work of other contractors performing work under separate contracts with Owner.

D. Schedules shall show the complete sequence of construction by activities. Dates for beginning and completion of each activity shall be indicated as well as projected percentage of completion for each activity as of the first day of each month.

E. Submittal schedule for shop drawing review, product data, and samples shall show the date of Contractor submittal and the date approved submittals will be required by the Engineer, consistent with the time frames established in the Specifications.

F. For Contract change orders granting time extensions, the impact on the Contract date(s) shall equal the calendar-day total time extension specified for the applicable work in the Contract change orders.

G. For actual delays, add activities prior to each delayed activity on the appropriate critical path(s). Data on the added activities of this type shall portray all steps leading to the delay and shall further include the following: separate activity identification, activity description indicating cause of the delay, activity duration consistent with whichever set of dates below applies, the actual start and finish dates of the delay or, if the delay is not finished, the actual start date and estimated completion date.

H. For potential delays, add an activity prior to each potentially delayed activity on the appropriate critical path(s). Data for added activities of this type shall include alternatives available to mitigate the delay including acceleration alternatives and further show the following: separate activity identification, activity description indicating cause of the potential delay and activity duration equal to zero work days.

2.04 SUPPORTING NARRATIVE

A. Status and scheduling reports identified below shall contain a narrative to document the project status, to explain the basis of Contractor's determination of durations, describe the Contract conditions and restraints incorporated into the schedule and provide an analysis pertaining to potential problems and practical steps to mitigate them.

B. The narrative shall specifically include:
   1. Actual completion dates for activities completed during the monthly report period and actual start dates for activities commenced during the monthly report period.
   2. Anticipated start dates for activities scheduled to commence during the following monthly report period.
   3. Changes in the duration of any activity and minor logic changes.
   4. The progress along the critical path in terms of days ahead or behind the Contract date.
   5. If the Monthly Status Report indicates an avoidable delay to the Contract completion date or interim completion dates as specified in the Agreement, Contractor shall identify the problem, cause and the activities affected and provide an explanation of the proposed corrective action to meet the milestone dates involved or to mitigate further delays.
   6. If the delay is thought to be unavoidable, the Contractor shall identify the problem, cause, duration, specific activities affected and restraints of each activity.
   7. The narrative shall also discuss all change order activities whether included or not in the revised/current schedule of legal status. Newly introduced change order work activities and the CPM path(s) that they affect, must be specifically identified. All change order work activities added to the schedule shall conform with the sequencing and Contract Time requirements of the applicable Change Order.
   8. Original Contract date(s) shall not be changed except by Contract change order. A revision need not be submitted when the foregoing situations arise unless required by Engineer. Review of a report containing added activities will not be construed to be concurrence with the duration or restraints for such

added activities; instead the corresponding data as ultimately incorporated into the applicable Contract change order shall govern.

9. Should Engineer require additional data, this information shall be supplied by Contractor within 10 calendar days.

2.05 SUBMITTALS

A. Contractor shall submit estimated and preliminary progress schedules (as identified in the Terms and Conditions of the Contract and the General Conditions), monthly status reports, a start-up schedule and an as-built schedule report all as specified herein.

B. All schedules, including estimated and preliminary schedules, shall be in conformance with the Contract Documents.

C. The finalized progress schedule discussed in the Contract Documents shall be the first monthly status report and as such shall be in conformance with all applicable specifications contained herein.

D. Monthly Status Report submittals shall include three copies of a time-scaled (days after notice to proceed) diagram showing all contract activities and supporting narrative. The initial detailed schedule shall use the notice to proceed as the start date. The finalized schedule, if concurred with by Owner, shall be the work plan to be used by the contractor for planning, scheduling, managing and executing the work.

E. The schedule diagram shall be formatted as above. The diagram shall include (1) all detailed activities included in the preliminary and estimated schedule submittals, (2) calendar days prior to substantial completion, (3) summary activities for the remaining days. The critical path activities shall be identified, including critical paths for interim dates, if possible.

F. The Contractor shall submit monthly progress schedules with each month's application for payment.

G. Contractor shall submit three monthly status reports which will be retained by the Owner and Engineer.

2.06 MONTHLY STATUS REPORTS

A. Contractor shall submit three copies of detailed schedule status reports on a monthly basis with the Application for Payment. The first such status report shall be submitted with the first Application for Payment and include data as of the last day of the pay period. The Monthly Report shall include a "marked-up" copy of the latest detailed schedule of legal status and a supporting narrative including updated information as described above. The Monthly Report will be reviewed by Engineer and Contractor at a monthly schedule meeting and Contractor will address Engineer's comments on the subsequent monthly report. Monthly status reports shall be the basis for evaluating Contractor's progress.

B. The "marked-up" diagram shall show, for the latest detailed schedule of legal status, percentages of completion for all activities, actual start and finish dates and remaining durations, as appropriate. Activities not previously included in the latest

detailed schedule of legal status shall be added, except that contractual dates will not be changed except by change order. Review of a marked-up diagram by Engineer will not be construed to constitute concurrence with the time frames, duration, or sequencing for such added activities; instead the corresponding data as ultimately incorporated into an appropriate change order shall govern.

2.07 STARTUP SCHEDULE

A. At least 60 calendar days prior to the date of substantial completion, Contractor shall submit a time-scaled (days after notice to proceed) diagram detailing the work to take place in the period between 60 days prior to substantial completion, together with a supporting narrative. Engineer shall have 10 calendar days after receipt of the submittal to respond. Upon receipt of Engineer's comments, Contractor shall make the necessary revisions and submit the revised schedule within 10 calendar days. The resubmittal, if concurred with by Owner, shall be the Work Plan to be used by Contractor for planning, managing, scheduling and executing the remaining work leading to substantial completion.

B. The time-scaled diagram shall use the latest schedule of legal status for those activities completed ahead of the last 60 calendar days prior to substantial completion and detailed activities for the remaining 60-day period within the time frames outlined in the latest schedule of legal status.

C. Contractor will be required to continue the requirement for monthly reports, as outlined above. In preparing this report, Contractor must assure that the schedule is consistent with the progress noted in the startup schedule.

2.08 REVISIONS

A. All revised Schedule Submittals shall be made in the same form and detail as the initial submittal and shall be accompanied by an explanation of the reasons for such revisions, all of which shall be subject to review by Engineer and concurrence by Owner. The revision shall incorporate all previously made changes to reflect current as-built conditions. Minor changes to the approved submittal may be approved at monthly meetings; a minor change is not considered a revision in the context of this paragraph.

B. A revised schedule submittal shall be submitted for review when required by Engineer.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01340

SHOP DRAWINGS, PROJECT DATA AND SAMPLES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall submit to the Engineer for review and approval: working drawings, shop drawings, test reports and data on materials and equipment (hereinafter in this section called data), and material samples (hereinafter in this section called samples) as are required for the proper control of work, including, but not limited to those working drawings, shop drawings, data and samples for materials and equipment specified elsewhere in the Specifications and in the Contract Drawings.

B. Within thirty (30) calendar days after the effective date of the Agreement, the Contractor shall submit to the Engineer, a complete list of preliminary data on items for which Shop Drawings are to be submitted. Included in this list shall be the names of all proposed manufacturers furnishing specified items and the date on which each Shop Drawing shall be submitted. Review of this list by the Engineer shall in no way relieve the Contractor from submitting complete Shop Drawings and providing materials, equipment, etc., fully in accordance with the Specifications. This procedure is required in order to expedite final review of Shop Drawings.

C. The Contractor is to maintain an accurate updated submittal log and will bring this log to each scheduled progress meeting with the Owner and the Engineer. This log should include the following items:
   1. Submittal description and number assigned.
   2. Date to Engineer.
   3. Date returned to Contractor (from Engineer).
   4. Status of Submittal (No exceptions taken, returned for confirmation or resubmittal, rejected).
   5. Date of Resubmittal and Return (as applicable).
   6. Date material released (for fabrication).
   7. Projected date of fabrication.
   8. Projected date of delivery to site.
   9. Projected date and required lead time so that product installation does not delay contact.
   10. Status of O&M manuals submitted.

1.02 CONTRACTOR'S RESPONSIBILITY

A. It is the duty of the Contractor to check all drawings, data and samples prepared by or for him before submitting them to the Engineer for review. Each and every copy of the Drawings and data shall bear Contractor's stamp showing that they have been so checked. Shop drawings submitted to the Engineer without the Contractor's stamp will be returned to the Contractor for conformance with this requirement. Shop drawings shall indicate any deviations in the submittal from requirements of the contract Documents.

B. Determine and verify:
   1. Field measurements.
   2. Field construction criteria.
   3. Catalog numbers and similar data.
   4. Conformance with Specifications and indicate all variances from the Specifications.

C. The Contractor shall furnish the Engineer a schedule of Shop Drawing submittals fixing the respective dates for the submission of shop and working drawings, the beginning of manufacture, testing and installation of materials, supplies and equipment. This schedule shall indicate those that are critical to the progress schedule.

D. The Contractor shall not begin any of the work covered by a drawing, data, or a sample returned for correction until a revision or correction thereof has been reviewed and returned to him, by the Engineer, with No Exceptions Taken or Approved As Noted.

E. The Contractor shall submit to the Engineer all drawings and schedules sufficiently in advance of construction requirements to provide no less than twenty-one (21) calendar days for checking and appropriate action from the time the Engineer receives them.

F. The Contractor shall submit five (5) copies of descriptive or product data submittals to complement shop drawings for the Engineer plus the additional copies if the Contractor requires more than 1 being returned. The Engineer shall retain four (4) sets.

G. The Contractor shall be responsible for and bear all cost of damages which may result from the ordering of any material or from proceeding with any part of work prior to the completion of the review by Engineer of the necessary Shop Drawings.

1.03 ENGINEER'S REVIEW OF SHOP DRAWINGS AND WORKING DRAWINGS

A. The Engineer's review of drawings, data and samples submitted by the Contractor shall cover only general conformity to the Specifications, external connections and dimensions which affect the installation.

B. The review of drawings and schedules shall be general and shall not be construed:
   1. As permitting any departure from the Contract requirements.
   2. As relieving the Contractor of responsibility for any errors, including details, dimensions and materials.
   3. As approving departures from details furnished by the Engineer, except as otherwise provided herein.

C. If the drawings or schedules as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in Contract Price or time for performance, the Engineer may return the reviewed drawings without noting any exception.

D. When reviewed by the Engineer, each of the Shop and Working Drawings shall be identified as having received such review being so stamped and dated. Shop

Drawings stamped "REJECTED" and with required corrections shown shall be returned to the Contractor for correction and resubmittal.

E. Resubmittals will be handled in the same manner as first submittals. On resubmittals, the Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, to revisions other than the corrections requested by the Engineer on previous submissions. The Contractor shall make any corrections required by the Engineer.

F. If the Contractor considers any correction indicated on the drawings to constitute a change to the Contract Drawings or Specifications, the Contractor shall give written notice thereof to the Engineer.

G. The Engineer shall review a submittal/resubmittal a maximum of two (2) times after which cost of review shall be borne by the Contractor. The cost of engineering shall be equal to the Engineer's actual payroll cost.

H. When the Shop and Working Drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

I. No partial submittals shall be reviewed. Incomplete submittals shall be returned to the Contractor and shall be considered not approved until resubmitted.

1.04 SHOP DRAWINGS

A. When used in the Contract Documents, the term "Shop Drawings" shall be considered to mean Contractor's plans for material and equipment which become an integral part of the Project. These drawings shall be complete and detailed. Shop Drawings shall consist of fabrication, drawings, setting drawings, schedule drawings, manufacturer's scale drawings and wiring and control diagrams. Cuts, catalogs, pamphlets, descriptive literature and performance and test data, shall be considered only as supportive to required Shop Drawings as defined above.

B. Drawings and schedules shall be checked and coordinated with the work of all trades involved, before they are submitted for review by the Engineer and shall bear the Contractor's stamp of approval and original signature as evidence of such checking and coordination. Drawings or schedules submitted without this stamp of approval and original signature shall be returned to the Contractor for resubmission.

C. Each Shop Drawing shall have a blank area 3-1/2 inches by 3-1/2 inches, located adjacent to the title block. The title block shall display the following:
   1. Number and title of the drawing.
   2. Date of Drawing or revision.
   3. Name of project building or facility.
   4. Name of contractor and subcontractor submitting drawing.
   5. Clear identification of contents and location of the work.
   6. Specification title and number.

D. If drawings show variations from Contract requirements because of standard shop practice or for other reasons, the Contractor shall describe such variations in his letter of transmittal. If acceptable, proper adjustment in the contract shall be

implemented where appropriate. If the Contractor fails to describe such variations, he shall not be relieved of the responsibility of executing the work in accordance with the Contract, even though such drawings have been reviewed.

E. Data on materials and equipment shall include, without limitation, materials and equipment lists, catalog sheets, cuts, performance curves, diagrams, materials of construction and similar descriptive material. Materials and equipment lists shall give, for each item thereon, the name and location of the supplier or manufacturer, trade name, catalog reference, size, finish and all other pertinent data.

F. For all mechanical and electrical equipment furnished, the Contractor shall provide a list including the equipment name and address and telephone number of the manufacturer's representative and service company so that service and/or spare parts can be readily obtained.

G. All manufacturers or equipment suppliers who proposed to furnish equipment or products shall submit an installation list to the Engineer along with the required shop drawings. The installation list shall include at least five installations where identical equipment has been installed and have been in operation for a period of at least one (1) year.

H. Only the Engineer will utilize the color "red" in marking shop drawing submittals.

1.05 WORKING DRAWINGS

A. When used in the Contract Documents, the term "working drawings" shall be considered to mean the Contractor's fabrication and erection drawings for structures such as roof trusses, steelwork, precast concrete elements, bulkheads, support of open cut excavation, support of utilities, groundwater control systems, forming and false work; underpinning; and for such other work as may be required for construction of the project.

B. Copies of working drawings as noted above, shall be submitted to the Engineer where required by the Contract Documents or requested by the Engineer and shall be submitted at least thirty (30) days (unless otherwise specified by the Engineer) in advance of their being required for work.

C. Working drawings shall be signed by a registered Professional Engineer, currently licensed to practice in the State of Florida and shall convey, or be accompanied by, calculation or other sufficient information to completely explain the structure, machine, or system described and its intended manner of use. Prior to commencing such work, working drawings must have been reviewed without specific exceptions by the Engineer, which review will be for general conformance and will not relieve the Contractor in any way from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error are assumed by the Contractor; the Owner and Engineer shall not have responsibility therefore.

1.06 SAMPLES

A. The Contractor shall furnish, for the review of the Engineer, samples required by the Contract Documents or requested by the Engineer. Samples shall be delivered to the Engineer as specified or directed. The Contractor shall prepay all shipping

charges on samples. Materials or equipment for which samples are required shall not be used in work until reviewed by the Engineer.

B. Samples shall be of sufficient size and quantity to clearly illustrate:
   1. Functional characteristics of the product, with integrally related parts and attachment devices.
   2. Full range of color, texture and pattern.
   3. A minimum of two samples of each item shall be submitted.

C. Each sample shall have a label indicating:
   1. Name of product.
   2. Name of Contractor and Subcontractor.
   3. Material or equipment represented.
   4. Place of origin.
   5. Name of Producer and Brand (if any).
   6. Location in project. (Samples of finished materials shall have additional markings that will identify them under the finished schedules.)
   7. Reference specification paragraph.

D. The Contractor shall prepare a transmittal letter in triplicate for each shipment of samples containing the information required above. He shall enclose a copy of this letter with the shipment and send a copy of this letter to the Engineer. Review of a sample shall be only for the characteristics or use named in such and shall not be construed to change or modify any Contract requirements.

E. Reviewed samples not destroyed in testing shall be sent to the Engineer or stored at the site of the work. Reviewed samples of the hardware in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in work shall match the reviewed samples. If requested at the time of submission, samples which failed testing or were rejected shall be returned to the Contractor at his expense.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01370

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall submit to the Engineer a Schedule of Values allocated to the various portions of the work, within 10 days after date of Notice to Proceed.

B. Upon request of the Engineer, the Contractor shall support the values with data which will substantiate their correctness.

C. The Schedule of Values shall be used only as the basis for the Contractor's Applications for Payment.

1.02 FORM AND CONTENT OF SCHEDULE OF VALUES

A. Schedule of Values will be considered for approval by Engineer upon Contractor's request. Identify schedule with:
   1. Title of Project and location.
   2. Project number.
   3. Name and address of Contractor.
   4. Contract designation.
   5. Date of submission.

B. Schedule of Values shall list the installed value of the component parts of the work in sufficient detail to serve as a basis for computing values for progress payments during construction.

C. Follow the table of contents for the Contract Document as the format for listing component items for structures:
   1. Identify each line item with the number and title of the respective major section of the specification.
   2. For each line item, list sub values of major products or operations under item.

D. Follow the bid sheets included in this Contract Documents as the format for listing component items for pipelines.

E. The sum of all values listed in the schedule shall equal the total Contract sum.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall employ a competent photographer to take construction record photographs or perform video, recording including furnishing all labor, materials, equipment and incidentals necessary to obtain photographs and/or video recordings of all construction areas.

B. Preconstruction record information shall consist of video recordings on digital video disks (DVD).

C. Construction progress information shall consist of photographs and digital photographs on a recordable compact disc (CD-R).

1.02 QUALIFICATIONS

A. All photography shall be done by a competent camera operator who is fully experienced and qualified with the specified equipment.

B. For the video recording, the audio portion should be done by a person qualified and knowledgeable in the specifics of the Contract, who shall speak with clarity and diction so as to be easily understood.

1.03 PROJECT PHOTOGRAPHS

A. Provide two prints of each photograph with each pay application.

B. Provide one recordable compact disc with digital photographs with each pay application.

C. Negatives:
   1. All negatives shall remain the property of photographer.
   2. The Contractor shall require that photographer maintain negatives or protected digital files for a period of two years from date of substantial completion of the project.
   3. Photographer shall agree to furnish additional prints to Owner and Engineer at commercial rates applicable at time of purchase. Photographer shall also agree to participate as required in any litigation requiring the photographer as an expert witness.

D. The Contractor shall pay all costs associated with the required photography and prints. Any parties requiring additional photography or prints shall pay the photographer directly.

E. All project photographs shall be a single weight, color image. All finishes shall be smooth surface and glossy and all prints shall be 8 inches x 10 inches.

F. Each print shall have clearly marked on the back, the name of the project, the orientation of view, the date and time of exposure, name and address of the photographer and the photographers numbered identification of exposure.

G. All project photographs shall be taken from locations to adequately illustrate conditions prior to construction, or conditions of construction and state of progress. The Contractor shall consult with the Engineer at each period of photography for instructions concerning views required.

1.04 VIDEO RECORDINGS

A. Video, recording shall be done along all routes that are scheduled for construction. Video, recording shall include full, recording of both sides of all streets and the entire width of easements plus 10 feet on each side on which construction is to be performed. All video recording shall be in full color.

B. A complete view, in sufficient detail with audio description of the exact location shall be provided.

C. The engineering plans shall be used as a reference for stationing in the audio portion of the recordings for easy location identification.

D. Two complete sets of video recordings shall be delivered to the Engineer on DVD for the permanent and exclusive use of the Engineer prior to the start of any construction on the project.

E. All video recordings shall contain the name of the project, the date and time of the video, recording, the name and address of the photographer and any other identifying information required.

F. Construction shall not start until preconstruction video recordings are completed, submitted and accepted by the Engineer. In addition, no progress payments shall be made until the preconstruction video recordings are accepted by the Engineer.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01410

TESTING AND TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Owner shall employ and pay for the services of an independent testing laboratory to perform testing specifically indicated on the Contract Documents or called out in the Specifications. Owner may elect to have materials and equipment tested for conformity with the Contract Documents at any time.
   1. Contractor shall cooperate fully with the laboratory to facilitate the execution of its required services.
   2. Employment of the laboratory shall in no way relieve the Contractor's obligations to perform the work of the Contract.

1.02 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:
   1. Release, revoke, alter or enlarge on requirements of Contract Documents.
   2. Approve or accept any portion of the Work.
   3. Perform any duties of the Contractor.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel; provide access to Work and/or to Manufacturer's operations.

B. Secure and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.

C. Provide to the laboratory the preliminary design mix proposed to be used for concrete, and other material mixes which require control by the testing laboratory.

D. Materials and equipment used in the performance of work under this Contract are subject to inspection and testing at the point of manufacture or fabrication. Standard specifications for quality and workmanship are indicated in the Contract Documents. The Engineer may require the Contractor to provide statements or certificates from the manufacturers and fabricators that the materials and equipment provided by them are manufactured or fabricated in full accordance with the standard specifications for quality and workmanship indicated in the Contract Documents. All costs of this testing and providing statements and certificates shall be a subsidiary obligation of the Contractor and no extra charge to the Owner shall be allowed on account of such testing and certification.

E. Furnish incidental labor and facilities:
   1. To provide access to work to be tested.
   2. To obtain and handle samples at the project site or at the source of the product to be tested.
   3. To facilitate inspections and tests.

4. For storage and curing of test samples.

F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.
   1. When tests or inspections cannot be performed due to insufficient notice, Contractor shall reimburse Owner for laboratory personnel and travel expenses incurred due to Contractor's negligence.

G. Employ and pay for the services of the same or a separate, equally qualified independent testing laboratory to perform additional inspections, sampling and testing required for the Contractor's convenience and as approved by the Engineer.

H. If the test results indicate the material or equipment complies with the Contract Documents, the Owner shall pay for the cost of the testing laboratory. If the tests and any subsequent retests indicate the materials and equipment fail to meet the requirements of the Contract Documents, the contractor shall pay for the laboratory costs directly to the testing firm or the total of such costs shall be deducted from any payments due the Contractor.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01510

TEMPORARY AND PERMANENT UTILITIES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall be responsible for furnishing all requisite temporary utilities, i.e., power, water, sanitation, etc. The Contractor shall obtain and pay for all permits required as well as pay for all temporary usages. The Contractor shall remove all temporary facilities upon completion of work.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. Comply with National Electric Code (NEC).

B. Comply with Federal, State and Local codes and regulations and with utility company requirements.

C. Comply with County Health Department regulations.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL

A. Materials for temporary utilities may be "used". Materials for electrical utilities shall be adequate in capacity for the required usage, shall not create unsafe conditions and shall not violate requirements of applicable codes and standards.

2.02 TEMPORARY ELECTRICITY AND LIGHTING

A. Arrange with the applicable utility company for temporary power supply. Provide service required for temporary power and lighting and pay all costs for permits, service and for power used.

2.03 TEMPORARY WATER

A. The Contractor shall arrange with Manatee County Utilities Customer Service office to provide water for construction purposes, i.e., meter, pay all costs for installation, maintenance and removal, and service charges for water used.

B. The Contractor shall protect piping and fitting against freezing.

2.04 TEMPORARY SANITARY FACILITIES

A. The Contractor shall provide sanitary facilities in compliance with all laws and regulations.

B. The Contractor shall service, clean and maintain facilities and enclosures.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall maintain and operate systems to assure continuous service.

B. The Contractor shall modify and extend systems as work progress requires.

3.02 REMOVAL

A. The Contractor shall completely remove temporary materials and equipment when their use is no longer required.

B. The Contractor shall clean and repair damage caused by temporary installations or use of temporary facilities.

END OF SECTION

SECTION 01580

PROJECT IDENTIFICATION AND SIGNS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnish, install and maintain County project identification signs.

B. Remove signs on completion of construction.

C. Allow no other signs to be displayed except for traffic control and safety.

1.02 PROJECT IDENTIFICATION SIGN (COUNTY)

A. One painted sign, of not less than 32 square feet (3 square meters) area, with painted graphic content to include:
   1. Title of Project.
   2. Name of Owner.
   3. Names and titles of authorities as directed by Owner.
   4. Prime Contractor.

B. Graphic design, style of lettering and colors: As approved by the Engineer and subject to approval of the Owner.

C. Erect on the site at a lighted location of high public visibility, adjacent to main entrance to site, as approved by the Engineer and the Owner

1.03 INFORMATIONAL SIGNS

A. Painted signs with painted lettering, or standard products.
   1. Size of signs and lettering: as required by regulatory agencies, or as appropriate to usage.
   2. Colors: as required by regulatory agencies, otherwise of uniform colors throughout project.

B. Erect at appropriate locations to provide required information.

1.04 QUALITY ASSURANCE

A. Sign Painter: Professional experience in type of work required.

B. Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

1.05 PUBLIC NOTIFICATION

A. Door Hangers: Manatee County Project Management shall generate and the General Contractor shall distribute door hangers to all residents who will be impacted by project construction.

1. Residents impacted include anyone who resides inside, or within 500 feet of project limits of construction.

B. Door Hangers shall be distributed prior to start of construction of the project. Hangers shall be affixed to doors of residents via elastic bands or tape.

EXAMPLE:

PLEASE PARDON THE INCONVENIENCE WHILE THE ROADWAY IS BEING RECONSTRUCTED IN YOUR NEIGHBORHOOD

This project consists of utility improvements and the reconstruction of ??? Boulevard from U.S. ??? to ??? Street West. The project is expected to begin in August, 200X and be completed in July 200X.

Location Map

WE HOPE TO KEEP ANY INCONVENIENCE TO A MINIMUM. HOWEVER, IF YOU HAVE ANY PROBLEMS, PLEASE CONTACT THE FOLLOWING:

A. Contractor
Contractor Address
Contractor Phone (Site Phone)

B. Project Inspector
Inspector Phone Number

C. Project Manager
PM Address
PM Phone No. & Ext.

AFTER HOURS EMERGENCY NUMBER – (941) 747-HELP
THANK YOU FOR YOUR UNDERSTANDING AND PATIENCE
MANATEE COUNTY GOVERNMENT – PROJECT MANAGEMENT DEPT.

PART 2 PRODUCTS

2.01 SIGN MATERIALS

A. Structure and Framing: May be new or used, wood or metal, in sound condition structurally adequate to work and suitable for specified finish.

B. Sign Surfaces: Exterior softwood plywood with medium density overlay, standard large sizes to minimize joints.
1. Thickness: As required by standards to span framing members, to provide even, smooth surface without waves or buckles.

C. Rough Hardware: Galvanized.

D. Paint: Exterior quality, as specified in the Contract Documents.

PART 3 EXECUTION

3.01 PROJECT IDENTIFICATION SIGN

A. Paint exposed surface or supports, framing and surface material; one (1) coat of primer and one (1) coat of exterior paint.

B. Paint graphics in styles, size and colors selected.

3.02 MAINTENANCE

A. The Contractor shall maintain signs and supports in a neat, clean condition; repair damages to structures, framing or sign.

3.03 REMOVAL

A. The Contractor shall remove signs, framing, supports and foundations at completion of project.

END OF SECTION

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SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Material and equipment incorporated into the work:
   1. Conform to applicable specifications and standards.
   2. Comply with size, make, type and quality specified, or as specifically approved in writing by the Engineer.
   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 gages, to be interchangeable.
      c. Two (2) or more items of the same kind shall be identical and manufactured by the same manufacturer.
      d. Products shall be suitable for service conditions.
      e. Equipment capacities, sizes and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing.
   4. Do not use material or equipment for any purpose other than that for which it is specified.
   5. All material and equipment incorporated into the project shall be new.

1.02 MANUFACTURER'S INSTRUCTIONS

A. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including two (2) copies to Engineer. Maintain one (1) set of complete instructions at the job site during installation and until completion.

B. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding. Do not proceed with work without clear instructions.

1.03 TRANSPORTATION AND HANDLING

A. Arrange deliveries of products in accordance with construction schedules, coordinate to avoid conflict with work and conditions at the site.
   1. Deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
   2. Immediately on delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved submittals and that products are properly protected and undamaged.

B. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

1.04 SUBSTITUTIONS AND PRODUCT OPTIONS

A. Contractor's Options:
   1. For products specified only by reference standard, select any product meeting that standard.
   2. For products specified by naming one or more products or manufacturers and "or equal", Contractor must submit a request for substitutions of any product or manufacturer not specifically named in a timely manner so as not to adversely affect the construction schedule.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01614

WIND DESIGN CRITERIA GENERAL SUMMARY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Wind design criteria.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Building code criteria: Design for wind in accordance with 2010 Florida Building Code, local amendments, and errata.
   2. Basic wind speed: 160 miles per hour.
   3. Exposure category: C.
   4. Topographic factor, K_{tz}: 1.0.
      a. Use anchor bolts, bolts, or welded studs for anchors for resisting wind forces. Anchor bolts used to resist wind forces shall have a standard hex bolt head. Do not use anchor bolts fabricated from rod stock with an L or J shape:
         1) Do not use concrete anchors, sleeve anchors, flush shells, chemical anchors, powder actuated fasteners, or other types of anchor unless indicated on the Drawings or accepted in writing by the Engineer.
         2) Wind forces must be resisted by direct bearing on the anchors used to resist wind forces. Do not use connections which use friction to resist wind forces.

1.03 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and wind design calculations where required by Specifications.

B. Calculations shall be signed and stamped by a Civil or Structural Engineer licensed in the state where the work will be installed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01620

STORAGE AND PROTECTION

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Provide secure storage and protection for products to be incorporated into the Work and maintenance and protection for products after installation and until completion of Work.

1.02 STORAGE

A. Store products immediately on delivery and protect until installed in the Work, in accordance with manufacturer's instructions, with seals and labels intact and legible.

B. Exterior Storage
   1. Provide substantial platform, blocking or skids to support fabricated products above ground to prevent soiling or staining.
      a. Cover products, subject to discoloration or deterioration from exposure to the elements, with impervious sheet coverings. Provide adequate ventilation to avoid condensation.
      b. Prevent mixing of refuse or chemically injurious materials or liquids.

C. Arrange storage in a manner to provide easy access for inspection.

1.03 MAINTENANCE OF STORAGE

A. Maintain periodic system of inspection of stored products on scheduled basis to assure that:
   1. State of storage facilities is adequate to provide required conditions.
   2. Required environmental conditions are maintained on continuous basis.
   3. Surfaces of products exposed to elements are not adversely affected. Any weathering of products, coatings and finishes is not acceptable under the requirements of these Contract Documents.

B. Mechanical and electrical equipment which require servicing during long term storage shall have complete manufacturer's instructions for servicing accompanying each item, with notice of enclosed instructions shown on exterior of package.
   1. Equipment shall not be shipped until approved by the Engineer. The intent of this requirement is to reduce on-site storage time prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one (1) month prior to installation without written authorization from the Engineer.
   2. All equipment having moving parts such as gears, electric motors, etc. and/or instruments shall be stored in a temperature and humidity controlled building approved by the Engineer until such time as the equipment is to be installed.
   3. All equipment shall be stored fully lubricated with oil, grease, etc. unless otherwise instructed by the manufacturer.

4. Moving parts shall be rotated a minimum of once weekly to insure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to insure that the equipment does not deteriorate from lack of use.
5. Lubricants shall be changed upon completion of installation and as frequently as required, thereafter during the period between installation and acceptance.
6. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

1.04 PROTECTION AFTER INSTALLATION

A. Provide protection of installed products to prevent damage from subsequent operations. Remove when no longer needed, prior to completion of Work.

B. Control traffic to prevent damage to equipment and surfaces.

C. Provide coverings to protect finished surfaces from damage.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Comply with requirements stated in Conditions of the Contract and in Specifications for administrative procedures in closing out the Work.

1.02 SUBSTANTIAL COMPLETION

A. The Contractor shall submit the following items when the Contractor considers the Work to be substantially complete:
   1. A written notice that the Work, or designated portion thereof, is substantially complete.
   2. A list of items to be completed or corrected.

B. Within a reasonable time after receipt of such notice, the Engineer and Owner shall make an inspection to determine the status of completion.

C. Project record documents and operations and maintenance manuals must be submitted before the project shall be considered substantially complete.

D. If the Engineer determines that the Work is not substantially complete:
   1. The Engineer shall notify the Contractor in writing, stating the reasons.
   2. The Contractor shall remedy the deficiencies in the Work and send a second written notice of substantial completion to the Engineer.
   3. The Engineer shall reinspect the Work.

E. When the Engineer finds that the Work is substantially complete:
   1. He shall prepare and deliver to the Owner a tentative Certificate of Substantial Completion (Manatee County Project Management Form PMD-8) with a tentative list of the items to be completed or corrected before final payment.
   2. The Engineer shall consider any objections made by the Owner as provided in Conditions of the Contract. When the Engineer considers the Work substantially complete, he will execute and deliver to the Owner and the Contractor a definite Certificate of Substantial Completion (Manatee County Project Management Form PMD-8) with a revised tentative list of items to be completed or corrected.

1.03 FINAL INSPECTION

A. When the Contractor considered the Work to be complete, he shall submit written certification stating that:
   1. The Contract Documents have been reviewed.
   2. The Work has been inspected for compliance with Contract Documents.
   3. The Work has been completed in accordance with Contract Documents.
   4. The equipment and systems have been tested in the presence of the Owner's representative and are operational.

5. The Work is completed and ready for final inspection.

B. The Engineer shall make an inspection to verify the status of completion after receipt of such certification.

C. If the Engineer determines that the Work is incomplete or defective:
   1. The Engineer shall promptly notify the Contractor in writing, listing the incomplete or defective Work.
   2. The Contractor shall take immediate steps to remedy the stated deficiencies and send a second written certification to Engineer that the Work is complete.
   3. The Engineer shall reinspect the Work.

D. Upon finding the Work to be acceptable under the Contract Documents, the Engineer shall request the Contractor to make closeout submittals.

E. For each additional inspection beyond a total of three (3) inspections for substantial and final completion due to the incompleteness of the Work, the Contractor shall reimburse the Owner for the Engineer's fees.

1.04 CONTRACTOR'S CLOSEOUT SUBMITTALS TO ENGINEER

A. Project Record Documents (prior to substantial completion).

B. Operation and maintenance manuals (prior to substantial completion).

C. Warranties and Bonds.

D. Evidence of Payment and Release of Liens: In accordance with requirements of General and Supplementary Conditions.

E. Certification letter from Florida Department of Transportation and Manatee County Department of Transportation, as applicable.

F. Certificate of Insurance for Products and Completed Operations.

G. Final Reconciliation, Warranty Period Declaration, and Contractor's Affidavit (Manatee County Project Management Form PMD-9).

1.05 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer.

B. Statement shall reflect all adjustments to the Contract Sum:
   1. The original Contract Sum.
   2. Additions and deductions resulting from:
      a. Previous Change Orders
      b. Unit Prices
      c. Penalties and Bonuses
      d. Deductions for Liquidated Damages
      e. Other Adjustments
   3. Total Contract Sum, as adjusted.
   4. Previous payments.
   5. Sum remaining due.

C. Project Management shall prepare a final Change Order, reflecting approved adjustments to the Contract Sum which were not previously made by Change Orders.

1.06 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment in accordance with procedures and requirements stated in the Conditions of the Contract.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01710

CLEANING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Execute cleaning during progress of the Work and at completion of the Work, as required by the General Conditions.

1.02 DISPOSAL REQUIREMENTS

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

PART 2 PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

A. Execute periodic cleaning to keep the Work, the site and adjacent properties free from accumulation of waste materials, rubbish and wind-blown debris, resulting from construction operations.

B. Provide on-site containers for the collection of waste materials, debris and rubbish.

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

3.02 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.03 FINAL CLEANING

A. Employ skilled workmen for final cleaning.

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

C. Prior to final completion or Owner occupancy, Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces and all work areas to verify that the entire Work is clean.

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Contractor shall maintain at the site for the Owner one (1) record copy of:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Engineer's field orders or written instructions.
   6. Approved shop drawings, working drawings and samples.
   7. Field test records.
   8. Construction photographs.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Store documents and samples in Contractor's field office apart from documents used for construction.
   1. Provide files and racks for storage of documents.
   2. Provide locked cabinet or secure storage space for storage of samples.

B. File documents and samples in accordance with CSI format.

C. Maintain documents in a clean, dry, legible, condition and in good order. Do not use record documents for construction purposes.

D. Make documents and samples available at all times for inspection by the Engineer.

1.03 MARKING DEVICES

A. Provide felt tip marking pens for recording information in the color code designated by the Engineer.

1.04 RECORDING

A. Label each document "PROJECT RECORD" in neat large printed letters.

B. Record information concurrently with construction progress.

C. Do not conceal any work until required information is recorded.

D. Drawings; Legibly mark to record actual construction:
   1. All underground piping with elevations and dimensions. Changes to piping location. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements. Actual installed pipe material, class, etc. Locations of drainage ditches, swales, water lines and force mains shall be shown every 200 feet (measured along the

centerline) or alternate lot lines, whichever is closer. Dimensions at these locations shall indicate distance from centerline of right-of-way to the facility.
2. Field changes of dimension and detail.
3. Changes made by Field Order or by Change Order.
4. Details not on original contract drawings.
5. Equipment and piping relocations.
6. Locations of all valves, fire hydrants, manholes, water and sewer services, water and force main fittings, underdrain cleanouts, catch basins, junction boxes and any other structures located in the right-of-way or easement, shall be located by elevation and by station and offset based on intersection P.I.'s and centerline of right-of-way. For facilities located on private roads, the dimensioning shall be from centerline of paving or another readily visible baseline.
7. Elevations shall be provided for all manhole rim and inverts; junction box rim and inverts; catch basin rim and inverts; and baffle, weir and invert elevations in control structures. Elevations shall also be provided at the PVI's and at every other lot line or 200 feet, whichever is less, of drainage swales and ditches. Bench marks and elevation datum shall be indicated.
8. Slopes for pipes and ditches shall be recalculated, based on actual field measured distances, elevations, pipe sizes, and type shown. Cross section of drainage ditches and swales shall be verified.
9. Centerline of roads shall be tied to right-of-way lines. Elevation of roadway centerline shall be given at PVI's and at all intersections.
10. Record drawings shall show bearings and distances for all right-of-way and easement lines, and property corners.
11. Sidewalks, fences and walls, if installed at the time of initial record drawing submittal, shall be located every 200 feet or alternate lot lines, whichever is closer. Dimensions shall include distance from the right-of-way line and the back of curb and lot line or easement line.
12. Sanitary sewer mainline wyes shall be located from the downstream manhole. These dimensions shall be provided by on-site inspections or televiewing of the sewer following installation.
13. Elevations shall be provided on the top of operating nuts for all water and force main valves.
14. Allowable tolerance shall be ± 6.0 inches for horizontal dimensions. Vertical dimensions such as the difference in elevations between manhole inverts shall have an allowable tolerance of ± 1/8 inch per 50 feet (or part thereof) of horizontal distance up to a maximum tolerance of ± 2 inch.
15. Properly prepared record drawings on mylar, together with two (2) copies, shall be certified by a design professional (Engineer and/or Surveyor registered in the State of Florida), employed by the Contractor, and submitted to the Owner/Engineer.

E. Specifications and Addenda; Legibly mark each Section to record:
1. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed.
2. Changes made by field order or by change order.

F. Shop Drawings (after final review and approval):
1. Five (5) sets of record drawings for each process equipment, piping, electrical system and instrumentation system.

1.05 SUBMITTAL

A. Prior to substantial completion and prior to starting the bacteria testing of water lines, deliver signed and sealed Record Documents and Record Drawings to the Engineer. These will be reviewed and verified by the inspector. If there are any required changes or additions, these shall be completed and the entire signed and sealed set resubmitted prior to final pay application.

B. The Contractor shall employ a Professional Engineer or Surveyor registered in the State of Florida to verify survey data and properly prepare record drawings. Record drawings shall be certified by the professional(s) (Engineer or Surveyor licensed in Florida), as stipulated by the Land Development Ordinance and submitted on signed and dated mylar drawings together with a recordable compact disk (CD-R).

C. The CD-R shall contain media in AutoCad Version 12 or later, or in any other CAD program compatible with AutoCad in DWG or DXF form. All fonts, line types, shape files or other pertinent information used in the drawing and not normally included in AutoCad shall be included on the media with a text file or attached noted as to its relevance and use.

D. Accompany submittal with transmittal letter, containing:
   1. Date.
   2. Project title and number.
   3. Contractor's name and address.
   4. Title and number of each Record Document.
   5. Signature of Contractor or his authorized representative.

   Note: The data required to properly prepare these Record Drawings shall be obtained at the site, at no cost to the County by the responsible design professional or his/her duly appointed representative. The appointed representative shall be a qualified employee of the responsible design professional or a qualified inspector retained by the responsible design professional on a project-by-project basis.

PART 2 STANDARDS

2.01 MINIMUM RECORD DRAWING STANDARDS FOR ALL RECORD DRAWINGS SUBMITTED TO MANATEE COUNTY

A. Record Drawings shall be submitted to at least the level of detail in the contract documents. It is anticipated that the original contract documents shall serve as at least a background for all record information. Original drawings in CAD format may be requested of the Engineer.

B. Drawings shall meet the criteria of paragraph 1.04 D above.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01730

OPERATING AND MAINTENANCE DATA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Compile product data and related information appropriate for Owner's maintenance and operation of products furnished under Contract.

B. Prepare operating and maintenance data as specified in this and as referenced in other pertinent sections of Specifications.

C. Instruct Owner's personnel in maintenance of products and equipment and systems.

D. Provide three (3) sets of operating and maintenance manuals for each piece of equipment provided within this Contract.

1.02 FORM OF SUBMITTALS

A. Prepare data in form of an instructional manual for use by Owner's personnel.

B. Format:
   1. Size: 8-1/2 inch x 11 inch
   2. Paper: 20 pound minimum, white, for typed pages
   3. Text: Manufacturer's printed data or neatly typewritten
   4. Drawings:
      a. Provide reinforced punched binder tab, bind in with text.
      b. Fold larger drawings to size of text pages.
   5. Provide fly-leaf for each separate product or each piece of operating equipment.
      a. Provide typed description of product and major component parts of equipment.
      b. Provide indexed tabs.
   6. Cover: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". List:
      a. Title of Project.
      b. Identity of separate structures as applicable.
      c. Identity of general subject matter covered in the manual.

C. Binders:
   1. Commercial quality three-ring binders with durable and cleanable plastic covers.
   2. Maximum ring size: 1 inch.
   3. When multiple binders are used, correlate the data into related consistent groupings.

1.03 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit three (3) copies of complete manual in final form.

B. Content for each unit of equipment and system, as appropriate:
   1. Description of unit and component parts.
      a. Function, normal operating characteristics and limiting conditions.
      b. Performance curves, engineering data and tests.
      c. Complete nomenclature and commercial number of replaceable parts.
   2. Operating Procedures:
      a. Start-up, break-in, routine and normal operating instructions.
      b. Regulation, control, stopping, shut-down and emergency instructions.
      c. Summer and winter operating instructions.
      d. Special operating instructions.
   3. Maintenance Procedures:
      a. Routine operations.
      b. Guide to "trouble-shooting".
      c. Disassembly, repair and reassembly.
      d. Alignment, adjusting and checking.
   4. Servicing and lubricating schedule.
      a. List of lubricants required.
   5. Manufacturer's printed operating and maintenance instructions.
   6. Description of sequence of operation by control manufacturer.
   7. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
      a. List of predicted parts subject to wear.
      b. Items recommended to be stocked as spare parts.
   8. As installed control diagrams by controls manufacturer.
   9. Each contractor's coordination drawings.
      a. As installed color-coded piping diagrams.
   10. Charts of valve tag numbers, with location and function of each valve.
   11. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.
   12. Other data as required under pertinent sections of specifications.

C. Content, for each electric and electronic system, as appropriate:
   1. Description of system and component parts.
      a. Function, normal operating characteristics and limiting conditions.
      b. Performance curves, engineering data and tests.
      c. Complete nomenclature and commercial number of replaceable parts.
   2. Circuit directories of panelboards.
      a. Electrical service.
      b. Controls.
      c. Communications.
   3. As-installed color-coded wiring diagrams.
   4. Operating procedures:
      a. Routine and normal operating instructions.
      b. Sequences required.
      c. Special operating instructions.
   5. Maintenance procedures:
      a. Routine operations.
      b. Guide to "trouble-shooting".
      c. Disassembly, repair and reassembly.
      d. Adjustment and checking.
   6. Manufacturer's printed operating and maintenance instructions.
   7. List of original manufacture's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.

8. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.

D. Prepare and include additional data when the need for such data becomes apparent during instruction on Owner's personnel.

E. Additional requirements for operating and maintenance data: Respective sections of Specifications.

1.04 SUBMITTAL SCHEDULE

A. Submit one (1) copy of completed data in final form fifteen (15) days prior to substantial completion.
   1. Copy will be returned after substantial completion, with comments (if any).

B. Submit two (2) copies of approved data in final form. Final acceptance will not be provided until the completed manual is received and approved.

1.05 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to final inspection or acceptance, fully instruct Owner's designated operating and maintenance personnel in operation, adjustment and maintenance of products, equipment and systems.

B. Operating and maintenance manual shall constitute the basis of instruction.
   1. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01740

WARRANTIES AND BONDS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Compile specified warranties and bonds.

B. Compile specified service and maintenance contracts.

C. Co-execute submittals when so specified.

D. Review submittals to verify compliance with Contract Documents.

E. Submit to Engineer for review and transmittal to Owner.

1.02 SUBMITTAL REQUIREMENTS

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

B. Number of original signed copies required: Two (2) each.

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

1.03 FORM OF SUBMITTALS

A. Prepare in duplicate packets.

B. Format:
   1. Size 8-1/2 inch x 11 inch punched sheets for standard 3-ring binder. Fold larger sheets to fit into binders.
   2. Cover: Identify each packet with typed or printed title "WARRANTIES AND BONDS". List:
      a. Title of Project.
      b. Name of Contractor.

C. Binders: Commercial quality, three-ring, with durable and cleanable plastic covers.

1.04 TIME OF SUBMITTALS

A. Make submittals within ten (10) days after date of substantial completion and prior to final request for payment.

B. For items of work, where acceptance is delayed materially beyond date of substantial completion, provide updated submittal within ten (10) days after acceptance, listing date of acceptance as start of warranty period.

1.05 SUBMITTALS REQUIRED

A. Submit warranties, bonds, service and maintenance contracts as specified in respective sections of Specifications.

B. Approval by the Owner of all documents required under this section is a pre-requisite to requesting a final inspection and final payment

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01756

TESTING, TRAINING, AND FACILITY START-UP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for equipment and system testing and facility start-up, including the following:
   1. Start-up plan.
   2. Performance testing.
   3. General start-up and testing procedures.
   4. Functional testing.
   5. Operational testing.
   6. Certificate of proper installation.
   7. Services of manufacturer's representatives.
   8. Training of OWNER's personnel.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 15050 - Basic Mechanical Materials and Methods
      b. Section 15958 - Mechanical Equipment Testing.

1.02 GENERAL TESTING, TRAINING, AND START-UP REQUIREMENTS

A. Contract requirements: Testing, training, and start-up are requisite to the satisfactory completion of the Contract.

B. Complete testing, training, and start-up within the Contract Times.

C. Allow realistic durations in the Progress Schedule for testing, training, and start-up activities.

D. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.

E. Provide competent, experienced technical representatives of equipment manufacturers for assembly, installation and testing guidance, and operator training.

1.03 START-UP PLAN

A. Submit start-up plan for each piece of equipment and each system not less than 3 weeks prior to planned initial start-up of equipment or system.

B. Provide detailed sub-network of Progress Schedule with the following activities identified:
   1. Manufacturer's services.
   2. Installation certifications.
   3. Operator training.
   4. Submission of Operation and Maintenance Manual.
   5. Functional testing.
   6. Performance testing.
   7. Operational testing.

C. Provide testing plan with test logs for each item of equipment and each system when specified. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.

D. Provide summary of shutdown requirements for existing systems which are necessary to complete start-up of new equipment and systems.

E. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

1.04 PERFORMANCE TESTING

A. Test equipment for proper performance at point of manufacture or assembly when specified.

B. When source quality control testing is specified:
   1. Demonstrate equipment meets specified performance requirements.
   2. Provide certified copies of test results.
   3. Do not ship equipment until certified copies have received written acceptance from ENGINEER. Written acceptance does not constitute final acceptance.
   4. Perform testing as specified in the equipment sections.

1.05 GENERAL START-UP AND TESTING PROCEDURES

A. Mechanical systems: As specified in the individual equipment Sections and Sections 15050, and 15958:
   1. Remove rust preventatives and oils applied to protect equipment during construction.
   2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.
   3. Flush fuel system and provide fuel for testing and start-up.
   4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
   5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
   6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
   7. Perform cold alignment and hot alignment to manufacturer's tolerances.

8. Adjust V-belt tension and variable pitch sheaves.
9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to insure no leakage, but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.
10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

B. Electrical systems:
1. Perform insulation resistance tests on wiring except 120 volt lighting, wiring, and control wiring inside electrical panels.
2. Perform continuity tests on grounding systems.
3. Test and set switchgear and circuit breaker relays for proper operation.
4. Perform direct current high potential tests on all cables that will operate at more than 2,000 volts. Obtain services of independent testing lab to perform tests.
5. Check motors for actual full load amperage draw. Compare to nameplate value.

C. Instrumentation systems:
1. Bench or field calibrate instruments and make required adjustments and control point settings.
2. Leak test pneumatic controls and instrument air piping.
3. Energize transmitting and control signal systems, verify proper operation, ranges, and settings.

1.06 FUNCTIONAL TESTING

A. Perform checkout and performance testing as specified in the individual equipment Sections.

B. Functionally test mechanical and electrical equipment, and instrumentation and controls systems for proper operation after general start-up and testing tasks have been completed.

C. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.

D. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation, and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.

E. Conduct continuous 8-hour test under full load conditions. Replace parts which operate improperly.

1.07 OPERATIONAL TESTING

A. After completion of operator training, conduct operational test of the entire facility. Demonstrate satisfactory operation of equipment and systems in actual operation.

B. Conduct operational test for continuous 7-day period.

C. OWNER will provide operations personnel, power, fuel, and other consumables for duration of test.

D. Immediately correct defects in material, workmanship, or equipment which became evident during operational test.

E. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified.

1.08 CERTIFICATE OF PROPER INSTALLATION

A. At completion of Functional Testing, furnish written report prepared and signed by manufacturer's authorized representative, certifying equipment:
   1. Has been properly installed, adjusted, aligned, and lubricated.
   2. Is free of any stresses imposed by connecting piping or anchor bolts.
   3. Is suitable for satisfactory full-time operation under full load conditions.
   4. Operates within the allowable limits for vibration.
   5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
   6. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.

B. Furnish written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:
   1. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.
   2. Control logic for equipment start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.
   3. Co-sign the reports along with the manufacturer's representative and subcontractors.

1.09 TRAINING OF OWNER'S PERSONNEL

A. Provide operations and maintenance training for items of mechanical, electrical, and instrumentation equipment. Utilize manufacturer's representatives to conduct training sessions.

B. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more than 2 sessions per week.

C. Provide Operation and Maintenance Manual for specific pieces of equipment or systems 1 month prior to training session for that piece of equipment or system.

D. Satisfactorily complete functional testing before beginning operator training.

E. Training sessions: Provide training sessions for equipment as specified in the individual equipment Sections.

F. The CONTRACTOR shall videotape all training sessions and provide a copy for the OWNER.

G. The CONTRACTOR shall designate and provide 1 or more persons to be responsible for coordinating and expediting his/her training duties. The person or persons so designated shall be present at all training coordination meetings with the OWNER.

H. The CONTRACTOR's coordinator shall coordinate the training periods with OWNER personnel and manufacturer's representatives, and shall submit a training schedule for each piece of equipment or system for which training is to be provided. Such training schedule shall be submitted not less than 21 calendar days prior to the time that the associated training is to be provided and shall be based on the current plan of operation.

1.10 RECORD KEEPING

A. Maintain and submit following records generated during start-up and testing phase of Project:
   1. Daily logs of equipment testing identifying all tests conducted and outcome.
   2. Logs of time spent by manufacturer's representatives performing services on the job site.
   3. Equipment lubrication records.
   4. Electrical phase, voltage, and amperage measurements.
   5. Insulation resistance measurements.
   6. Data sheets of control loop testing including testing and calibration of instrumentation devices and setpoints.

END OF SECTION

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SECTION 02485

SEEDING AND SODDING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials and equipment necessary to satisfactorily return all construction areas to their original conditions or better.

B. Work shall include furnishing and placing seed or sod, fertilizing, planting, watering and maintenance until acceptance by Engineer/Owner.

1.02 RELATED WORK NOT INCLUDED

A. Excavation, filling and grading required to establish elevation shown on the Drawings are included under other sections of these Specifications.

1.03 QUALITY ASSURANCE

A. It is the intent of this Specification that the Contractor is obliged to deliver a satisfactory stand of grass as specified. If necessary, the Contractor shall repeat any or all of the Work, including grading, fertilizing, watering and seeding or sodding at no additional cost to the Owner until a satisfactory stand is obtained. For purposes of grassing, a satisfactory stand of grass is herein defined as a full lawn cover over areas to be sodded or seeded, with grass free of weeds, alive and growing, leaving no bare spots larger than 3/4 square yard within a radius of eight (8) feet.

B. All previously grassed areas where pipelines are laid shall be sodded. All sodding and grassing shall be installed in accordance with these Specifications or as directed by the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fertilizer: The fertilizer shall be of the slow-release type meeting the following minimum requirements: 12 percent nitrogen, 8 percent phosphorus, 8 percent potassium; 40 percent other available materials derived from organic sources. At least 50 percent of the phosphoric acid shall be from normal super phosphate or an equivalent source which will provide a minimum of two units of sulfur. The amount of sulfur shall be indicated on the quantitive analysis card attached to each bag or other container. Fertilizer shall be uniform in composition, dry and free flowing delivered to sites in original unopened containers bearing manufacturer's statement or guarantee.

B. Seeding/Grassing: The Contractor shall grass all unpaved areas disturbed during construction which do not require sod. All grassing shall be completed in conformance with FDOT Specifications, Sections 570 and 981. The grassed areas

shall be mulched and fertilized in accordance with FDOT Specifications, except that no additional payment will be made for mulching, fertilizing and/or watering.

C. Sodding: Sod shall be provided as required on the construction drawings or at locations as directed by the Engineer in accordance with Florida Department of Transportation, Specifications Section 575 and 981. The Contractor shall furnish bahia grass sod or match existing sod. Placement and watering requirements shall be in accordance with FDOT Specifications Section 575, except that no additional payment will be made for placement and/or watering. This cost shall be included in the Contract price bid for sodding.

D. Topsoil: Topsoil stockpiled during excavation may be used as necessary. If additional topsoil is required to replace topsoil removed during construction, it shall be obtained off site at no additional cost to the Owner. Topsoil shall be fertile, natural surface soil, capable of producing all trees, plants and grassing specified herein.

E. Water: It is the Contractor's responsibility to supply all water to the site, as required during seeding and sodding operations and through the maintenance period and until the work is accepted. The Contractor shall make whatever arrangements that may be necessary to ensure an adequate supply of water to meet the needs for his work. He shall also furnish all necessary hose, equipment, attachments and accessories for the adequate irrigation of lawns and planted areas as may be required. Water shall be suitable for irrigation and free from ingredients harmful to plant life.

PART 3 EXECUTION

3.01 INSTALLATION

A. When the trench backfill has stabilized sufficiently, the Contractor shall commence work on lawns and grassed areas, including fine grading as necessary and as directed by the Engineer.

B. Finish Grading: Areas to be seeded or sodded shall be finish graded, raked, and debris removed. Soft spots and uneven grades shall be eliminated. The Engineer shall approve the finish grade of all areas to be seeded or sodded prior to seed or sod application.

C. Protection: Seeded and sodded areas shall be protected against traffic or other use by placing warning signs or erecting barricades as necessary. Any areas damaged prior to acceptance by the Owner shall be repaired by the Contractor as directed by the Engineer.

3.02 CLEANUP

A. Soil or similar materials spilled onto paved areas shall be removed promptly, keeping those areas as clean as possible at all times. Upon completion of seeding and sodding operations, all excess soil, stones and debris remaining shall be removed from the construction areas.

3.03 LANDSCAPE MAINTENANCE

A. Any existing landscape items damaged or altered during construction by the Contractor shall be restored or replaced as directed by the Engineer.

B. Maintain landscape work for a period of 90 days immediately following complete installation of work or until Owner accepts project. Watering, weeding, cultivating, restoration of grade, mowing and trimming, protection from insects and diseases, fertilizing and similar operations as needed to ensure normal growth and good health for live plant material shall be included at no additional cost to the Owner.

3.04 REPAIRS TO LAWN AREAS DISTURBED BY CONTRACTOR'S OPERATORS

A. Lawn areas planted under this Contract and all lawn areas damaged by the Contractor's operation shall be repaired at once by proper soil preparation, fertilizing and sodding, in accordance with these Specifications.

END OF SECTION

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SECTION 02640

VALVES AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.

B. All valves and appurtenances shall be of the size shown on the Drawings and, to the extent possible, all equipment of the same type on the Project shall be from one manufacturer.

C. All valves and appurtenances shall have the name of the manufacturer and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

D. All valves shall have a factory applied, fusion bonded epoxy coating on interior and exterior unless noted otherwise in the plans or this specification.

E. The equipment shall include, but not be limited to, the following:
   1. Pressure Sustaining and Check Valves
   2. Ball Valves for PVC Pipe
   3. Plug Valves
   4. Hose Bibs

1.02 DESCRIPTION OF SYSTEMS

A. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of potable water, reclaim water, wastewater, etc., depending upon the applications.

1.03 QUALIFICATIONS

A. All of the types of valves and appurtenances shall be products of well established, reputable firms who are fully experienced and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed and, installed in accordance with the best practices and methods and shall comply with these Specifications as applicable. Valves shall be as covered under mechanical devices in Section 8 of ANSI/NSF Standard 61.

1.04 SUBMITTALS

A. Submit to the Engineer within 30 days after execution of the contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.

B. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer for approval in accordance with the Specifications.

1.05 TOOLS

A. Special tools, if required for normal operation and maintenance shall be supplied with the equipment.

PART 2 PRODUCTS

2.01 PRESSURE SUSTAINING AND CHECK VALVE

A. Pressure sustaining and check valve shall be pilot operated diaphragm actuated valve with cast iron body, bronze trim, and 125-pound flanged ends. The valve shall be hydraulically operated, diaphragm type globe valve. The main valve shall have a single removable seat and a resilient disc, of rectangular cross section, surrounded on three and a half sides. The stainless steel stem shall be fully guided at both ends by a bearing in the valve cover, and an integral bearing in the valve seat. It shall be sleeved at both ends with delrin. No external packing glands are permitted and there shall be no pistons operating the main valve or any controls. The valve shall be equipped with isolation cocks to service the pilot system while permitting flow if necessary. Main valve and all pilot controls shall be manufactured in the United States of America. Valve shall be single chamber type, with seat cut to 5 degrees taper.

B. Valve shall maintain a minimum (adjustable) upstream pressure to a preset (adjustable) maximum. The pilot system shall consist of two direct acting, adjustable, spring loaded diaphragm valves.

C. Valve shall be cast iron (ASTM A48) with main valve trim of brass (QQB-B-626) and bronze (ASTM B61). The pilot control valves shall be cast brass (ASTM B62) with 303 stainless steel trim. All ferrous surfaces inside and outside shall have a 2-part epoxy coating. Valve shall be similar in all respects to CLA-VAL Company, Model 692G-01ABKG, as manufactured by CLA-VAL Company, , or similar pressure sustaining and check valve as manufactured by Golden Alderson; or approved equal.

2.02 BALL VALVES FOR PVC PIPE

A. Ball valves for PVC pipe shall be of PVC Type 1 with union, socket, threaded or flanged ends as required. Ball valves shall be full port, full flow, all plastic construction, 150 psi rated with teflon seat seals and T-handles. PVC ball valves shall be as manufactured by Celanese Piping Systems, Inc., Wallace and Tiernan, Inc., Plastiline, Inc., or approved equal.

B. All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

2.03 PLUG VALVES

A. All plug valves shall be eccentric plug valves capable of sustaining 150 psi in either direction without leaking.Exception: Single direction plug valves may be used if it is

clearly demonstrated they will never be required to resist pressure in both directions either in service or during pipe line testing.

B. Plug valves shall be tested in accordance with current AWWA Standard C-504-80 Section 5. Each valve shall be performance tested in accordance with paragraph 5.2 and shall be given a leakage test and hydrostatic test as described in paragraphs 5.3 and 5.4. The manufacturer shall furnish certified copies of reports covering proof of design testing as described in Section 5.5.

C. Plug valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connections as shown on the Plans. Flanged valves shall be faced and drilled to the ANSI 150 lb. standard. Mechanical joint ends shall be to the AWWA Standard C111-72. Bell ends shall be to the AWWA Standard C100-55 Class B. Screwed ends shall be to the NPT standard.

D. Plug valve bodies shall be of ASTM A126 Class B Semi-steel, 31,000 psi tensile strength minimum in compliance with AWWA Standard C507-73, Section 5.1 and AWWA Standard C504-70 Section 6.4. Port areas for valves 20-inches and smaller shall be 80 percent of full pipe area. Valves 24 inch and larger shall have a minimum port area between 80 and 100 percent of full nominal pipe area. All exposed nuts, bolts, springs, washers, etc. shall be zinc or cadmium plated. Resilient plug facings shall be of Hycar or Neoprene.

E. Plug valves shall be furnished with permanently lubricated stainless steel or oil-impregnated bronze upper and lower plug stem bushings. These bearings shall comply with current AWWA Standards.

2.04 HOSE BIBS

A. Hose bibs shall be 3/4" or 1" brass, polished chromium plated brass, with vacuum breaker as noted on the drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. All valves and appurtenances shall be installed in the location shown, true to alignment and rigidly supported. Any damage occurring to the above items before they are installed shall be repaired to the satisfaction of the Engineer.

B. After installation, all valves and appurtenances shall be tested at least two hours at the working pressure corresponding to the class of pipe, unless a different test pressure is specified. If any joint proves to be defective, it shall be repaired to the satisfaction of the Engineer.

C. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and he shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.

D. Pipe for use with flexible couplings shall have plain ends as specified in the respective pipe sections.

E. Flanged joints shall be made with high strength, low alloy Corten bolts, nuts and washers. Mechanical joints shall be made with mild corrosion resistant alloy steel bolts and nuts. All exposed bolts shall be painted the same color as the pipe. All buried bolts and nuts shall be heavily coated with two (2) coats of bituminous paint comparable to Inertol No. 66 Special Heavy.

F. Prior to assembly of split couplings, the grooves as well as other parts shall be thoroughly cleaned. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap or graphite paste, and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, the gasket shall be centered properly over the pipe ends with the lips against the pipes. The housing sections then shall be placed. After the bolts have been inserted, the nuts shall be tightened until the housing sections are firmly in contact, metal-to-metal, without excessive bolt tension.

G. Prior to the installation of sleeve-type couplings, the pipe ends shall be cleaned thoroughly for a distance of 8". Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6 inches from the end.

3.02 SHOP PAINTING

A. Ferrous surfaces of valves and appurtenances shall receive a coating of rust-inhibitive primer. All pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation.

3.03 FIELD PAINTING

A. All metal valves and appurtenances specified herein and exposed to view shall be painted.

3.04 INSPECTION AND TESTING

A. Completed pipe shall be subjected to hydrostatic pressure test for two (2) hours at 180 psi. All leaks shall be repaired and lines retested as approved by the Engineer. Prior to testing, the pipelines shall be supported in an approved manner to prevent movement during tests.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Cast-in-place concrete.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete.
   2. ACI Manual of Concrete Practice.

B. American Society for Testing and Materials (ASTM):
   1. C 31 - Practice for Making and Curing Concrete Test Specimens in the Field.
   2. C 33 - Specification for Concrete Aggregates.
   3. C 39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   4. C 40 - Test Method for Organic Impurities in Fine Aggregates for Concrete.
   5. C 42 – Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   6. C 88 - Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   7. C 94 - Specification for Ready-Mixed Concrete.
   8. C 114 - Test Methods for Chemical Analysis of Hydraulic Cement.
   9. C 117 - Test Method for Material Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing.
   10. C 123 - Test Method for Lightweight Particles in Aggregate.
   11. C 131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   12. C 136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   13. C 138 - Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
   14. C 142 - Test Method for Clay Lumps and Friable Particles in Aggregate.
   15. C 143 - Test Method for Slump of Hydraulic Cement Concrete.
   16. C 150 - Specification for Portland Cement.
   17. C 156 - Test Method for Water Retention by Concrete Curing Materials.
   18. C 157 - Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   19. C 171 - Specification for Sheet Materials for Curing Concrete.
   20. C 172 - Practice for Sampling Freshly Mixed Concrete.
   21. C 231 - Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   22. C 260 - Specification for Air-Entraining Admixtures for Concrete.
   23. C 289 - Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).

24. C 295 - Guide for Petrographic Examination of Aggregates for Concrete.
25. C 309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
26. C 311 - Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
27. C 494 - Specification for Chemical Admixtures for Concrete.
28. C 595 - Specification for Blended Hydraulic Cements.
29. C 618 - Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland-Cement Concrete.
30. C 1064 - Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
31. C 1017 - Specification for Chemical Admixtures for use in Producing Flowing Concrete.
32. D 75 - Practices for Sampling Aggregates.

C. NSF International (NSF)
   1. NSF Standard 61 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Alkali: Is defined to mean sum of sodium oxide and potassium oxide calculated as sodium oxide.

B. Hairline Crack: Crack with a crack width of less than 4 thousandths of an inch (0.004 inches).

1.04 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of portland cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.
      b. Proportion materials in a manner that will secure lowest water-cement ratio which is consistent with good workability, plastic, cohesive mixture, and one which is within specified slump range.
      c. Proportion fine and coarse aggregate in manner such as not to produce harshness in placing nor honeycombing in structures.
   2. Watertightness of Concrete Work: It is intent of this Section to secure for every part of the Work concrete and grout of homogeneous structure that, when hardened will have required strength, watertightness, and durability.
      a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.
      b. Construction, control and expansion joints have been positioned in structures as indicated on the Drawings, and curing methods have been specified, to reduce number and size of these expected cracks, due to normal expansion and contraction expected from specified concrete mixes.

c. Class A and Class B Concrete: Watertight: Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
d. Pressure inject visible cracks, other than hairline cracks and crazing, in following areas with epoxy as specified in Section 03931.
1) Floors and walls of water bearing structures.
2) Walls and overhead slabs of passageways or occupied spaces, outsides of which are exposed to weather or may be washed down and are not specified to receive separate waterproof membrane.
3) Other Items Not Specified to Receive Separate Waterproof Membrane: Slabs over water channels, wet wells, reservoirs, and other similar surfaces.
e. Walls or slabs, as specified above, that leak or sweat because of porosity or cracks too small for successful pressure grouting: Seal on water or weather side by coatings of surface sealant system, as specified in this Section.
f. Grouting and Sealing: Continue as specified above until structure is watertight and remains watertight for not less than one year after final acceptance or date of final repair, whichever occurs later in time.

3. Workmanship and Methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318 and ACI Manual of Concrete Practice.

1.05 SUBMITTALS

A. Product Data: Submit data completely describing products.

B. Information on Heating Equipment to Be Used for Cold Weather Concreting: Submit information on type of equipment to be used for heating materials and/or new concrete in process of curing during cold weather.

C. For conditions that promote rapid drying of freshly placed concrete such as low Humidity, high temperature, and wind: Submit corrective measures proposed for use prior to placing concrete.

D. Copies of Tests of Concrete Aggregates: Submit certified copies of commercial laboratory tests not more than 90 days old for samples of each aggregate proposed for use in concrete aggregates.
1. Fine Aggregate:
a. Clay lumps.
b. Reactivity.
c. Shale and chert.
d. Soundness.
e. Color.
f. Decantation.
2. Coarse Aggregate:
a. Clay lumps and friable particles.
b. Reactivity.
c. Shale and chert.
d. Soundness.
e. Abrasion loss.
f. Coal and lignite.

g. Materials finer than 200 sieve.

E. Sieve Analysis: Submit sieve analyses of fine and coarse aggregates being used at least every 3 weeks and at any time there is significant change in grading of materials.

F. Concrete Mixes: Submit full details, including mix design calculations for concrete mixes proposed for use for each class of concrete.
   1. Include information on correction of batching for varying moisture contents of fine aggregate.
   2. Submit source quality test records with mix design submittal.
      a. Include calculations for required average compression strength of concrete (f'_cr) based on source quality test records.

G. If There is Change in Aggregate Source, or Aggregate Quality from Same Source: Submit new set of design mixes covering each class of concrete.

H. Test Batch Test Data:
   1. Submit data for each test cylinder.
   2. Submit data that identifies mix and slump for each test cylinder.

I. Sequence of Concrete Placing: Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements.

J. Curing Compound: Submit complete data on proposed compound.

K. Repair of Defective Concrete: Submit mix design for grout.

L. Acceptance of Method of Concrete Repair: Make no repair until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.

M. If Either Fine or Coarse Aggregate Is Batched from More than One Bin: Submit analyses for each bin, and composite analysis made up from these, using proportions of materials to be used in mix.

N. Cement Mill Tests: Include alkali content, representative of each shipment of cement for verification of compliance with specified requirements.

O. Pozzolan Certificate of Compliance: Identify source of Pozzolan and certify compliance with requirements of ASTM C 618.

P. Admixtures: Manufacturer’s catalog cuts and product data indicating compliance with standards specified.
   1. If air entraining admixture requires test method other than ASTM C 231 to accurately determine air content, make special not of requirements in submittal.

Q. Information on mixing equipment.

R. CONTRACTOR’s report of field quality control testing for slump, temperature, unit weight, and air entrainment. Include designation numbers for associated compressive strength test cylinders with report.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:
   1. Deliver, store, and handle concrete materials in manner as to prevent damage and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.
   3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.

B. Acceptance at Site: Reject material containers or materials showing evidence of water or other damage.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Hot Weather Concreting:
      a. When Ambient Air Temperature Is above 90 Degrees Fahrenheit: Prior to placing concrete, cool forms and reinforcing steel to by water cooling to below 90 degrees Fahrenheit.
      b. Temperature of Concrete Mix at Time of Placement: Keep temperature below 90 degrees Fahrenheit by methods that do not impair quality of concrete.
   2. Cold Weather Concreting:
      a. Concrete placed below ambient air temperature of 45 degrees Fahrenheit and falling or below 40 degrees Fahrenheit: Make provision for heating water.
      b. If materials have been exposed to freezing temperatures to degree that any material is below 35 degrees Fahrenheit: Heat such materials.
      c. Heating Water, Cement, or Aggregate Materials:
         1) Do not heat in excess of 160 degrees Fahrenheit.
      d. Protection of Concrete in Forms:
         1) Protect by means of covering with tarpaulins, or other acceptable covering.
         2) Provide means for circulating warm moist air around forms in manner to maintain temperature of 50 degrees Fahrenheit for at least 5 days.
   3. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Take corrective measures to minimize rapid water loss from concrete.
   4. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature around concrete.

1.08 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in such manner as to complete any single placing operation to construction, contraction, or expansion joint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate:

1. General:
   a. Provide concrete aggregates that are sound, graded as specified, and free of deleterious material in excess of allowable amounts specified.
   b. Test for aggregate gradation in accordance with ASTM D 75 and C 136.
   c. Provide unit weight of fine and coarse aggregate to produce in place concrete with weight of:
      1) Not less than 140 pounds per cubic foot for normal weight concrete.
      2) Not more than 115 pounds per cubic foot for lightweight concrete.
2. Aggregate for Normal Weight Concrete
   a. Fine Aggregate:
      1) Provide fine aggregate conforming to ASTM C 33, except as modified in the following paragraphs.
      2) Deleterious Substances: Not in excess of following percentages by weight.

Item	Test Method	Percent
Shale or Chert	ASTM C 295	1
Clay Lumps	ASTM C 142	1

   b. Coarse Aggregate:
      1) General: Provide coarse aggregate conforming to the requirements of ASTM C 33, except as modified in the following paragraphs.
      2) Weight: Not exceeding 15 percent, for thin or elongated pieces having length greater than 5 times average thickness.
      3) Deleterious Substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

Item	Test Method	Percent
Shale or chert	ASTM C 295	1
Coal and lignite	ASTM C 123	1/4
Clay lumps and friable particles	ASTM C 142	1/4
Materials finer than Number 200 sieve	ASTM C 117	1/2*
* Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.		

      4) Grading:
         a) As specified in ASTM C 33, Size Number 57, unless otherwise specified or authorized in writing by the ENGINEER.
         b) Aggregate for Class CE Concrete for Encasement of Electrical Conduits: Graded as specified in ASTM C 33, Size Number 8.
3. Aggregate for Lightweight Concrete
   a. Fine Aggregate:
      1) Provide fine aggregate conforming to ASTM C330.

b. Coarse Aggregate:
    1) General: Provide coarse aggregate conforming to the requirements of ASTM C330.
    2) Grading: As specified in ASTM C330 for 3/4 inch to No. 4, unless otherwise specified or authorized in writing by the ENGINEER.

B. Portland Cement:
1. General: Conform to specifications and tests for ASTM C 150, Types II or III, Low Alkali, except as specified otherwise.
2. Low Alkali Portland: Have total alkali containing not more than 0.60 percent.
3. Exposed Concrete in Any Individual Structure: Use only one brand of portland cement.
4. Cement for Finishes: Provide cement from same source and of same type as concrete to be finished.

C. Admixtures:
1. General:
    a. Do not use admixtures of any type, except as specified, unless written authorization has been obtained from the ENGINEER.
    b. Admixtures shall be compatible with concrete constituents and with other admixtures. All admixtures in a given mix shall be products of the same manufacturer to ensure compatibility.
    c. Admixtures for concrete that will be in contact with potable water shall be non-toxic and shall not impart taste or odor to the water. Admixtures shall be listed under NSF 61 or carry other approval, that is acceptable to the ENGINEER, for use in contact with potable water
    d. Do not use admixtures containing chlorides calculated as chloride ion in excess of 0.5 percent by weight.
    e. Use in accordance with manufacturer's recommendations and add each admixture to concrete mix separately.
2. Air Entraining Admixture:
    a. Provide entrained air of evenly dispersed air bubbles at time of placement.
    b. Conform to ASTM C 260.
3. Fly Ash Pozzolan Admixture:
    a. Pozzolan:
        1) Conforming to requirements of ASTM C 618, Class F.
        2) Pozzolan may replace portland cement at ratio of 1.0 pound fly ash for each pound of portland cement replaced.
        3) Maximum of 20 percent by weight of minimum quantity of portland cement listed in Table A under paragraph 2.03D may be replaced with pozzolan.
        4) Do not use pozzolan as an admixture in concrete made with portland-pozzolan cement.
    b. Loss on Ignition for Pozzolan: Not exceed four percent.
4. Water Reducing Admixture:
    a. May be used at the CONTRACTOR's option.
    b. Conform to ASTM C 494, Type A.
    c. Not contain air entraining agents.
    d. Liquid form before adding to the concrete mix.
    e. No decrease in cement is permitted as result of use of water reducing admixture.
5. High-Range Water Reducer / Superplasticizer:

a. Conform to ASTM C 494, Type F or ASTM C 1017, Type I. Use shall produce non-segregating plasticized concrete with little bleeding and the physical properties of low water/cement ratio concrete. Admixture shall maintain treated concrete in a plasticized state for not less than 2 hours.

D. Water:
   1. Water for Concrete, Washing Aggregate, and Curing Concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
   2. Chlorides and Sulfate Ions:
      a. Water for Conventional Reinforced Concrete: Use water not containing more than 1,000 (mg/L) of chlorides calculated as chloride ion, nor more than 1,000 (mg/L) of sulfates calculated as sulfate ion.

E. Non-slip Abrasive:
   1. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate, homogenous, non-glazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
   2. Manufacturers: One of the following or equal:
      a. Exolon Company, Tonawanda, New York.
      b. Abrasive Materials, Incorporated, Hillsdale, Michigan.

F. Conduit Encasement Coloring Agent:
   1. Color: Red color concrete used for encasement of electrical ducts, conduits, similar type items.
   2. Manufacturers: One of the following or equal.
      a. Frank D. Davis Company, Red Oxide Number 1117.
      b. I. Reiss Company, Inc., equivalent product.
   3. Conduit Encasement Concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

G. Curing and Finishing Materials
   1. General:
      a. Materials shall be compatible with concrete and with other materials.
      b. Curing and finishing materials for concrete that will be in contact with potable water shall be non-toxic and shall not impart taste or odor to the water. Materials shall be listed under NSF 61 or carry other approval that is acceptable to ENGINEER for use in contact with potable water.
   2. Sprayed Membrane Curing Compound: Clear type with fugitive dye conforming to ASTM C 309, Type 1D.
   3. Evaporation Retardant:
      a. Manufacturers: One of the following or equal:
         1) Master Builders Technologies, Cleveland, Ohio, Confilm.
         2) Eucid Chemical Company, Cleveland, Ohio, Eucobar.
   4. Plastic Membrane Curing: Use polyethylene film conforming to ASTM C 171 unless otherwise noted.
      a. Color: White
      b. Thickness: Minimum 6 mils.
      c. Loss of Moisture: Not exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C 156.

2.02 EQUIPMENT

A. Mixing Concrete:
   1. Mixers may be of stationary plant, paver, or truck mixer type.
   2. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material.
   3. Mixing Equipment:
      a. Capable of combining aggregates, cement, and water within specified time into thoroughly mixed and uniform mass and of discharging mixture without segregation.
      b. Maintain concrete mixing plant and equipment in good working order and operated at loads, speeds, and timing recommended by manufacturer or as specified.
      c. Proportion cement and aggregate by weight.

B. Machine Mixing:
   1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.
   2. If bulk cement is used, weigh it on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
   3. Prevent cement from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
   4. Procedure of mixing cement with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
   5. Retempering of concrete (re-mixing of concrete that has started to take its initial set) will not be permitted.
   6. Discharge entire batch before recharging.
   7. Volume of Mixed Material Per Batch: Not exceed manufacturer's rated capacity of mixer.
   8. Mixers:
      a. Perform mixing in batch mixers of acceptable type.
      b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
      c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing.
         1) Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.

C. Transit-mixed Concrete:
   1. Mix and deliver in accordance with ASTM C 94.
   2. Total Elapsed Time Between Addition of Water at Batch Plant and Discharging Completed Mix: Not to exceed 90 minutes nor 300 revolutions of the mixing drum. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the ENGINEER.
   3. Temperature - Minimum and Maximum Allowable During Mixing and Transporting:
      a. Minimum: 55°F
      b. Maximum: 90°F

4. Equip each truck mixer with device interlocked so as to prevent discharge of concrete from drum before required number of turns and furnish such device that is capable of counting number of revolutions of drum.
5. Continuously revolve drum after it is once started until it has completely discharged its batch.
    a. Do not admit water until drum has started revolving.
    b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The CONTRACTOR will not be entitled to additional compensation because of such increase or decrease.

D. Other Types of Mixers: In case of other types of mixers, mixing shall be as follows:
1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than one cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.03 MIXES

A. Measurements of Materials:
1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the ENGINEER.
2. Furnish apparatus for weighing aggregates and cement that is suitably designed and constructed for this purpose.
3. Accuracy of Weighing Devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within one percent of desired amount of that material.
4. Measuring or Weighing Devices: Subject to review by the ENGINEER, and bear valid seal of the Sealer of Weights and Measures having jurisdiction.
5. Weighing Cement:
    a. Weigh cement separately.
    b. Cement in Unbroken Standard Packages (Sacks): Need not be weighed.
    c. Bulk Cement and Fractional Packages: Weigh such cement.
6. Mixing Water: Measured by volume or by weight.

B. Concrete Proportions and Consistency:
1. Concrete Consistency and Composition:
    a. Provide concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on surface.
    b. Prevent unnecessary or haphazard changes in consistency of concrete.
2. Ratio of Coarse Aggregate to Fine Aggregate: Not less than 1.0 nor more than 2.0 for all concrete Classes, with exception of Class CE.
3. Aggregate:
    a. Obtain aggregate from source that is capable of providing uniform quality, moisture content, and grading during any single day's operation.
4. Concrete Mix Water to Cement Ratio, Minimum Cement Content, and Slump Range: Conform to values specified in Table A in this Section.

5. Concrete Batch Weights: Control and adjust so as to secure maximum yield, and at all times maintain proportions of concrete mix within specified limits.
6. Mixture Modification: If required, by the ENGINEER, modify mixture within limits set forth in this Section.
7. Admixtures: Provide admixtures as specified in this Section.
    a. Air Entraining Admixture
        1) Add agent to batch in portion of mixing water.

C. Concrete Mixes:
1. Proportioning of Concrete Mix: Proportion mixes for required average ~~on~~ compressive strength (f'_cr) as defined in Subparagraph 2.04A2.
2. Mixes:
    a. Adjusting of Water: After acceptance, do not change mixes without acceptance by ENGINEER, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.
    b. Total Water Content of Each Concrete Class: Not exceed those specified in Table A in this Section.
    c. Checking Moisture Content of Fine Aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
3. Change in Mixes: Undertake new trial batch and test program as specified in this Section.

D. Classes of Concrete:
1. Provide concrete classes, referenced herein as Classes A, B, C and CE, and use where specified or indicated on the Drawings.
2. Class A Concrete: Normal weight concrete with minimum weight of 140 pounds per cubic foot. Use Class A concrete at all locations except those where Classes B, C and CE are specified or indicated on the Drawings.
3. Class B Concrete: Normal weight concrete with minimum weight of 140 pounds per cubic foot. Class B concrete may be substituted for Class A concrete, when high-early strength concrete is needed in areas specifically accepted by the ENGINEER and that do not require sulfate resistant concrete.
4. Class C Concrete: Normal weight concrete with minimum weight of 140 pounds per cubic foot. Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
5. Class CE Concrete: Normal weight concrete with minimum unit weight of 140 pounds per cubic foot. Use Class CE for electrical conduit encasements.
6. Class D Concrete: Lightweight concrete with maximum unit weight of 115 pounds per cubic foot. Use Class D for lightweight precast prestressed concrete roof framing including tees, inverted tee beams, rectangular roof beams.

"TABLE A" CONCRETE WITH AIR ENTRAINMENT						
Class	Specified Compressive Strength f'c at 28 Days (pounds per square inch)	Aggregate Type	Ratio of Maximum Net Water to Cementitious Materials	Minimum Cementitious Materials per Cubic Yard of Concrete (by weight - pounds)	Slump Range (Inches)	Entrained Air (Percent)
A (Type II cement)	4,500	Normal weight	0.42	564	2 to 4*	6±1.5
B (Type III cement)	4,500	Normal weight	0.42	564	2 to 4*	6±1.5
C	2,500	Normal weight	0.62	423	3 to 6	5±1
CE	2,500	Normal weight	0.62	564	3 to 6	5±1
D	5,000	Light weight	0.45	658	2 to 4	5±1
* NOTE: Slump for slabs, decks, walks, and beams shall be not more than 3-1/2 inches. Slump for drilled piers shall be 5 inches ±1 inch.						

7. Pumped Concrete: Provide pumped concrete that complies with all requirements of this Section.
8. Do not place concrete with slump outside limits indicated in Table A.
9. Classes:
    a. Classes A, C, and CE Concrete: Make with Type II low alkali cement.
    b. Class B Concrete: Make with Type III low alkali cement.
    c. Class D Concrete: Make with Type II or Type III low alkali cement.

E. Admixtures:
1. Air Entraining Admixture:
    a. Add agent to batch in portion of mixing water.
    b. Batch solution by means of mechanical batcher capable of accurate measurement.

2.04 SOURCE QUALITY CONTROL

A. Tests:
1. Concrete Mixes:
    a. Trial Batches
        1) After concrete mixes have been accepted by ENGINEER, have trial batches of the accepted Class A, Class B, and Class D concrete mix designs prepared by testing laboratory acceptable to the ENGINEER.
        2) Prepare trial batches for each class and slump range required within that class. Use cement and aggregates proposed to be used for the Work.

3) Trial Batches: Provide batches of sufficient quantity to determine slump, workability, consistency, and finishing characteristics, and to provide sufficient test cylinders.
4) Perform test batches and tests required to establish trial batches and acceptability of materials without change in Contract Price.
5) If trial batch tests do not meet specified requirements for slump, strength, workability, consistency, drying shrinkage, and finishing, change concrete mix design proportions and, if necessary, source of aggregate. Make additional trial batches and tests until an acceptable trial batch is produced that meets requirements of this Section.
6) Do not place concrete until the concrete mix design and trial batch have been accepted by ENGINEER.

b. Test Cylinders: Provide cylinders having six-inch diameter by 12-inch length and that are prepared in accordance with ASTM C 31 for tests specified in this Section.
1) Test 8 cylinders from each trial batch for compressive strength in accordance with ASTM C 39.
a) Test 4 cylinders at 7 days and 4 at 28 days.
b) Establish ratio between 7 day and 28 day strength for mix. Seven-day strength may be taken as satisfactory indication of 28-day strength provided effects on concrete of temperature and humidity between 7 day and 28 day are taken into account.
2) Average Compressive Strength of 4 Test Cylinders Tested At 28 Days shall be equal to or greater than required average compressive strength f'cr on which concrete mix design is based.

c. Required Average Compressive Strength:
1) Determine required average compressive strength (f'cr) for selection of concrete proportions for mix design, for each class of concrete, using calculated standard deviation and its corresponding specified compressive strength f'c, in accordance with ACI 318, Part 3, Chapter 5.
2) When test records of at least 30 consecutive tests that span period of not less than 45 calendar days are available, establish standard deviation as described in ACI 318, Part 3, Chapter 5 and modified herein.
3) Provide test records from which to calculate standard deviation that represent materials, quality control procedures, and conditions similar to materials, quality control procedures, and conditions expected to apply to concrete for the Work.
4) Provide changes in materials and proportions within test records that are more restricted than those for the Work.
5) Specified Compressive Strength (f'c) of Concrete Used in Test Records: Within 1,000 pounds per square inch of that specified for the Work.
6) When lacking adequate test records for calculation of standard deviation meeting requirements, determine required average compressive strength f'cr from following Table B.

TABLE B	
Specified Compressive Strength f'_c (pounds per square inch)	**Required Average Compressive Strength f'_cr (pounds per square inch)**
Less than 3,000	f'_c + 1,000
3,000 to 5,000	f'_c + 1,200

2. Pozzolan:
   a. Sampling and Testing:
      1) Sample and test pozzolan in accordance with ASTM C 311.
      2) In Computing Water to Cement Ratio And Cement Content Per Cubic Yard Of Concrete: Consider cement weight to be weight of portland cement plus 100 percent of weight of fly ash.
3. Aggregate:
   a. Testing of concrete aggregate is at CONTRACTOR's expense.
   b. Sieves:
      1) Use sieves with square openings for testing grading of aggregates.
      2) Sieve Analyses: If sieve analyses indicate significant change in materials, the ENGINEER may require that new mix design be submitted and accepted before further placing of concrete.
   c. Sample aggregate in accordance with ASTM D 75 and C 136.
   d. Fine Aggregate:
      1) Provide fine aggregate not containing strong alkali nor organic matter which gives color darker than standard color when tested in accordance with ASTM C 40.
      2) Provide aggregate having soundness complying with requirements of ASTM C 33 when tested in accordance with ASTM C 88.
      3) Provide aggregate complying with reactivity requirements of ASTM C 33 when tested in accordance with ASTM C 289.
   e. Coarse Aggregate:
      1) Soundness when tested in accordance with ASTM C 88: Have loss not greater than 10 percent when tested with sodium sulfate.
      2) Abrasion Loss: Not exceed 45 percent after 500 revolutions when tested in accordance with ASTM C 131.
      3) Reactivity: Not exceed limits specified in Appendix of ASTM C 33 when tested in accordance with ASTM C 289.
   f. Portland Cement:
      1) Determination Alkali Content: Determine by method set forth in ASTM C 114.

PART 3 EXECUTION

3.01 INSTALLATION

A. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, immediately after the concrete has been screeded, coat the surface of the concrete with a liquid evaporation retardant. Apply the evaporation retardant again after each work operation as necessary to prevent drying shrinkage cracks.

Conditions which result in rapid evaporation of moisture may include one or more of the following:

1. Low humidity.
2. Windy conditions.
3. High temperature.

B. Joints and Bonding:

1. As far as practicable construct concrete work as monolith.
2. Locations of contraction, construction, expansion, and other joints are indicated on the Drawings or as specified in this Section.
3. Construction Joints:
    a. Where construction joints are not indicated on the Drawings, provide slabs and walls with construction joints at intervals not greater than 30 feet.
    b. In order to preserve strength and watertightness of structures, make no other joints, except as authorized the ENGINEER.
    c. At construction joints, thoroughly clean concrete of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of heavy sandblasting, and wash surfaces just prior to succeeding concrete placement.
    d. At Horizontal Joints: Immediately prior to resuming concrete placing operations, thoroughly spread bed of grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over horizontal joint surfaces.
4. Keyways in Joints:
    a. Provide keyways in joints as indicated on the Drawings.
    b. Treat lumber keyway material with form release coating, applied in accordance with manufacturer's instructions.
5. Take special care to ensure that concrete is well consolidated around, below, and against waterstops and that waterstops are secured in proper position.
6. Cleaning of Construction Joints:
    a. Wash construction joints free of sawdust, chips, and other debris after forms are built and immediately before concrete or grout placement.
    b. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
    c. Provide cleanout hole at base of each wall and column for inspection and cleaning.
7. Expansion and Construction Joints
    a. Constructed where and as indicated on the Drawings.
    b. Waterstops, Expansion Joint Material, Synthetic Rubber Sealing Compound, and Other Similar Materials: As specified in Section 03150.
8. Repair of Concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first coat surface of set concrete with epoxy bonding agent.

C. Conveying and Placing Concrete:

1. Convey concrete from mixer to place of final deposit by methods that prevent separation or loss of materials.
2. Use chutes and equipment for pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without separation of materials.

3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of any day's placement.

D. Placing Concrete:
1. Place no concrete without prior authorization of the ENGINEER.
2. Do Not Place Concrete Until:
    a. Reinforcement is securely and properly fastened in its correct position and loose form ties at construction joints have been retightened.
    b. Dowels, bucks, sleeves, hangers, pipes, conduits, bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
    c. Forms have been cleaned and oiled as specified.
3. Placement of concrete in which initial set has occurred, or of retempered concrete, will not be permitted.
4. Place no concrete during rainstorms or high velocity winds.
5. Protect concrete placed immediately before rain to prevent water from coming in contact with such concrete or winds causing excessive drying.
6. Keep sufficient protective covering on hand at all times for protection of concrete.
7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested and accepted by the ENGINEER.
8. Notify the ENGINEER in writing of readiness, not just intention, to place concrete in any portion of the work.
    a. Provide this notification in such time in advance of operations as the ENGINEER deems necessary to make final inspection of preparations at location of proposed concrete placing.
    b. Place forms, steel, screeds, anchors, ties, and inserts in place before notification of readiness is given to the ENGINEER.
    c. Depositing Concrete:
        1) Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
        2) Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
        3) Do not drop concrete freely into place from height greater than 5 feet.
        4) Use tremies for placing concrete where drop is over 5 feet.
        5) Commence placement of concrete on slopes, at bottom of slope.
9. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
10. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached.
11. After placement begins, continue without significant interruption. Take precautions to prevent any delay from exceeding 20 minutes.
12. If concrete is to be placed over previously placed concrete and more than 20 minutes have elapsed, then spread layer of grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over surface before placing additional concrete.
13. Placement of Concrete for Slabs, Beams, or Walkways:
    a. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.

b. Allow set time of not less than one hour for shrinkage.

E. Consolidating Concrete:
1. Place concrete with aid of acceptable mechanical vibrators.
2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.
3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
   a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
   b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
   c. Place no concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
5. Take special care to place concrete solidly against forms so as to leave no voids.
6. Take every precaution to make concrete solid, compact, and smooth, and if for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the ENGINEER.

F. Footings and Slabs on Grade:
1. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the ENGINEER.
2. If necessary, sprinkle subgrade with water not less than 6 nor more than 20 hours in advance of placing concrete.
3. If it becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
4. Place no concrete if subgrade is muddy or soft.

G. Loading Concrete:
1. Green Concrete:
   a. No heavy loading of green concrete will be permitted.
   b. Green concrete is defined as concrete with less than 100 percent of the specified strength.
2. No backfill shall be placed against concrete walls until the concrete has reached the specified strength and the connecting slabs and beams have been cast and have reached the specified strength.
3. Use construction methods, sequencing, and allow time for concrete to reach adequate strength to prevent overstress of the concrete structure during construction.

H. Curing Concrete:
1. General:
   a. Cure concrete by methods specified in this Section.
   b. Cure concrete minimum of 7 days at average daily temperature not less than 50ºF. In no case shall temperature of curing concrete drop below 40ºF.
      1) Average daily temperature is calculated by summing hourly measurements of air temperature in the shade at the face of the concrete, and dividing the sum by 24. In calculating sum of the

temperatures recorded, any measurement less than 50ºF shall be recorded as 0ºF and included in the sum.

c. Cure concrete to be painted or cast against adjacent concrete (including construction joints) with water or plastic membrane.
d. Do not use curing compound on concrete surfaces that are to receive paint or upon which any material is to be bonded.
e. Water cure or plastic membrane cure concrete slabs that are specified to be sealed by concrete sealer or to receive grout topping.
f. Cure other concrete by water curing or sprayed curing membrane at the CONTRACTOR's option.
g. Floor slabs may be cured using plastic membrane curing.

2. Water Curing:
   a. Keep surfaces of concrete being water cured (including tops of walls) constantly and visibly moist day and night for period of not less than 7 days.
   b. Each day forms remain in place may count as 1 day of water curing.
   c. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
   d. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
   e. When steel forms are used, leave forms in place minimum 48 hours. Application of water for curing shall commence only after, but within 1 hour of, the time forms are removed.
3. Sprayed Membrane Curing:
   a. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
   b. If more than 1 hour elapses after removal of forms, do not use membrane curing compound, but apply water curing for full curing period.
   c. If surface requires repairing or painting, water cure such concrete surfaces.
   d. Curing Compound:
      1) Do not remove curing compound from concrete in less than 7 days.
      2) Curing compound may be removed only upon written request by the CONTRACTOR and acceptance by the ENGINEER, stating what measures are to be performed to adequately cure structures.
      3) Remove curing compound placed within construction joint silhouette by heavy sandblasting prior to placing any new concrete.
      4) Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound.
      5) Apply compound in at least 2 coats.
      6) Apply each coat in direction 90 degrees to preceding coat.
      7) Apply compound in sufficient quantity so that concrete has uniform appearance and that natural color is effectively and completely concealed at time of spraying.
      8) Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
      9) Thickness and Coverage of Compound: Provide compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
      10) The CONTRACTOR is cautioned that method of applying curing compound specified herein may require more compound than

normally suggested by manufacturer of compound and also more than is customary in the trade.

11) Apply amounts specified herein, regardless of manufacturer's recommendations or customary practice, if curing compound is used in place of water curing.
12) If the CONTRACTOR desires to use curing compound other than specified compound, coat sample areas of concrete wall with proposed compound and also similar adjacent area with specified compound in specified manner for comparison.
    a) If proposed sample is not equal or better, in opinion of the ENGINEER, in all features, proposed substitution will not be allowed.
13) Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

4. Plastic Membrane Curing:
    a. Polyethylene film may be used to cure slabs. Seal joints and edges with small sand berm.
    b. Install plastic membrane as soon as concrete is finished and can be walked on without damage.
    c. Keep concrete moist under plastic membrane.

3.02 CONCRETE FINISHING

A. Edges of Joints:
    1. Provide joints having edges as indicated on the Drawings.
    2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

3.03 FIELD QUALITY CONTROL

A. Testing Laboratory:
    1. OWNER will designate a testing laboratory for compression testing of field-cast concrete cylinders in accordance with ASTM C 39. Laboratory testing expenses will be paid by OWNER.

B. Testing
    1. During progress of construction, sample concrete in accordance with ASTM C 172 and make tests to determine whether concrete produced complies with project specifications.
    2. CONTRACTOR’s personnel to prepare test report including date and location of placement, name(s) of personnel performing tests, concrete batch delivery ticket number, concrete temperature, slump, unit weight, and air content.
    3. CONTRACTOR shall make, protect, and cure cylinders for compression strength testing in accordance with ASTM C 31.
        a. Label cylinders to indicate location of pour and cylinder numbers.
        b. Required number of cylinders for test set: Not less than 4 cylinder specimens, each 6 inches in diameter by 12 inches long. Two cylinders to be tested at 7 days, and two cylinders to be tested at 28 days.
        c. Required number of test sets:

1) Provide at least one test set for each class of concrete placed each day.
2) Provide at least on test set for each half-day's placement of each class of concrete.
3) Provide at least on test set for each 150 cubic yards of each class placed.

4. Additional testing performed by CONTRACTOR's ACI-certified personnel:
   a. Slump test in accordance with ASTM C 143.
      1) Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to do so by the ENGINEER.
   b. Temperature test in accordance with ASTM C 1064.
   c. Test for unit weight in accordance with ASTM C 138.
   d. Test for air content in accordance with ASTM C 231.
      1) If air entraining admixture used requires testing methods other than ASTM C 231 to accurately determine air content, report testing requirements to ENGINEER well in advance of concrete placement.
      2) Test percentage of entrained air at beginning of each placement, when requested by ENGINEER, and as often as necessary to maintain entrained air within specified range.

C. Enforcement of Specification Requirements
   1. Compressive Strength.
      a. Concrete is expected to reach higher compressive strength than that which is indicated in Table A as specified compressive strength f'c.
      b. Strength Level of Concrete: Will be considered acceptable if following conditions are satisfied.
         1) Average of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength f'c.
         2) No individual strength test (average of 2 cylinders) falls below specified compressive strength f'c by more than 500 pounds per square inch.
         3) Whenever one, or both, of 2 conditions stated above is not satisfied, provide additional curing of affected portion followed by cores taken in accordance with ASTM C 42 and ACI 318 and comply with the following requirements:
            a) If additional curing does not bring average of 3 cores taken in affected area to at least specified compressive strength f'c, designate such concrete in affected area as defective.
            b) The ENGINEER may require the CONTRACTOR to strengthen defective concrete by means of additional concrete, additional reinforcing steel, or replacement of defective concrete, all of the CONTRACTOR's expense.
   2. Slump, Temperature, and Air Entrainment.
      a. Do not use concrete that does not meet specification requirements in regards to slump, temperature, or air entrainment, but remove such concrete from project site.

3.04 ADJUSTING

A. Repair of Defective Concrete:
   1. Remove and replace or repair defective work.

2. Correct defective work as specified in this Article.
3. Do not patch, repair, or cover defective work without inspection by the ENGINEER.
4. Provide repairs having strength equal to or greater than specified concrete for areas involved.
    a. Chip out and key imperfections in the work and make them ready for repair.
5. Dry Pack Method:
    a. Dry Pack Method: Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt, and narrow slots cut for repair.
    b. Smooth Holes: Clean and roughen by heavy sandblasting before repair.
6. Mortar Method of Replacement: Use for following:
    a. Holes too wide to dry pack and too shallow for concrete replacement.
    b. Comparatively shallow depressions, large or small, which extend no deeper than reinforcement nearest surface.
7. Concrete Replacement:
    a. Use: When holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.
    b. Method of Repair for Surfaces of Set Concrete to Be Repaired: First coat with epoxy bonding agent.
8. Acceptable Method of Concrete Repair:
    a. Make no repair until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.

END OF SECTION

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SECTION 03926

CONCRETE REPAIR AND REHABILITATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to repair or rehabilitate all existing concrete members and surfaces identified in the Contract Documents.
   2. Repair all damage to new concrete construction as specified herein, except that where such repairs are specified in Section 03300, Cast-in-Place Concrete.

B. Coordination:
   1. Review installation procedures in the following Section and coordinate the installation of items that must be included with the repair and rehabilitation of concrete.

1.02 QUALITY CONTROL

A. Reference Standards: Comply with the applicable provisions and recommen-dations of the following, except as otherwise shown or specified:
   1. ASTM C 109, Test Method for Compressive Strength of Hydraulic Cement Mortars.
   2. ASTM C 157, Test Method for Length Change of Hardened Cement Mortar and Concrete.
   3. ASTM C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
   4. ASTM D 412, Test Methods for Vulcanized and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
   5. ASTM D 624, Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   6. ASTM D 903, Test Method for Peel or Stripping Strength of Adhesive Bonds.
   7. ASTM G 109, Test Method for Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments.

B. Construction Tolerances: Construction tolerances shall be as specified in Section 03300, Cast-in-Place Concrete, except as specified herein and elsewhere in the Contract Documents.

1.03 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Submit manufacturer's product information and recommended placement procedures for all repair materials.

2. Submit Shop Drawings, when requested by ENGINEER, to show all methods for supporting existing structures, pipes, etc., during demolition and repair activities. Comply with the requirements of Section 01340.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver all materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label, and the following information.
      a. Name or title of material.
      b. Manufacturer's stock number and date of manufacture.
      c. Manufacturer's name.

B. Storage of Materials:
   1. Storage only acceptable project materials on project site.
   2. Store in a suitable location approved by ENGINEER. Keep area clean and accessible.
   3. Restrict storage to repair materials and related equipment.
   4. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970.

C. Handling of Materials:
   1. Handle materials carefully to prevent inclusion of foreign materials.
   2. Do not open containers or mix components until necessary preparatory Work has been completed and application Work will start immediately.

PART 2 PRODUCTS

2.01 REPAIR MORTAR

A. Repair mortar shall be a prepackaged cement based product specifically formulated for the repair of concrete surface defects. The repair mortar shall be a one-component, portland cement, fast setting, trowel-grade mortar. The repair mortar shall be enhanced with a penetrating corrosion inhibitor and shall have the following properties:

Physical Property	**Value**	**ASTM Standard**
Compressive Strength (minimum)		
at 1 day	2000 psi	C 109
at 28 days	6000 psi	C 109
Bond Strength (minimum)		
at 28 days	1800 psi	C 882*
* Modified for use with repair mortars.		

B. Where the least dimension of the placement in width or thickness, exceeds 1-inch, the repair mortar shall be extended by addition of aggregate as recommended by the manufacturer.

C. Product and Manufacturer: Provide one of the following:
   1. SikaRepair 222 or SikaRepair 223 , as manufactured by Sika Corporation.
   2. Or equal.

2.02 JOINT REPAIR SYSTEM

A. Joint Repair System: The joint repair system shall consist of two components, an epoxy resin adhesive and hypalon sheeting.
   1. Epoxy Resin Adhesive: Provide a two-component epoxy resin as follows:
      a. Component A shall be a modified epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents and pigments. It shall not contain butyl glycidyl ether.
      b. Component B shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents, pigments and accelerators.
   2. Hypalon Sheeting: Provide Hypalon sheeting as follows:
      a. Hypalon sheeting shall consist of Hypalon rubber. It shall be perforated along the bonding edge to provide a mechanical key. It shall have the ability to be vulcanized with hydrocarbon solvent to permit its adhesion to an epoxy resin adhesive.
      b. The sheeting shall be provided in 12-inch width with a thickness of 40 mils.
      c. The sheeting shall be able to be lapped or seamed by heat or by anaromatic hydrosolvent strip.
      d. The sheeting shall be supplied with a removable center expansion strip.
   3. Product and Manufacturer: Provide one of the following:
      a. Sikadur Combiflex, as manufactured by Sika Corporation.
      b. Or equal.

2.03 EXPOSED REBAR REPAIR/BONDING AGENT

A. Bonding agent shall be a three component epoxy modified cementitious product with an anti-corrosion ingredient.

B. Product and Manufacturer: Provide one of the following:
   1. Sika Armatec 110 EpoCem, as manufactured by Sika Corporation.
   2. Or equal.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which repair Work is to be installed, and notify ENGINEER, in writing, of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.02 GENERAL

A. Surface Preparation:
   1. The entire area to be repaired shall have all laitance, foreign material, and unsound concrete removed by chipping, abrasive blasting or hydroblasting.

Size and effort of equipment shall be limited such that sound concrete is not removed or damaged. The surface shall be further roughened as specified herein. Where non-shrink grout or repair mortar is used, any additional surface preparation steps recommended by the manufacturer shall be performed.

2. Where repair concrete, shotcrete, or cement grout is used, and a bonding agent is not required, or where the repair mortar or non-shrink grout manufacturer recommends a wet or saturated surface, water shall be delivered to the surface continuously for a minimum of four hours. Where large surface areas are to be repaired, fog spray nozzles mounted on stands shall be provided in sufficient numbers such that the entire surface to be repaired is in contact with the fog spray cloud. The concrete shall be prevented from drying until after the repair operation is completed or seven days, whichever is more. Unrepaired surfaces shall be rewetted by water spray on at least a daily basis. Should more than four days elapse without rewetting the unrepaired surfaces, the original saturating procedure shall be repeated. All standing water in areas to be repaired shall be removed prior to placement of repair material. Means to remove excess water from the structure shall be provided.
3. Where the repair material manufacturer recommends the use of an epoxy-bonding agent, the recommendations of both the repair material and bonding agent manufacturers shall be followed.

B. Care shall be taken to fully consolidate the repair material, completely filling all portions of the area to be filled.

C. The repair surface shall be brought into alignment with the adjacent existing surfaces to provide a uniform, even surface. The repair surface shall match adjacent existing surfaces in texture and shall receive any coatings or surface treatments which had been provided for the existing surface.

D. Curing:
   1. Curing of repair mortar shall be according to the manufacturer's recommendations except that the minimum cure period shall be seven days.
   2. Curing of other materials shall be according to Section 03300, Cast-in-Place Concrete.

3.03 TREATMENT OF SURFACE DEFECTS

A. Surface defects are depressions in a concrete surface which do not extend all the way through the member. The depressions can result from the removal of an embedded item, the removal of an intersecting concrete member, physical damage, unrepaired rock pockets created during original placement, or spalls from corroded reinforcing steel or other embeds.

B. Preparation:
   1. All loose, damaged concrete shall be removed by chipping to sound material.
   2. Where existing reinforcing bars are exposed, concrete shall be removed to a minimum of 1-inch all around the bars. If the existing bars are cut through, cracked, or the cross sectional area is reduced by more than 25 percent, the ENGINEER shall be notified immediately.
   3. The perimeter of the damaged area shall be score cut at a right angle to the concrete surface to a minimum depth of 0.5-inch and a maximum depth to not cut any existing reinforcing steel. Existing concrete shall be chipped up to the

score line so that the minimum thickness of repair mortar is 0.5-inch. “Feather Edges” will not be permitted.

C. Repair Material:
   1. Repair of surface defects in members, which are normally in contact with water or soil, or in the interior surfaces of enclosed chambers that contain water shall be made only with repair mortar.
   2. Repair of other surface defects may be by the application of repair mortar, repair concrete, shotcrete, or cement grout, as appropriate.

3.04 PATCHING OF HOLES IN CONCRETE

A. For holes larger than 48-inches, refer to the Drawings for reinforcement details.

3.05 REPAIR OF DETERIORATED CONCRETE

A. This Section pertains to concrete which has been damaged due to corrosion of reinforcing steel, physical damage due to abrasion, and damage due to chemical attack. The only material acceptable for surface repair is repair mortar as specified herein. Where the repaired surface is to be subsequently covered with a PVC liner material, the finishing details shall be coordinated with the requirements of installing the liner material.

B. Surface Preparation:
   1. All loose, broken, softened, and acid contaminated concrete shall be removed by abrasive blasting and chipping down to sound, uncontaminated concrete.
   2. When the removal of deteriorated concrete is completed, CONTRACTOR to notify the ENGINEER, in writing. Two weeks shall be scheduled for the ENGINEER to inspect the surface, perform testing for acid contamination, determine if additional concrete must be removed, and to develop any special repair details that may be required. Should it be determined that additional concrete must be removed to reach sound, uncontaminated material, another two week period shall be scheduled for further evaluation after the end of the additional removal.
   3. Additional surface preparation shall follow the recommendations of the repair mortar manufacturer.
   4. Isolated areas of exposed reinforcing bars shall be treated as required for repair of surface defects. If extensive areas of reinforcement are uncovered after removal of deteriorated concrete, repair methods shall be as determined by the ENGINEER.

C. Repair Mortar Placement:
   1. The procedures recommended by the manufacturer for the mixing and placement of the repair mortar shall be followed.
   2. After the initial mixing of the repair mortar, additional water shall not be added to change the consistency should the mix begin to stiffen.
   3. Apply bonding agent per manufacturer’s recommendations. Do not exceed open time before applying repair mortar. If temperature in area is greater than 95°F, contact manufacturer.
   4. Repair mortar shall be placed to a minimum thickness as recommended by the manufacturer, but not less than 0.50-inch. Where removal of deteriorated concrete results in a repair thickness of less than 0.5-inch to return to original concrete surface location in isolated areas totaling less than ten percent of the

total repair area, additional concrete shall be removed to obtain the 0.5-inch thickness. Where the area with repair thickness of less than 0.5-inch exceeds ten percent of the total repair area, notify the ENGINEER. In any case, repair mortar shall be added so that the minimum cover over existing reinforcing steel is 2-inches. Do not place repair mortar so as to create locally raised areas. Where there is a transition with wall surfaces which are not in need of repair, the repair mortar shall not be feathered at the transition. A score line shall be sawcut to not less than the minimum repair mortar depth and concrete chipped out to it to form the transition. Care shall be taken to not cut or otherwise damage any reinforcing steel.

5. The repair mortar shall be placed to an even, uniform plane to restore the member to its original surface. Tolerance for being out of plane shall be such that the gap between a 12-inch straight edge and the repair mortar surface does not exceed 0.125-inch and the gap between a 48-inch straight edge and the repair mortar surface does not exceed 0.25-inch. This shall apply to straight edges placed in any orientation at any location.

D. Finishing:
   1. The repair mortar shall receive a smooth, steel trowel finish.
   2. When completed, there shall be no sharp edges. All exterior corners, such as at penetrations, shall be made with a 1-inch radius. All interior corners shall be square except corners to receive PVC lining shall be made with a 2-inch repair mortar fillet.

E. Curing:
   1. Curing shall be performed as recommended by the repair mortar manufacturer, except that the cure period shall be at least 24 hours and shall be by means of a continuous fog spray. If the manufacturer recommends the use of a curing compound, no material shall be used that would interfere with the bond of the protective coating system or adhesive used for placing PVC lining, where required.

3.06 TREATMENT OF EXPANSION JOINT REPAIR

A. Surfaces to be repaired shall have all laitance, foreign material, and unsound concrete removed by chipping, abrasive blasting or hydroblasting.

B. Follow all other surface preparation and application specifications as recommended by manufacturer.

3.07 EXPOSED REBAR REPAIR

A. The entire area to be repaired shall have all corrosion, foreign materials, and unsound concrete by means of abrasive blasting or hydroblasting.

B. Surface shall be visually dry before application of the corrosion inhibitor. The corrosion inhibitor shall be placed liberally to achieve 100 sq ft/gal coverage in two or more coats by allowing it to soak into the substrate. The re-coat time between coats shall be a minimum of one hour. Apply by use of rollers, brushes, or hand-pressure spray equipment.

C. After the last coat of the corrosion inhibitor is applied, a minimum curing time of 24 hours is required.

D. For mortar coating, refer to Paragraph 3.05.C, Repair Mortar Placement, Paragraph 3.05.D, Finishing, and Paragraph 3.05.E, Curing.

3.08 FIELD QUALITY CONTROL

A. CONTRACTOR shall employ a testing laboratory to perform field quality control testing.

B. ENGINEER will direct the CONTRACTOR on the number of standard compression tests and specimens required as specified below, under the direct inspection by ENGINEER.

C. CONTRACTOR shall furnish all necessary assistance required by ENGINEER. Provide all labor, material and equipment required including rods, molds, thermometer, curing in a heated storage box, and all other incidentals required. Above will be subject to approval by ENGINEER. Furnish all necessary storage, curing, and transportation required by the testing.

D. Repair Concrete: Repair concrete shall be tested as required in Section 03300, Cast-in-Place Concrete.

END OF SECTION

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SECTION 03931

EPOXY INJECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Epoxy injection system.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 638 - Standard Test Method for Tensile Properties of Plastics.
   2. D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.
   3. D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.03 SUBMITTALS

A. Product data: Submit manufacturer's data completely describing epoxy injection system materials.

B. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers: One of the following or equal:
   1. BASF, MBT, Concresive Standard LVI.
   2. Sika Chemical Corp., Sikadur 35, Hi-Mod LV.

B. Epoxy:
   1. Provide epoxy materials that are new and use them within shelf-life limitations set forth by manufacturer.
   2. Water-insensitive 2-part type low viscosity epoxy adhesive material containing 100 percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified:

Physical Characteristic	Test Method	Required Results
Tensile Strength	ASTM D 638	8,000 pounds per square inch at 14 days.
Flexure Strength	ASTM D 790	11,000 pounds per square inch at 14 days.
Compressive Strength	ASTM D 695	11,000 pounds per square inch at 24 hours.
Bond Strength	--	Concrete shall fail before failure of epoxy.
Gel Time for 5 Mil Film	--	4 hours maximum.
Elongation	ASTM D 638	1 percent minimum at 14 days.

2.02 EQUIPMENT

A. Pump unit:
   1. Furnish unit to be used for injection that is positive displacement type with interlock to provide in-line mixing and metering system for 2 component epoxy.
   2. Furnish pressure hoses and injection nozzle of such design as to allow proper mixing of 2 components of epoxy.
   3. Presence of standby injection unit may be required.

2.03 MIXES

A. Epoxy injection system materials:
   1. Mix epoxy in accordance with manufacturer's installation instructions.
   2. Do not use solvents to thin epoxy system materials introduced into cracks or joints.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Epoxy injection system:
      a. General: Before processing, sweep or clean area in vicinity of crack location to receive epoxy and leave in generally clean condition.
      b. Joints to receive epoxy: Clean in manner such that joints are free from dirt, laitance, and other loose matter.

3.02 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Perform and conduct work of this Section in neat, orderly manner.

C. Epoxy injection system:
   1. Apply adequate surface seal to crack or joint to prevent escape of epoxy.
   2. Establish entry points at distance along seal not less than thickness of cracked member.
   3. Force epoxy into crack at first port with sufficient pressure to advance epoxy to adjacent port.

4. Seal original port and shift entry to port at which epoxy appears.
5. Continue this manner of port-to-port injection until each joint has been injected for its entire length.
6. For small amounts, or where excessive grout pressure developed by pump unit might further damage structure, premixed material and hand caulking gun may be used if acceptable to the ENGINEER.
7. Seal ports, including adjacent locations where epoxy seepage occurs, as necessary to prevent drips or run out.
8. After epoxy injection is complete, remove surface seal material and refinish concrete in area where epoxy was injected to match existing concrete.

END OF SECTION

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SECTION 09960

HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Field applied coatings.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. D 4262-83 - Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
   2. D 4263-83 - Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   3. D4285-83 - Test Method for Indicating Oil or Water in Compressed Air.
   4. D4541-93 - Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers.

B. NACE International, The Corrosion Society (NACE):
   1. RPO188-99 - Discontinuity (Holiday) Testing of Protective Coatings.

C. National Association of Pipe Fabricators (NAPF):
   1. NAPF 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.

D. NSF International (NSF):
   1. NSF 61 - Drinking Water System Components - Health Effects.

E. SSPC – Society for Protective Coatings:
   1. SSPC SP1 - Solvent Cleaning.
   2. SSPC SP2 - Hand Tool Cleaning.
   3. SSPC SP3 - Power Tool Cleaning.
   4. SSPC SP5 - White Metal Blast Cleaning.
   5. SSPC SP6 - Commercial Blast Cleaning.
   6. SSPC SP7 - Brush-Off Blast Cleaning.
   7. SSPC SP10 - Near-White Blast Cleaning.
   8. SSPC SP 11 - Power Tool Cleaning to Bare Metal.
   9. SSPC-SP 12 - High- and Ultrahigh-Pressure Water Jetting.

F. Underwriters' Laboratory (UL):
   1. UL 3P83 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Submerged Metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.

B. Submerged Concrete and Masonry Surfaces: Surfaces which are or will be:
   1. Underwater.
   2. In structures which normally contain water.
   3. Below tops of walls of water containing structures.

C. Exposed Surface: Any metal or concrete surface, indoors or outdoors that is exposed to view.

D. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils.

E. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.

F. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.

G. Where SSPC surface preparation standards are specified or implied for ductile iron pipe or fittings, the equivalent NAPF surface preparation standard shall be substituted for the SSPC standard.

1.04 PERFORMANCE REQUIREMENTS

A. Coating materials for concrete and metal surfaces shall be especially adapted for use in wastewater treatment plants.

B. Coating for final coats shall be fume resistant, compounded with pigment suitable for exposure to sewage gases, especially to hydrogen sulfide and to carbon dioxide.

C. Pigments shall be materials that do not darken, discolor, or fade due to action of sewage gases.

1.05 SUBMITTALS

A. Shop Drawings: Include schedule of where and for what use coating materials are proposed in accordance with requirements for Product Data.

B. Product Data: Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips.
   1. Regulatory Requirements: Submit data concerning the following:
      a. Volatile organic compound limitations.
      b. Coatings containing lead compounds and PCBs.
      c. Abrasives and abrasive blast cleaning techniques, and disposal.

C. Samples: Include 8-inch square drawdowns or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.

D. Certificates: Submit in accordance with requirements for Product Data.

E. Manufacturer's Instructions: Include the following:
   1. Special requirements for transportation and storage.

2. Mixing instructions.
3. Shelf life.
4. Pot life of material.
5. Precautions for applications free of defects.
6. Surface preparation.
7. Method of application.
8. Recommended number of coats.
9. Recommended dry film thickness (DFT) of each coat.
10. Recommended total dry film thickness (DFT).
11. Drying time of each coat, including prime coat.
12. Required prime coat.
13. Compatible and non-compatible prime coats.
14. Recommended thinners, when recommended.
15. Limits of ambient conditions during and after application.
16. Time allowed between coats (minimum and maximum).
17. Required protection from sun, wind and other conditions.
18. Touch-up requirements and limitations.

F. Manufacturer's Representative's Field Reports.

G. Operations and Maintenance Data:
1. Reports on visits to project site to view and approve surface preparation of structures to be coated.
2. Reports on visits to project site to observe and approve coating application procedures.
3. Reports on visits to coating plants to observe and approve surface preparation and coating application on items that are "shop coated."

H. Quality Assurance Submittals:
1. Quality Assurance plan.
2. Qualifications of coating applicator including List of Similar Projects.

I. Warranty
1. Warrant free of defects in material and workmanship for 3 years from the date of acceptance or date of first beneficial use by the OWNER.

1.06 QUALITY ASSURANCE

A. Applicator Qualifications:
1. Minimum of 5 years experience applying specified type or types of coatings under conditions similar to those of the Work.
   a. Provide qualifications of applicator and references listing five similar projects completed in the past two years.
2. Manufacturer approved applicator when manufacturer has approved applicator program.
3. Approved and licensed by polymorphic polyester resin manufacturer to apply polymorphic polyester resin coating system.
4. Approved and licensed by elastomeric polyurethane (100 percent solids) manufacturer to apply 100 percent solids elastomeric polyurethane system.
5. Applicator of off-site application of coal tar epoxy shall have successfully applied coal tar epoxy on similar surfaces in material, size, and complexity as on the Project.

B. Regulatory Requirements: Comply with governing agencies regulations by using coatings that do not exceed permissible volatile organic compound limits and do not contain lead.

C. Certification: Certify that applicable pigments are resistant to discoloration or deterioration when exposed to hydrogen sulfide and other sewage gases and product data fails to designate coating as "fume resistant."

D. Field Samples: Prepare and coat an area between corners or limits such as control or construction joints of each system. Approved field sample may be part of Work.

E. Compatibility of Coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

F. Services of Coating Manufacturers Representative: Make periodic visits to the project site to provide consultation and inspection services during surface preparation and application of coatings, and to make visits to coating plants to observe and approve surface preparation procedures and coating application of items to be “shop primed and coated”.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturers recommendations.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.

D. Store coatings in well-ventilated facility that provides protection form the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

1.08 PROJECT CONDITIONS

A. Surface Moisture Contents: Do not coat surfaces that exceed manufacturer specified moisture contents, or when not specified by the manufacturer, the following moisture contents:
   1. Masonry, Concrete and Concrete Block: 12 percent.

B. Do Not Apply Coatings:
   1. Under dusty conditions, unless tenting, covers, or other such protection is provided for structures to be coated.
   2. When light on surfaces measures less than 15 foot-candles.
   3. When ambient or surface temperature is less than 50 degrees Fahrenheit unless manufacturer allows a lower temperature.
   4. When relative humidity is higher than 85 percent.
   5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
   6. When surface temperature exceeds the manufacturer's recommendation.

7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
8. Apply clear finishes at minimum 65 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Special Coatings: One of the following or equal:
   1. Ameron: Ameron International, Brea, CA.
   2. Carboline: Carboline, St. Louis, MO.
   3. Devoe: Devoe Coatings, Louisville, KY.
   4. Dudick: Dudick, Inc., Streetsboro, OH.
   5. Sanchem: Sanchem, Chicago, IL.
   6. S-W: Sherwin-Williams Co., Cleveland, OH.
   7. Tnemec: Tnemec Co., Kansas City, MO.

B. Paints, Exterior Exposure: One of the following or equal:
   1. Modified Waterborne Acrylate: One of following or equal:
      a. Tnemec: Enviro-Crete.

2.02 PREPARATION AND PRETREATMENT MATERIALS

A. Metal Pretreatment: As manufactured by one of the following or equal:
   1. Ameron: Galvaprep.
   2. International: Galvaprep 5 or Alumiprep 33.
   3. S-W: P60G2, Wash Primer.
   4. Tnemec: Series N69 Hi-Build Epoxoline II

B. Surface Cleaner and Degreaser: As manufactured by one of the following or equal:
   1. Carboline Surface Cleaner No.3.
   2. Devoe: Devprep 88.
   3. S-W: Clean and Etch.

2.03 COATING MATERIALS

A. Waterborne acrylic emulsion: As manufactured by one of the following or equal:
   1. S-W: DTM Acrylic B66W1.
   2. Tnemec: Tneme-Cryl Series 6.

2.04 MIXES

A. Mix epoxy parts in accordance with manufacturer's instructions.

PART 3 EXECUTION

3.01 GENERAL PROTECTION

A. Protect adjacent surfaces from coatings and damage. Repair damage resulting from inadequate or unsuitable protection:

B. Protect adjacent surfaces not to be coated from spatter and droppings with drop cloths and other coverings.
   1. Mask off surfaces of items not to be coated or remove items from area.

C. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being coated and in particular, surfaces within storage and preparation area.

D. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.

E. Remove electrical plates, surface hardware, fittings and fastenings, prior to application of coating operations. Carefully store, clean and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

3.02 GENERAL PREPARATION

A. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements are specified in this Specification.

B. Protect following surfaces from abrasive blasting by masking, or other means:
   1. Threaded portions of valve and gate stems.
   2. Machined surfaces for sliding contact.
   3. Surfaces to be assembled against gaskets.
   4. Surfaces of shafting on which sprockets are to fit.
   5. Surfaces of shafting on which bearings are to fit.
   6. Machined surfaces of bronze trim, including those slide gates.
   7. Cadmium-plated items except cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment requiring abrasive blasting.
   8. Galvanized items, unless scheduled to be coated.

C. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.

D. PVC and FRP Surfaces:
   1. Prepare surfaces to be coated by light sanding and wipe-down with clean cloths, or by solvent cleaning in strict accordance with coating manufacturer's instructions.

E. Cleaning of Previously Coated Surfaces:
   1. Utilize cleaning agent to remove soluble salts such as chlorides and sulfates from concrete and metal surfaces.
      a. Cleaning Agent: Biodegradable non-flammable and containing no volatile organic compounds.
      b. Manufacturer: Chlor-Rid International, Inc., or accepted equal.
   2. Cleaning of surfaces utilizing the decontamination cleaning agent may be accomplished in conjunction with abrasive blast cleaning, high pressure, washing, or hand washing as approved by the coating manufacturer's representative and the ENGINEER.
   3. Test cleaned surfaces in accordance with the cleaning agent manufacturer's instructions to ensure all soluble salts have been removed. Additional cleaning shall be carried out as necessary.

4. Final surface preparation prior to application of new coating system shall be made in strict accordance with coating manufacturer's printed instructions

3.03 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Remove grilles, covers and access panels for mechanical and electrical system from location and coat separately.

B. Finish coat primed equipment with color selected by the ENGINEER.

C. Prime and coat insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with prefinished coating.

D. Replace identification markings on mechanical or electrical equipment when coated over or spattered.

E. Coat interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line.

F. Coat exposed conduit and electrical equipment occurring in finished areas with color and texture to match adjacent surfaces.

G. Coat both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them

H. Color code equipment, piping, conduit and exposed ductwork and apply color banding and identification, such as flow arrows, naming and numbering, in accordance with DIVISIONS 15 and 16.

3.04 GENERAL APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer's instructions.

B. Coat metal unless specified otherwise.
1. Aboveground piping to be coated shall be empty of contents during application of coatings.

C. Verify metal surface preparation immediately before applying coating in accordance with SSPC Pictorial Surface Preparation Standard.

D. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

E. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.

F. Prime shop primed metal surfaces. Spot prime exposed metal of shop primed surfaces before applying primer over entire surface.

G. Apply minimum number of specified coats.

H. Apply coats to thicknesses specified, especially at edges and corners.

I. Apply additional coats when necessary to achieve specified thicknesses.

J. Coat surfaces without drops, ridges, waves, holidays, laps, or brush marks.

K. Remove spatter and droppings after completion of coating.

L. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.

M. Dust coatings between coats. Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.

N. Apply coating by brush, roller, trowel, or spray, unless particular method of application is required by coating manufacturer's instructions or these Specifications.

O. Spray Application:
   1. Stripe coat edges by brush before beginning spray application, as necessary, to ensure specified coating thickness along edges.
   2. When using spray application, apply coating to thickness not greater than that recommended in coating manufacturer's instructions for brush coat application.
   3. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
   4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist or spray.

P. Drying and Recoating:
   1. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
   2. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
   3. Do not allow excessive drying time or exposure which may impair bond between coats.
   4. Recoat epoxies within time limits recommended by coating manufacturer.
   5. When time limits are exceeded, abrasive blast clean prior to applying another coat.
   6. When limitation on time between abrasive blasting and coating cannot be met before attachment of components to surfaces which cannot be abrasive blasted, coat components before attachment.
   7. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
   8. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
   9. Leave no holidays.
   10. Sand and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to naked eye.

3.05 WATERBORNE ACRYLIC EMULSION

A. Preparation:
   1. Remove all oil, grease, dirt, and other foreign material by Solvent Cleaning in accordance with SSPC SP-1.
   2. Lightly sand all surfaces and wipe thoroughly with clean cotton cloths before applying coating.

B. Application:
   Apply 2 or more coats to obtain a minimum dry film thickness (DFT) of 5.0 mils.

3.06 FIELD QUALITY CONTROL

A. Each coat will be inspected. Strip and remove defective coats, prepare surfaces and recoat. When approved, apply next coat.

B. Control and check dry film thicknesses and integrity of coatings.

C. Measure dry film thickness with calibrated thickness gauge.

D. Dry film thicknesses on ferrous-based substrates may be checked with Elcometer Type 1 Magnetic Pull-off gage or Positector 6000.

E. Verify coat integrity with low-voltage holiday detector. Allow ENGINEER to use detector for additional checking.

F. Check wet film thickness before coal tar epoxy coating cures on concrete or non-ferrous metal substrates.

G. Arrange for services of coating manufacturer's field representative to provide periodic field consultation and inspection services to ensure proper surface preparation of facilities and items to be coated, and to ensure proper application and curing.
   1. Notify ENGINEER 24 hours in advance of each visit by coating manufacturer's representative.
   2. Provide ENGINEER with a written report by coating manufacturer's representative within 48 hours following each visit.

3.07 SCHEDULE OF ITEMS NOT REQUIRING COATING

A. General: Unless specified otherwise, the following items do not require coating.
   1. Items that have received final coat at factory and not listed to receive coating in field.
   2. Aluminum (except where in contact with concrete), brass, bronze, copper, plastic, rubber, stainless steel, chrome, everdur, or lead.
   3. Buried or encased piping or conduit.
   4. Exterior Concrete.
   5. Galvanized roof decking, electrical conduits, pipe trays, cable trays, and other items.
      a. Areas on galvanized items or parts where galvanizing has been damaged during handling or construction shall be repaired as follows:

1) Clean damaged areas by SSPC SP-1, SP-2, SP-3, or SP-7 as required.
2) Apply two coats of a cold galvanizing zinc compound such as ZRC World Wide Inovatie Zinc Technologies of Mansfield, MA or accepted equal, in strict accordance with manufacturer's instructions.

6. Grease fittings.
7. Steel to be encased in concrete or masonry.

3.08 SCHEDULE OF SURFACES TO BE COATED IN THE FIELD

A. In general, apply coatings to steel, iron, galvanized surfaces, and wood surfaces unless specified or otherwise indicated on the Drawings. Coat concrete surfaces and anodized aluminum only when specified or indicated on the Drawings.

B. Following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Verify questionable surfaces.

C. Fiberglass and PVC pipe surfaces:
1. Waterborne acrylic emulsion.
a. PVC piping exposed to view.

END OF SECTION

SECTION 09984

COATINGS FOR CONCRETE SUBJECT TO HYDROGEN SULFIDE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Trowel-on aggregate filled chemical resistant coatings for concrete subject to hydrogen sulfide and acid attack from microbiological sources.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. C 307 - Test Method for Tensile Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.
   2. C 308 - Test Methods for Working and Setting Times of Chemical Resistant Resin Mortars.
   3. C 413 - Test Method for Absorption of Chemical-Resistant, Mortars, Grouts, and Monolithic Surfacing.
   4. C 579 - Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing.
   5. C 580 - Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
   6. D 4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gauges.
   7. D 4541 - Test method for pull off strength of coatings using portable adhesion testers.
   8. D 4787 - Standard Practice for continuity verification of liquid or sheet linings applied to concrete substrates.
   9. E 96 - Standard test methods for water vapor transmission of materials.

1.03 SUBMITTALS

A. Product Data.

B. Manufacturer's Instructions.

C. Manufacturer's Field Reports.

D. Warranties.

E. Qualifications of the coating applicator.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Qualified by manufacturer to apply:
   1. Coating applicators shall have a minimum of three (3) years experience in applying one of the specified coatings in the wastewater industry. The coating

applicator shall submit a successful “Performance History” for the application of the specified coating in the wastewater industry for the previous three (3) years. The Performance History shall have a minimum of three (3) references completed on the form. The Performance History shall be submitted to the OWNER after the bid opening for approval and verification. The coating applicator shall submit this Performance History on the form labeled “Performance history,” which is attached to these Specifications.

2. The coating applicator shall submit certification from the manufacturer of the specified product, stating that the applicator is certified to apply the coating specified herein.
3. The coating applicator shall submit a minimum of three (3) reference letters relating to the quality of workmanship performed on other wastewater projects for the specified coating.
4. Apply compatible underlayment and coating materials manufactured by same manufacturer.
5. Underlayment and coating materials shall be factory manufactured only. Jobsite manufactured or formulated products shall not be acceptable.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading: In accordance with Section 01600.

1.06 PROJECT OR SITE CONDITIONS

A. Environmental Requirements:
   1. Handle and Use Coatings at temperatures between 65 and 80 degrees Fahrenheit. At colder temperatures to 50 degrees Fahrenheit, expect longer curing times. At warmer temperatures to 90 degrees Fahrenheit, expect shorter working time.
   2. Avoid application under direct sunlight and rising surface temperatures to prevent blistering.
   3. Shade concrete for minimum 24 hours before applying coatings.

1.07 WARRANTY

A. Warrant to replace defective materials with new and correct defective workmanship for minimum 2 years.

PART 2 PRODUCTS

2.01 CHEMICAL RESISTANT COATINGS

A. Manufacturers: One of the following or equal:
   1. SewerGard 210 Saureisen, Pittsburgh, PA.
   2. Raven 405 Epoxy Lining, Raven Lining Systems, Tulsa, OK.

B. Characteristics: As follows:

Properties	Test	Results of Test
Absorption	ASTM C 413	Less than 0.03 percent
Application Time, Working Time at 70 degrees F.	ASTM C 308 modified	40 to 50 minutes
Application Time, Initial Set at 70 degrees F	ASTM C 308 modified	17 hours
Bond Strength to Dry or Damp Concrete Manhole	ASTM D 4541	Concrete failed
Compressive Strength	ASTM C 579	7,300 psi
Flexural Strength	ASTM C 580	4,900 psi
Modulus of Elasticity	ASTM C 580	2.75×10^{5} psi
Tensile Strength	ASTM C 307	2,000 psi
Thermal Expansion Coefficient		3.5×10^{-5} in/in/degree F
Permeance	ASTM E 96 Method A	6.88×10^{-9} perms

2.02 UNDERLAYMENTS

A. Manufacturers: One of the following or equal:
   1. Sauereisen, Pittsburgh, PA; F-120 Trowelable, F-120, Castable, and No. 209 Filler.

B. Characteristics: As follows for trowelable grade:

Properties	Results
Color	Tan
Compressive Strength at 5 Hours	1,000 psi
Compressive Strength at 24 Hours	3,000 psi
Density	135 pcf

2.03 MIXES

A. Trowelable Underlayment:
   1. Mix underlayment powder with potable water in clean mortar mixers.
   2. Mix ratio of 9:1 powder to 1 part clean and potable water by weight.
   3. Pour entire amount of potable water into mixing container and add powder slowly. Mix continuously to reduce potential for entrapped air. Mix slowly and thoroughly for minimum 10 minutes until achieving uniform consistency. Do not add more water.

B. Castable Underlayment: As recommended by manufacturer.

C. Filler Underlayment:
   1. Add contents of hardener to liquid and mix with slow speed paddle or Jiffy mixer for 1 minute until thoroughly blended.
   2. Add powder gradually while mixing with same slow speed mixer to obtain uniform consistency.

D. Coating:
   1. Thoroughly remix coating liquid by hand.
   2. Shake hardener thoroughly before opening.
   3. Pour liquid into clean, dry mixing containers.
   4. Add hardener and mix thoroughly for at least one minute using slow-speed drill with 5 inch Jiffy mixer.
   5. Add powder gradually while mixing with same slow-speed, paddle type or drill motor mixer to obtain uniform consistency.
   6. Discard mixture that has begun to set.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are free of dust, loose particles, oils, grease, chemical contaminants and previously applied paints or protective coatings.

3.02 PREPARATION

A. Chemically clean or scarify surfaces to remove conventional curing compounds and form oils or grease before abrasive blasting or hydro blasting.

B. Abrasive blast or hydro blast surfaces until surface has uniform texture resembling coarse sandpaper with exposed fine aggregate. The time between blasting and coating application shall not exceed two hours without re-blasting.

C. Remove foreign particles and attacked or unsound mortar from brick joints. Regrout loose brickwork with underlayment grout.

D. Stop active hydrostatic leaks. Repair structural defects, voids, and cracks.

E. When necessary to restore concrete surfaces, attach 2 by 2-inch by 10 or 12 gauge wire mesh to concrete. Apply castable or gunite grade underlayment to required thickness.

F. Fill voids, holes, rough, or irregular concrete to obtain uniform surfaces.
   1. When deeper than 1/2-inch, fill with castable or trowelable underlayment.
   2. When from 1/8 to 1/2-inch deep, fill with trowelable underlayment.
   3. When less than 1/8-inch deep, fill with filler underlayment. Spread mixed filler underlayment on plasterer's hawk upon completion of mixing. Apply with smooth plasterer's rubber float. Remove excess material with edge of float or squeegee. Allow for working time of 15 minutes.

G. Cure trowelable and castable underlayment for 5 hours, and filler underlayment for 3 hours, before applying coating.

H. Cure with fog spray, wet burlap, or coating manufacturer's approved curing compound.

I. Brush underlayment before initial set when coating will be applied 24 hours or more after application of underlayment.

J. Epoxy based underlayments do not require a moist cure.

3.03 APPLICATION

A. Trowel apply coating at minimum 1/8-inch thick. Use screed bars to control thickness on large surface areas.

B. Roll coating surface with short nap mohair paint rollers slightly dampened with water to obtain pinhole free surface.

C. Coordinate transition with plastic liner by lapping the coating over the plastic liner a minimum of six inches (6 in.). Areas of liner to be coated shall be roughened as recommended by the manufacturer to assure good adhesion of the coating.

3.04 CURING

A. Coating: Do not allow flowing water or chemicals on coating for minimum 24 hours at 70 degrees Fahrenheit. For temperatures below 70 degrees Fahrenheit, cure at minimum 48 hours before allowing flowing water or chemical exposure.

3.05 FIELD QUALITY CONTROL

A. During application, a wet film thickness gage meeting the ASTM D4414 shall be used to ensure a monolithic coating and uniform thickness.

B. Test coating for pinholes with holiday detector in accordance with ASTM D-4787 after coating has cured for 24 hours.

C. Testing shall be with a minimum test voltage of 100 volts per mil (where 1 mil = 1/1000-inch) of finished surface coat thickness. For example, a minimum of 12,500 volts shall be used for a surface coat of 1/8-inch (125 mils). Any imperfections found in the coating systems shall be ground down and refilled. The patch material shall be a contrasting color and shall be trowelable. Repaired areas shall be re-tested.

D. The CONTRACTOR shall perform repairs and re-testing at no additional cost to OWNER. Inspector shall observe and approve of all testing and retesting. In addition, the CONTRACTOR shall provide certification for each structure stating that the coating is free of holes or other imperfections.

E. Inspect coating with manufacturer and Owner at 9 and 23 months after Final Project Acceptance.

3.06 CLEANING

A. Any spilled or over-sprayed material must be cleaned-up prior to curing. After curing has occurred, clean up may be accomplished by chipping or blasting. All discarded materials shall be disposed of properly. Clean up and disposal of discarded material shall be at no additional cost to the OWNER.

3.07 SCHEDULE OF SURFACES TO BE COATED

A. Headworks influent channels floors, and walls.

END OF SECTION

SECTION 11321

CYCLONE SEPARATOR AND GRIT CLASSIFIER

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for providing one grit dewatering unit assembly, consisting of one cyclone grit concentrator mounted on a screw type grit classifier.
   1. Equipment Numbers:
      a. Cyclone No. 1 (GC-1011)
      b. Cyclone No. 2 (GC-1021)
      c. Grit Classifier No. 1 (GC-1012)
      d. Grit Classifier No. 2 (GC-1022)

B. Related Sections:
   1. Section 01614 - Wind Design Criteria.
   2. Section 01730 - Operating and Maintenance Data
   3. Section 01740 - Warranties and Bonds
   4. Section 15050 - Basic Mechanical Materials and Methods.
   5. Section 15958 - Mechanical Equipment Testing.
   6. Section 16405– Electric Motors.
   7. Division 16 - Electrical

C. All equipment shall conform to the requirements of Section 15050, Basic Mechanical Materials and Methods, except as modified herein.

D. Inclusion of a specific manufacturer’s name in the Specifications does not mean that the specified manufacturer’s standard product will be acceptable. Specified manufacturer’s or other manufacturer’s standard product shall be modified as required to meet the Specifications.

1.02 SUBMITTALS

A. Submit as specified in Section 15050.

B. Product Data.

C. Manufacturer's Installation Instructions.

D. Shop Drawings:
   1. General arrangement drawings showing the complete assembly, part numbers, and material list.
   2. Detailed Drawings: Include details on the grit dewatering unit, motors, gear drives, equipment, supports, and size and length of each support frame member.
   3. Performance Data: Include cyclone inlet flow rate and corresponding underflow rate at 5 psig, 10 psig, 15 psig, and 20 psig inlet pressures based on the specified vortex finder size. Also include cyclone capacity curves.

E. Calculations:
   1. Structural Calculations: Include the following to support structural adequacy of the grit dewatering unit prepared and signed by a registered professional structural engineer in the State of Florida.
      a. Structural anchoring to concrete foundation.
   2. Mechanical and Hydraulic Calculations:
      a. Demonstrate that dewatering unit's power train (screw, drive, and motor) is adequately sized for starting with settling tank fully loaded with grit.
   3. Screw shaft design and fatigue life.

F. Technician Qualifications Resume: Submit resume of technician to perform adjustments, inspections, start-up, observations of test operations, and training.

G. Performance Test Data.

H. Operating and Maintenance Manual:
   1. Submit operation and maintenance manuals in accordance with Section 01730.
   2. Include complete lubrication, maintenance, and operation instructions, including initial start-up instructions, and unloading and handling methods.

1.03 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:
   1. Minimum 10 years experience in production of equipment substantially similar to the specified equipment.
   2. Submit evidence of satisfactory operation of grit dewatering units similar to the specified grit dewatering units in at least five separate facilities in accordance with the following requirements:
      a. All grit dewatering units on the submitted installation list shall use the same design for critical components as specified for this project as follows:
         1) Cyclones.
         2) Grit classifiers.
         3) Service: Municipal wastewater in U.S. or Canada.
      b. Multiple grit dewatering units at a plant shall be considered as one installation toward meeting the experience requirements.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

C. The manufacturer of the grit classifiers shall assume complete responsibility for furnishing the cyclones and shall have sole-source responsibility for furnishing the complete assemblies and meeting the specified performance requirements.

1.04 WARRANTY

A. As specified in Section 01740

B. Warrant free of defects in material and workmanship for 3 years from the date of acceptance or date of first beneficial use by the OWNER.

1.05 SPARE PARTS AND SPECIAL TOOLS

A. Furnish the following spare parts:
   1. Cyclone:

Item	Quantity
Apex Liners	1
Vortex Finder	1
Replaceable Liners	1 set
Gaskets	1 set

   2. Classifier and Drive Unit:

Item	Quantity
Screw Lower Bearing Assembly	1
Cyclodrive Assembly	1
V-belts	1 set
Drive Bearings	1 set

B. Special Tools: Furnish any special tools required for maintenance and disassembly of furnished equipment.

C. Deliver spare parts and special tools in boxes labeled with contents, equipment to which spare parts belong, and name of CONTRACTOR.

D. CONTRACTOR, inspector, and OWNER's maintenance representative shall inventory and account for all tools and spare parts delivered to the site. Each party shall sign a turn over agreement. OWNER will then take possession and responsibility for items.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal, modified as needed to meet the Specification requirements:
   1. Cyclones
      a. Envirocare
      b. Sprirac
      c. Wemco
      d. Westech
   2. Grit Classifiers
      a. Envirocare
      b. Sprirac
      c. Wemco
      d. Westech

B. The ENGINEER has designed the piping, controls, and all other functions around Wemco equipment. The CONTRACTOR is responsible for any changes resulting from selecting another manufacture. This includes, but not limited to design changes to provide for variations in piping arrangements, controls, and electrical requirements.

C. The changes shall be made at no additional cost to the OWNER.

2.02 PERFORMANCE REQUIREMENTS

A. The complete grit dewatering unit shall include a cyclone type grit separator mounted on a grit classification mechanism as indicated on the Drawings. The combined unit, with the cyclone in service at the specified design feed flow rate, shall be capable of removing 90 percent size 150-mesh or greater particles having a specific gravity of 2.65 or greater, from the pumped grit slurry.

2.03 EQUIPMENT COMPONENTS

A. Cyclone:
   1. Design for highly abrasive applications.
   2. Sectional construction including inlet head, a separate cylindrical section, conical sections, vortex finder, and fixed apex valve.
   3. Inlet Head:
      a. Heavy-duty cast iron, ASTM A 48, Class 30 minimum.
      b. 10-inch diameter.
      c. Involute shape entry.
      d. Minimum 4-inch inlet and 6-inch outlet with adapter pieces to fit the piping layout shown on the Drawings.
   4. Provide cylindrical section to allow increased residence time for grit capture:
      a. 10-inch diameter.
      b. Fabricated steel, ASTM A 108.
   5. Completely line each cyclone section with an individual, independently replaceable neoprene or natural rubber liner.
   6. Vortex Finder: Ni-hard with a minimum hardness of 500 Brinell.
   7. Provide a hinge and quick disconnect clamp between the apex assembly and lower cone section to allow easy access for cleaning without disconnecting any piping.
   8. Design and furnish a structural supporting framework for the cyclones. Fabricate supports using Type 316L stainless steel.
   9. Design Criteria:
      a. Design Feed Flow Rate (each cyclone): 250 gpm.
      b. Maximum inlet pressure required at the design flow rate: 7.5 psig.
      c. Maximum allowable underflow from each cyclone at the design flow rate: 15 gpm.
   10. Performance Requirements:
      a. Design cyclone to remove not less than 95 percent of the 150-mesh grit having a specific gravity of 2.65 or greater from the pumped grit slurry stream.

B. Classifier:
   1. Design classifier to receive underflow discharge from one cyclone.

2. Design classifier to maintain necessary velocities to retain organic matter in suspension and remove the non-organic matter of a size retained on a 150-mesh screen.
3. Capable of removing substantially all 150-mesh grit having a specific gravity of 2.65 or greater from the cyclone underflow.
4. 12-inch straight side classifier with a screw-type grit conveyor.
5. Minimum classifier grit handling and raking capacity: 0.75 tons per hour at 12 rpm.
6. Design unit's power train (screw, drive, and motor) to be capable of starting with settling tank fully loaded with grit.
7. Settling Tank:
    a. Fabricated of Type 316L stainless steel plate (1/4-inch minimum) and reinforcements.
    b. Mounted on Type 316L stainless steel supports and self-supporting base at a slope of not more than 3.5 inches to 12 inches (vertical to horizontal).
    c. Design settling compartment where grit separation takes place with a minimum full water depth of 150 percent of the screw diameter.
    d. Minimum Pool Area: 8.3 square feet.
    e. Minimum Weir Length: 24 inches.
    f. Provide launder box to receive weir overflow. Equip launder box with a 2.5-inch pipe grooved-end fitting for connection to drain.
    g. Provide inlet boxes to receive the feed from the apex of each cyclone.
        1) Inlet boxes shall be of 316L stainless steel and provided with rubber liners. Feed boxes shall be reinforced minimum 3/8-inch stainless steel plate, and shall be lined with 1/2-inch soft, natural gum rubber to protect against abrasion, and to function as a splashguard. Radial flow diffusers shall not be acceptable.
        2) The classifier manufacturer shall ensure that the inlet boxes are designed to dissipate the energy from the cyclone underflow within the inlet box, so disruption of settling does not occur in the classifier. Evidence of satisfactory design from previous installations shall be provided with the Shop Drawings submittal.
        3) The inlet boxes shall be designed and located by the manufacturer to minimize short-circuiting to the overflow weir of the respective classifier and to handle maximum cyclone underflow discharge.
    h. Provide settling tank with a 2-inch grooved-end drain connection.
    i. Provide the classifier tank with a welded bar, running from the top of the tank to below the water level to provide a sluice channel, in order to prevent the buildup of grit opposite the raked material, to aid in drainage.
    j. The manufacturer shall furnish and install a valve cock with NPT nipple for the spiral sluice water (wash water).
    k. Provide settling tank with sectional, removable, gasketed, FRP or Type 316 stainless steel covers.
        1) Design covers to serve as protective guard over the full length of the rotating screw to protect personnel.
        2) Comply with all OSHA requirements.
        3) Bolt or clamp each cover section to classifier.
    l. Provide plexiglass view port, 6 inches by 4 inches, in the cover above the overflow weir to allow visual observation of weir area.
8. Grit Screw (Auger):
    a. 12-inch diameter.
    b. 50-percent pitch, single helical screw.

c. The screw shaft shall be minimum 3-inch nominal diameter pipe size, Schedule 80, and shall be of ASTM A 53, Grade B steel. Preformed 3/16-inch thick steel flight sections shall be continuously welded to the shaft and fitted with easily replaceable, abrasion-resistant wear shoes as specified.
    1) Wear shoes shall be of abrasion-resistant, Ni-hard or High Chrome cast iron, minimum Brinell of 550, and mounted on the flights by means of 316 or 304 stainless steel bolts and lock nuts.
    2) The wear shoes shall protrude at least 1 inch from the edge of the welded flight and extend to within 1/2 inch of the pipe shaft, and taper from 3/4 inch at the outer periphery to 3/16 inch at the shaft for maximum abrasion resistance and grit conveying capacity.

d. The pipe shaft of the screw shall be designed with a maximum stress of 3,000 psi and a fatigue life, at 98-percent reliability, of 20 years minimum. Calculations signed by a registered Professional Engineer showing compliance with these requirements shall be included with the Shop Drawing submittal.

e. Rigidly support the screw conveyor at both the upper and lower ends by special bearings, so that the screw conveyor is mounted above, and does not contact classifier tank. This mounting shall provide for a clearance between the screw conveyor and the tank bottom, so that a buildup of sand or grit will provide a bed for the screw, eliminating tank wear, and providing a drainage area for the conveyed grit.
    1) The upper end of the screw conveyor shall be connected to a cycloidal motion speed reducer by a flanged, rigid coupling. The cycloidal speed reducer shall be designed so that all torque is transmitted by rollers, and shall be capable of withstanding shock loads of not less than 500 percent of rated loading.
        a) The cyclodrive shall take radial and all thrust loads from the shaft, and at maximum load provide a minimum B-10 bearing life of 50,000 hours. Gear type speed reducers are not acceptable.
    2) The lower end of the screw shall be supported by a submerged bearing, housed in a water-tight cast iron housing, suitable for completely submerged operation in grit service.
        a) The bearing shall be designed to accept radial loads from the spiral screw conveyor.
        b) The cast iron housing shall be provided with stainless steel cap screws, fill, and drain plugs.
        c) The bearing shall use a sealed bronze sleeve-type bearing, running completely submerged in oil, and shall require only yearly inspection and oil change.
        d) The bearing shall be provided with permanent stellite seals to prevent the leakage of oil and infiltration of grit and other foreign particles into the housing. The seal shall be of the self-compensating type, consisting of two mating hardened steel alloy rings, each held in place by a rubber toric. The wearing surfaces of the rings shall be precision lapped to form an initial sealing band of approximately 1/32 inch in width. The seal shall be designed such that as seal rings wear through normal operation, the pressure from the rubber torics shall push the rings further against each other to form a broadened contact band.

e) Lower bearing designs incorporating conventional packing or requiring external flushing will not be acceptable.

f. The entire motor, cyclodrive, and screw conveyor and lower bearing assembly shall be designed so that the screw can be raised for inspection without the need to disassemble any components, or to drain the classifier tank.
   1) The complete drive assembly shall be pivoted at the shaft centerline so that the screw assembly can be raised for periodic inspection.
   2) The lower end of the assembly shall be attached to a manually operated hand wheel and screw-type lifting device designed to allow the entire assembly to be lifted above the maximum water level without the use of any special tools, or any dismantling of components.

g. Maximum Slope of Screw: 3.5 to 12 (vertical to horizontal).

9. Grit Screw Drive:
   a. Consists of a totally enclosed, ball bearing, constant-speed motor with V-belt drive to a cyclodrive-type speed reducer with oil-tight housing.
   b. Design grit screw drive with safety factor of 1.50, based on motor horsepower.
   c. Mount the screw drive unit on top of the screw trough.
   d. Directly connect the reducer output shaft to the upper end of the screw conveyor.
   e. Provide a pivot for the entire motor and reducer assembly at the shaft centerline so that the screw assembly can be raised.
   f. Provide a fiberglass or 316 stainless steel belt guard meeting all OSHA requirements.
   g. Maximum Screw Speed: 12 rpm.
10. Drive Motor:
   a. Induction, single-speed, continuous-duty, squirrel-cage type, designed, manufactured, and tested in accordance with NEMA MG1.
   b. The motor shall have a Class 1, Division 2, enclosure.
   c. Horsepower (minimum): 1
   d. Maximum Speed, rpm: 1,750.
   e. Volts: 460.
   f. Phase: Three.
   g. Frequency: 60.
   h. Enclosure: TEFC.
   i. Ambient Temperature (degrees Fahrenheit): 20-110.
   j. Service Factor: 1.15.
   k. Insulation: Class F.
   l. Temperature rise under full load: Not to exceed that for Class B insulation.
   m. Refer to Specification Section 16405 for additional requirements.
11. Dewatered Grit Discharge Connection: Minimum opening size 3 inches by 5.5 inches with stainless steel flanged end for connection to grit discharge chute.
12. Overall Dimensions:
   a. Overall length of the complete grit dewatering unit assembly including classifier, cyclone, gear reducer, and supports shall be not greater than 13 feet.
   b. Overall width of the complete grit dewatering unit assembly including classifier, cyclone, gear reducer, and supports shall be not greater than 4 feet.

2.04 ACCESSORIES

A. Zero Speed Switch:
   1. Provide each screw drive unit with a zero speed switch located and mounted per the grit dewatering unit manufacturer's recommendations.
   2. Zero speed sensor to be of the non-contacting type using a probe with an internal pre-amplifier and main electronic assembly. Probe shall be rated for Hazardous location. Do not install probe in direct sunlight. If needed, provide sunshield for probe.
   3. Use a magnetic pick-up welded on one of the spiral shoes or a reader plate on the end of the tail shaft to sense motion.
   4. Main electronic unit to operate on 120 volt, single-phase, 60 Hz power supply and shall be located and powered from the grit classifier control panel.
   5. House main electronic unit (probe) in a Class 1, Division 2 enclosure.
   6. Furnish and install all accessories required for a complete working system and coordinate requirements with the Electrical Drawings and Section 16050. MFA-4 shall be installed in the grit classifier control panel.
   7. As manufactured by Milltronics model MFA-4 motion failure alarm, or equal.

B. Emergency STOP Cable Switch:
   1. Furnish each grit dewatering unit with a cable-operated latching type emergency STOP safety switch.
   2. Hook safety switch to a cable running around the entire periphery of the classifier tank and provide accessories as required.
      a. Provide orange plastic coated safety cable and mount through eyebolts spaced no more than 10 feet.
   3. House main electronic unit in a Class 1, Division 2 enclosure.
   4. Safety switch as manufactured by Material Control, Inc.; or equal.
   5. Furnish and install all accessories required for a complete working system and coordinate requirements with the Electrical Drawings and Section 16050.

C. Lifting Lugs: Provide equipment and each disassemblable part weighing over 100 pounds with lifting lugs for easy handling.

D. Equipment Identification Plates: Securely mount a 16-gauge stainless steel identification plate on each grit dewatering unit in a readily visible location. The plate shall bear the 1/4-inch die-stamped equipment name and tag identification number listed in this Section or indicated on the Drawings.

E. Safety signage.

2.05 CONTROL SYSTEM

A. Grit Classifier Control Panels:
   1. The control panels shall be supplied by manufacture.
   2. One (1) control panel shall be supplied to house the controls for the grit classifier system. The control panel shall have a NEMA 4X, type 316 stainless steel enclosure and shall contain operating and adjustment controls including main breaker with external handle, motor circuit protectors, step-down control transformer (480V to 120V step-down), HOA selector switches, push buttons, emergency mushroom push buttons, and LED indicating lights, NEMA rated Full-voltage reversing starters with overloads, relays, and timers as required for a complete and fully operational grit classifier system. The power supply for

the grit classifier control panel shall be 480V, 3-phase, 60-Hz. Refer to Instrumentation drawings for the minimum input and output signals requirements.

B. Grit Classifier Controls: The following control devices/functions shall be provided for the grit classifier:
   1. At control panel:
      a. HAND-OFF-AUTO Selector Switch:
         1) HAND: Start the grit classifier.
         2) OFF: Inhibit the grit classifier from running.
         3) AUTO: Start the grit classifier when receiving a running signal from the grit pump and stop with 3 minutes (adjustable) time delay after grit pump stops.
      b. RESET Pushbutton: Resets alarm interlocks.
      c. Emergency STOP Latching Cable Switch: Stop grit classifier motor in all modes of operation and annunciate EMERGENCY STOP alarm at SCADA.
      d. Emergency STOP Pushbutton: Stop grit classifier motor and grit pump motor in all modes of operation and annunciate EMERGENCY STOP alarm at SCADA.
      e. Zero Speed Switch: Stop the classifier motor in all modes of operation when auger speed is ZERO.
   2. Process Control System (Plant PLC):
      a. No control of grit classifier through SCADA will be provided and only monitoring of the running and fail signals will be provided.
      b. SCADA shall monitor statuses and annunciate alarm conditions for each grit classifier.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as indicated on the Drawings and in strict accordance with the manufacturer's written instructions, shop drawings, and recommendations.

B. Prior to start-up, fill the clearance between the bottom of screw conveyor and the tank with a clean coarse sand to allow a porous bed for drain back and provide a conveying surface for the screw. Sand gradation to be per grit dewatering unit manufacturer's recommendation.

C. Prior to start-up, the equipment shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance.

3.02 FIELD QUALITY CONTROL

A. General:
   1. The Grit Classifier Supplier shall understand that carrying out the start-up and field-testing may depend on the plant shutdown, and water production. Any interruption for reasons not attributable to the Grit Classifier Supplier actions or the classifier operations will not affect the continuity of the start-up. The startup of the grit classifier systems, and the screw conveyor, most likely, will take place at the same time to ensure proper function of the instrumentation and

controls, including interlocks. Therefore, the Grit Classifier Supplier shall coordinate with the Screw Conveyor Supplier and General Contractor in carrying out the start-up.

B. Start-Up:
   1. The Grit Classifier Supplier shall submit a start-up test procedure and schedule (after training is completed) to the OWNER for approval. Start-up will begin only if the training has been completed and the start-up test procedure and schedule have been reviewed and approved by the OWNER. The Grit Classifier Supplier technical representative, the OWNER's trained personnel, and Construction Manager shall be present for the start-up testing.
   2. The Grit Classifier Supplier's technical representative shall be available on site for the tuning, monitoring, inspection and restarting of each classifier during the entire start-up procedure.
   3. The start-up procedure shall include the following:
      a. To begin the initial start-up, each classifier shall be tuned and adjusted to undergo operation. Faulty components found during initial inspection shall be repaired and replaced within 48 hours by the Grit Classifier Supplier, at no cost to the OWNER. Subsequent to the initial inspection, each classifier shall be operated for a minimum of 48 hours of continuous operation. If no malfunctions occur during the 48 hours of continuous operation, the initial start-up procedure shall be deemed complete.
      b. If malfunctions occur during 48 hours of continuous operation, the Grit Classifier Supplier shall start performing corrective action within 48 hours and restart the classifier for a minimum of 96 hours of additional continuous operation. If no problems are evident during the 96 hours of subsequent operation, the start-up procedure shall be deemed complete.
      c. If malfunctions occur during the 96 hours of subsequent continuous operation, the start-up period shall be terminated and the Grit Classifier Supplier shall perform corrective action within 48 hours prior to requesting additional start-up test. If an additional start-up procedure is necessary, it shall follow the procedure as specified above and be subject to the OWNER's approval. The satisfactory completion of the start-up procedure shall be at the sole discretion of the OWNER.

END OF SECTION

SECTION 14556

SHAFTED SCREW CONVEYORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: shafted screw conveyors.
   1. Equipment Number
      a. Conveyor No. 1 (SC-1013)
      b. Conveyor No. 2 (SC-1023)

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01310 – Construction Schedule and Project Restraints
      b. Section 01614 - Wind Design Criteria
      c. Section 01730 - Operating and Maintenance Data
      d. Section 01740 – Warranties and Bonds
      e. Section 15050 – Basic Mechanical Materials and Methods.
      f. Section 16010 – Basic Electrical Requirements
      g. Section 16050 – Basic Electrical Materials and Methods
      h. Section 16120 – Conductors
      i. Section 16405 – Electric Motors
      j. Section 16450 – Grounding

1.02 REFERENCES

A. American Gear Manufacturer's Association (AGMA).

B. American Institute of Steel Construction (AISC).

C. American Iron and Steel Institute (AISI).

D. American Welding Society (AWS).

E. National Electrical Manufacturer's Association (NEMA):
   1. 250 – Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA Type 4 enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. The 12-inch minimum conveyor shall be designed and manufactured to handle a continuous loading dewatered grit.
      a. Conveying capacity of the conveyor shall be 2 times the design loading without changing the design operating speed.
   2. Design calculations showing dead, live, and dynamic loadings are required.
      a. Calculations shall demonstrate that the design stress at 250 percent of the motor nameplate horsepower in the auger shall not exceed 30 percent of the F_y value in the extreme fiber of the flight material.
   3. The conveyor system shall consist of shafted screw conveyors as indicated on the Drawings, complete with drive, shafted screw, UHMW liner, grit ports for discharged from the bars screens, and grit classifiers**,** and drop chute to discharge in a continuous manner to bin.
      a. Sectional welded plate sections are not acceptable.
      b. The conveyor system shall be of the size and location as indicated on the Drawings.
      c. Manufacturer shall provide support mountings and discharge chutes for grit classifier, bar screen, and conveyor as indicated on the Drawings.
   4. The conveyor system shall be sized for a capacity of 30 cubic feet per hour. Maximum loading shall be 30 percent of trough filling.
   5. Basis of design:
      a. The Drawings have been prepared based upon the layout of the conveyor manufacturer listed in this specification section.
      b. If alternate equipment is proposed which requires modifications to the basis of design, then include in the lump sum bid all modifications and accessories as required to provide a complete and operable system.
      c. In addition, include in the lump sum bid all necessary structural, electrical, and mechanical modifications to the proposed system.

B. Supports:
   1. Provide structural supports.
      a. The support structure shall be designed and provided by the conveyor manufacturer.
   2. Provide full structural steel ground supports.
      a. The design of the support structure shall be integrated with the classifiers.
   3. All structural members shall be designed so that the unit stresses will not exceed AISC allowable stresses by more than 1/3 when subject to loading of twice the static load.

1.05 SUBMITTALS

A. General: Submit as specified in Section 15050.

B. Product data.

C. Sample of chute material.

D. Shop drawings: Include manufacturer's complete erection, installation, and adjustment instructions and recommendations, details of parts individually and severally, and detailed test procedures for field-testing.

E. Structural and mechanical calculations: prepared, signed, and sealed by Professional Engineer in the state of Florida.

F. Operating and Maintenance Manual:
   1. Submit operation and maintenance manuals in accordance with Section 01730.

G. Submit structural design calculations and all other product drawings and information required for a complete submittal.
   1. The structural calculations for the supports and anchoring of the unit and associated accessories as well any other structural supports as part of the system shall be done, signed, and stamped by a structural professional engineer in the state of Florida.

H. Video of factory test on DVD.

1.06 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Minimum 5 years experience in production of equipment substantially similar to the specified equipment.
   2. Submit evidence of satisfactory operation of shafted screw conveyor units similar to the specified units in at least five separate facilities in accordance with the following requirements:
      a. All shafted screw conveyor units on the submitted installation list shall use the same design for critical components as specified for this project.
      b. Service: Municipal wastewater in U.S. or Canada.
      c. Multiple screw conveyors units at a plant shall be considered as one installation toward meeting the experience requirements.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

1.07 WARRANTY

A. As specified in Section 01740

B. Liner Wear
   1. In addition to the equipment warranty required by the Contract Documents, each screw conveyor's trough liner shall not require replacement due to wear before 3,000 hours of operation or 18 months, after acceptance, whichever comes first. If any screw conveyor trough liner or segment thereof requires replacement due to wear, as evidenced within 3,000 hours of operation or 18 months after acceptance, whichever comes first, provide all labor and materials to replace the entire trough liner without additional cost to the OWNER.
   2. Liner failure shall be defined by a loss of 25 percent or more of liner depth over a length of more than 0.25 times the flight diameter at any point within the trough; or a failure of the liner attachment method at more than one point on a given conveyor.

C. Screw Wear

1. In addition to the equipment warranty required by the Contract Documents, the polyethylene screw shall not require replacement due to wear before 3,000 hours of operation or 18 months, after acceptance, whichever comes first. If any screw requires replacement due to wear, as evidenced within 3,000 hours of operation or 18 months after acceptance, whichever comes first, provide all labor and materials to replace the entire screw without additional cost to the OWNER.
2. Polyethylene screw wear failure shall be defined by a loss of 3/8-inch or more of the radius of a 12-inch polyethylene screw which equates to a 6.25% loss of diameter for all screws diameters.

1.08 SPARE PARTS AND SPECIAL TOOLS

A. Special Tools: Furnish any special tools required for maintenance and disassembly of furnished equipment. A minimum of two liner replacement tools shall be provided.

B. The following spare parts shall be provided:
1. Sufficient wear stripping to completely replace the wear strips on one conveyor
2. One complete set of tools and fasteners to make repairs
3. One complete set of all gaskets and seals for each sized chute provided
4. One replacement motor
5. Sufficient oil for reducer gear motors to provide two oil changes or an 18 month supply, whichever is greater

C. Deliver spare parts and special tools in boxes labeled with contents, equipment to which spare parts belong, and name of CONTRACTOR.

D. CONTRACTOR, inspector, and OWNER's maintenance representative shall inventory and account for all tools and spare parts delivered to the site. Each party shall sign a turn over agreement. OWNER will then take possession and responsibility for items.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Shafted screw conveyor: One of the following or equal:
1. Hydro-Dyne
2. Keller Angelillis

2.02 MATERIALS

A. Shafted screw conveyor: The shafted screw conveyor shall be new and of current manufacture, and shall be designed to transfer municipal dewatered grit as specified and shall be constructed in accordance with CEMA 350 standards.
1. Trough, chutes: 1/8-inch minimum Type 316 stainless steel.
2. Covers: 1/8-inch minimum Type 316 stainless steel.
3. Drive and end plates: 1/2-inch minimum Type 316 stainless steel, removable.
4. Screw flights: 12-inch polyethylene screw mounted on a 2.5-inch x 3/16-inch Type 316 stainless steel square tube.
5. Wear liner: Plastimeric, (UHMW) 1/2-inch thickness minimum, 2 color.
6. Hardware: Type 316 stainless steel.

7. Cover fasteners:
    a. Type 304 stainless steel hinges and toggle clamps.
    b. Hinges shall be located on the side of the conveyor closest to the wall or equipment.
8. Drive shaft: AISI 4150.

2.03 SCREW FLIGHT

A. 12-inch diameter polyethylene screw conveyor.

B. Spiral flighting for the shafted screw conveyors shall be full pitch, mounted on a 2.5-inch x 3/16-inch Type 316 stainless steel square tube. The drive and tail shaft shall be Type 316 stainless steel. The tail shaft shall run in a “Arguto” oil impregnated wooden bearing.

C. The shafted screw will run the full length of the trough transferring the grit from the classifiers and bar screen to the discharge chute.

2.04 TROUGH AND LINER

A. Construction: Materials shall be 1/8-inch minimum thick, Type 316 stainless steel, U-trough with neoprene gasketing at each trough flange and 1/8-inch gauge stainless steel cover.

B. Each trough section body shall be fabricated in single welded constructions for lengths up to 20 feet. Troughs greater than 20 feet in length shall be constructed for two or more sections bolted together at the trough joining the flanges.

C. Conveyor shall have standard removable trough end plates (both ends) with split-gland seal at the drive end.
    1. Provide zerk fitting for lubrication of seal.

D. Provide a 3-inch diameter drain at each end of the conveyor.

E. Conveyor trough shall have removable bolted cross braces.

F. Conveyor covers shall be hinged.
    1. Hinge shall be removable pin-style with a length at least 90 percent of the lid length.
    2. Cover shall come equipped with lid stops to prevent over-opening the cover.

G. Each lid shall have 2 stainless steel pull-action toggle clamps to keep the lid secure during operation.
    1. Each clamp shall be double-locking with a U-bolt arm adjustable up to 1/2 inch.
    2. The latch plate shall be mounted on the lid with the toggle body mounted below the lid on the trough.

H. The trough shall have a replaceable liner constructed of preformed 1/2-inch minimum ultra-high molecular weight polyethylene with anti-wear agents and retainer strips welded to the trough along the top of the liner.
    1. Fasteners shall not be used below the spiral centerline to hold the liner.

I. The liner shall be a single piece, formed and bonded with 2 layers, each a different color, to provide a visible indication when the liner is nearing the end of its useful life and there is only 1/8 inch remaining.

2.05 DRIVE UNITS

A. The drive units shall be a hollow shaft-mounted, roller-bearing gear motor rated a minimum AGMA Class II, single or double reduction or triple reduction.

B. Drive finish shall be severe duty washdown surface protection finish with stainless steel paint.

C. Provide a maximum 5-horsepower TEFC 230/460-volt, 60-hertz, 3-phase constant speed drive at discharge end of conveyor running at approximately 30 revolutions per minute. The motor shall have a Class 1, Division 2, explosion-proof enclosure.
   1. Provide NORD Gear Corporation Unicase, or equal, shaft-mounted drive with hollow shaft design.

D. V-belt-driven speed reducer or chain-driven reducers not permitted.

E. Motors shall be mounted at the end of the conveyors as indicated on the Drawings.

F. Refer to Specification Section 16405 for additional requirements.

2.06 CONTROLS AND ACCESSORIES

A. Control panel: A NEMA 4X type 316 stainless steel control panel shall be provided for conveyor system. The control panel shall contain operating and adjustment controls including main breaker with external handle, motor circuit protectors, branch breakers, step-down control transformer, on-off selector switches, push buttons, LED indicating lights, NEMA rated full voltage reversing starters, relays, elapsed time meters, and timers as required for a complete and fully operational conveyor system. Power supply for conveyor control panel shall be 480V, 3-phase, 60Hz. Refer to Instrumentation drawings for the minimum input and output signals requirements. Control panel shall have appropriate UL label and minimum of 25kAIC rating.

B. Emergency stop cables:
   1. Provide emergency stop cables on both sides of the conveyor with 2 switches per 50 feet minimum length of cable.
   2. Cable shall be orange plastic coated safety cable mounted through eyebolt spaced no more than 10 feet.

C. Non-Contacting-Type Zero-Motion Switches:
   1. Non-contacting-type zero-motion switches shall be provided and installed so they stop the operation of the drive motor when conveyor motion is not detected.
   2. Zero speed sensor to be of the non-contacting type using a probe with an internal pre-amplifier and main electronic assembly. Probe shall be rated for Hazardous location. Do not install probe in direct sunlight. If needed, provide sunshield for probe.
   3. Use a magnetic pick-up welded on one of the spiral shoes or a reader plate on the end of the tail shaft to sense motion.

4. Main electronic unit to operate on 120 volt, single-phase, 60 Hz power supply and shall be located and powered from conveyor control panel.
5. House main electronic unit (probe) in a Class 1, Division 2 enclosure.
6. Furnish and install all accessories required for a complete working system and coordinate requirements with the Electrical Drawings and Section 16050. MFA-4 shall be installed in the grit classifier control panel.
7. As manufactured by Milltronics model MFA-4 motion failure alarm, or equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. The overall dimensions of the shafted screw conveyors and appurtenances shall fit within the space shown on the Drawings. Verify dimensions and clearances and coordinate the installation of the shafted screw conveyors with the existing bar screen, drop chute, and new grit classifiers.related work included in other Sections. Verify equipment supports, structure dimensions and arrangement and notify the Engineer of any discrepancy before submitting shop and erection drawings for approval. Coordinate all interfaces of the shafted screw equipment with all related equipment specified in other related Sections. The shafted screw conveyors shall comprise complete coordinated systems including, but not limited to: the shafted screws, drives, troughs, supports, trough covers, liners, gear reducers, motors, discharge chutes, limit switches, motion sensors, and all appurtenances as shown on the Drawings or specified herein.

3.02 INSTALLATION

A. Install screw conveyors in accordance with manufacturer's recommendations.
   1. All field welds shall be passivated.

3.03 SHOP TESTING

A. Conveyors, in their entire length, shall be inspected and operated in the shop with the actual drive unit for the project.
   1. Unit shall be fully assembled with tack welds at the factory and test run for 15 minutes to check for equipment tolerances and proper operation.
   2. Conveyors shall be corrected as necessary.
   3. Prior to shipment, the tack welds will be broken apart and conveyors suitably prepared for shipment.
   4. A DVD video of the test shall be submitted to the ENGINEER for record purposes.

3.04 FIELD QUALITY CONTROL

A. General:
   1. The Screw Conveyor Supplier shall understand that carrying out the start-up and field-testing may depend on the plant shutdown, and water production. Any interruption for reasons not attributable to the Screw Conveyor Supplier actions or the conveyor operations will not affect the continuity of the start-up. The startup of the screw conveyor systems, and the grit classifiers, most likely, will take place at the same time to ensure proper function of the

instrumentation and controls, including interlocks. Therefore, the Screw Conveyor Supplier shall coordinate with the Grit Classifier Supplier and General Contractor in carrying out the start-up.

B. Start-Up:
   1. The Screw Conveyor Supplier shall submit a start-up test procedure and schedule (after training is completed) to the OWNER for approval. Start-up will begin only if the training has been completed and the start-up test procedure and schedule have been reviewed and approved by the OWNER. The Screw Conveyor Supplier technical representative, the OWNER's trained personnel, and Construction Manager shall be present for the start-up testing.
   2. The Screw Conveyor Supplier's technical representative shall be available on site for the tuning, monitoring, inspection and restarting of each conveyor during the entire start-up procedure.
   3. The start-up procedure shall include the following:
      a. To begin the initial start-up, each conveyor shall be tuned and adjusted to undergo operation. Faulty components found during initial inspection shall be repaired and replaced within 48 hours by the Screw Conveyor Supplier, at no cost to the OWNER. Subsequent to the initial inspection, each conveyor shall be operated for a minimum of 48 hours of continuous operation. If no malfunctions occur during the 48 hours of continuous operation, the initial start-up procedure shall be deemed complete.
      b. If malfunctions occur during 48 hours of continuous operation, the Screw Conveyor Supplier shall start performing corrective action within 48 hours and restart the conveyor for a minimum of 96 hours of additional continuous operation. If no problems are evident during the 96 hours of subsequent operation, the start-up procedure shall be deemed complete.
      c. If malfunctions occur during the 96 hours of subsequent continuous operation, the start-up period shall be terminated and the Screw Conveyor Supplier shall perform corrective action within 48 hours prior to requesting additional start-up test. If an additional start-up procedure is necessary, it shall follow the procedure as specified above and be subject to the OWNER's approval. The satisfactory completion of the start-up procedure shall be at the sole discretion of the OWNER.

END OF SECTION

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic design and performance requirements for mechanical equipment.

1.02 REFERENCES

A. American Gear Manufacturer's Association (AGMA) Standards:
   1. AGMA 2001-B88 - Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
   2. AGMA 6000-A88 - Specification for Measurement of Linear Vibration on Gear Units.
   3. AGMA 6010-E88 - Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives.
   4. AGMA 6019-E89 - Standard for Gear motors using Spur, Helical, Herringbone, Straight Bevel or Spiral Bevel Gears.
   5. AGMA 6025-C90 - Sound for Enclosed Helical, Herringbone, and Spiral Bevel Gear Drives.

B. American Society of Mechanical Engineers (ASME):
   1. ASME PTC 8.2 - Performance Test Code for Centrifugal Pumps.
   2. ASME PTC 10 - Performance Test Code - Compressors and Exhausters.
   3. ASME PTC 17 - Performance Test Code - Reciprocating Internal-Combustion Engines.
   4. ASME PTC 11 - Performance Test Code - Measurement of Shaft Horsepower - Instruments and Apparatus.

C. American Bearing Manufactures Association (ABMA) Standards:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

D. American Society for Testing and Materials (ASTM):
   1. A 36 - Standard Specification for Structural Steel.
   2. A 48 - Standard Specification for Gray Iron Castings.
   3. A 526 - Standard Specification for Steel Sheet, Zinc Coated by the Hot Dip Process, Commercial Quality.
   4. B 61 - Standard Specification for Steam or Valve Bronze Castings.
   5. B 62 - Standard specification for Composition Bronze or Ounce Metal Castings.
   6. E 527 - Standard Practice for Numbering Alloys and Metals (UNS).

E. Hydraulic Institute Standards (HI):
   1. HI 1.1-1.5 - Centrifugal Pumps - Nomenclature, Definitions, Application, and Operation.

2. HI 1.6 - Centrifugal Pump Tests.
3. HI 2.1-2.5 - Vertical Pumps - Nomenclature, Definitions, Application, and Operation.
4. HI 2.6 - Vertical Pump Tests.
5. HI 3.1-1.5 - Rotary Pumps - Nomenclature, Definitions, Application, and Operation.
6. HI 3.6 - Rotary Pump Tests.
7. HI 4.1-4.6 - Sealless Rotary Pumps - Nomenclature, Definitions, Application, Operation, and Test.
8. HI 5.1-1.6 - Sealless Centrifugal Pumps - Nomenclature, Definitions, Application, Operation, and Test.
9. HI 6.1-6.5 - Reciprocating Power Pumps - Nomenclature, Definitions, Application, and Operation.
10. HI 7.1-7.5 - Controlled Volume Pumps - Nomenclature, Definitions, Application, and Operation.
11. HI 9.1-9.5 - Pumps - General Guidelines for Types, Definitions, Application, and Sound Measurement.

F. American Petroleum Institute (API):
1. ANSI/API 682 - Shaft Sealing Systems for Centrifugal and Rotary Pumps.

1.03 DEFINITIONS

A. Special Tools: Tools that have been specifically made for use on unit of equipment for assembly, disassembly, repair, or maintenance.

B. Resonant Frequency: That frequency at which a small driving force produces an ever-larger vibration if no dampening exists.

C. Rotational Frequency: The revolutions per unit of time usually expressed as revolutions per minute.

D. Critical Frequency: Same as resonant frequency for the rotating elements or the installed machine and base.

E. Peak Vibration Velocity: The root mean square average of the peak velocity of the vibrational movement times the square root of 2 in inches per second.

F. Rotational Speed: Same as rotational frequency.

G. Maximum Excitation Frequency: The excitation frequency with the highest vibration velocity of several excitation frequencies that are a function of the design of a particular machine.

H. Critical Speed: Same as critical frequency.

I. Free Field Noise Level: Noise measured without any reflective surfaces (an idealized situation); sound pressure levels at 3 feet from the source unless specified otherwise.

J. Operating Weight: The weight of unit plus weight of fluids or solids normally contained in unit during operation.

1.04 SYSTEM DESCRIPTION

A. General:
   1. Provisions specified under each technical equipment specification prevail over and supersede conflicting provisions as specified in this Section.
   2. Provide equipment and parts that are suitable for stresses, which may occur during fabrication, transportation, erection, and operation.
   3. Provide equipment that has not been in service prior to delivery, except as required by tests.
   4. Like parts of duplicate units are to be interchangeable.
   5. When 2 or more units of equipment for the same purpose are required, provide products of same manufacturer.
   6. Equipment manufacturer's responsibility extends to selection and mounting of gear drive units, motors or other prime movers, accessories, and auxiliaries required for proper operation.
   7. When necessary, modify manufacturer's standard product to conform to specified requirements or requirements indicated on the Drawings and contained in Laws and Regulations.

B. Material Requirements:
   1. Materials: Suitable for superior corrosion resistance and for services under conditions normally encountered in similar installations.
   2. Dissimilar Metals: Separate contacting surfaces with dielectric material.

C. Power Transmission Systems:
   1. Power Transmission Equipment: V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints are to be rated for 24 hour-a-day continuous service or frequent stops-and-starts intermittent service, whichever is most severe, and sized with a minimum service factor of 1.5.
      a. Apply 1.5 service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
      b. Apply service factors higher than 1.5 when recommended for continuous 24 hour-per-day operation and shock loadings specified in AGMA 6010-E88, other applicable AGMA standards, or other applicable referenced standards.
      c. When manufacturer recommends service factor greater than 1.5, manufacturer's recommendation takes precedence.

D. Vibration:
   1. Resonant Frequency: Ensure there are no natural resonant torsional, radial, or axial frequencies within 25 percent above or below the operating rotational frequencies or multiples of the operating rotational frequencies that may be excited by the equipment design.
   2. Design, balance and align equipment to meet the vibration criteria specified in Section 15958.

E. Equipment Mounting and Anchoring:
   1. Mount equipment on cast iron or welded steel bases with structural steel support frames. Utilize continuous welds to seal seams and contact edges between steel members. Grind welds smooth.
   2. Provide bases and supports with machined support pads, dowels for alignment of mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits.
   3. Provide jacking screws in bases and supports for equipment weighing over 1,000 pounds.
   4. Anchorage of Equipment to Concrete: Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
   5. Provide bolt sleeves for anchor bolts for heavy equipment. Adjust bolts to final location and fill sleeve with non-shrink grout.
   6. Anchorage of Equipment to Metal Supports: Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.
   7. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load, and other loads as required for proper operation of equipment.

F. Equipment Units Weighing 50 Pounds or More: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.

1.05 SUBMITTALS

A. Product Data:
   1. For Each Item of Equipment:
      a. Design features.
      b. Load capacities.
      c. Efficiency ratings.
      d. Material designations by UNS alloy number or ASTM Specification and Grade.
      e. Data needed to verify compliance with the Specifications.
      f. Catalog data.
      g. Name plate data.
      h. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
   2. Gear Reduction Units:
      a. Engineering information per applicable AGMA standards.
      b. Gear mesh frequencies.

B. Shop Drawings:
   1. Drawings for Equipment:
      a. Drawings that include outline drawings, cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
   2. Outline drawings showing equipment, driver, driven equipment, pumps, seal, motor(s) or other specified drivers, variable frequency drive, shafting, U-joints, couplings, drive arrangement, gears, baseplate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
   3. Installation and checkout instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial start-up procedures.

4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer based controls.
5. Recommended or normal operating parameters such as temperatures and pressures.
6. Alarm and shutdown set points for all controls furnished.

C. Calculations:
1. Calculations and other information to substantiate equipment base plates, supports, bolts, anchor bolts, and other connections meet minimum design strength requirements.
2. Bearing L_{10} life calculations in accordance with ABMA 9 or ABMA 11 calculation methods for drivers, pumps, gears, shafts, motors, and other drive line components with bearings.
3. Calculations and other information to substantiate that operating rotational frequencies meet the requirements of this Section.
4. Torsional Analysis of Power Transmission Systems: When torsional analysis specified in the equipment Sections, provide:
   a. Sketch of system components identifying physical characteristics including mass, diameter, thickness, and stiffness.
   b. Results of analysis including first and second critical frequencies of system components and complete system.
5. Calculations shall be signed and stamped by a civil or structural engineer registered to practice in the state where the Project is located.

D. Quality Control Submittals:
1. Source quality control reports and certified test data as specified in Section 15958.
2. Submit factory test reports before shipment.
3. Certified static and dynamic balancing reports for rotating equipment.
4. Field quality control reports and test data as specified in Section 15958.
5. Start-Up Plan: Proposed plan for field-testing equipment.
6. Certificate of Proper Installation.
7. Submit material test reports a specified in the equipment sections.

E. Operation and Maintenance Manuals:
1. Submit prior to training of OWNER's personnel.
2. Make available at project site complete copy of manuals for use by field personnel and ENGINEER during start-up and testing of equipment.
3. Include manufacturer and model number of every bearing; include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.
4. Include motor rotor bar pass frequencies.

1.06 QUALITY ASSURANCE

A. Manufacturer's Field Service:
1. Furnish services of authorized representative specially trained in installation of equipment.
   a. Visit project site and perform tasks necessary to certify installation.
   b. Furnish Certificate of Proper Installation.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:
   1. Equipment: Pack in boxes, crates, or otherwise protect from damage and moisture, dust, or dirt during shipment, handling, and storage.
   2. Bearings: Separately pack or otherwise suitably protect during transport.
   3. Spare Parts: Deliver in boxes labeled with contents, equipment to which spare parts belong, and name of CONTRACTOR.

B. Storage:
   1. Equipment Having Bearings: Store in enclosed facilities. Rotate units at least once per month or more often as recommended by the manufacturer to protect rotating elements and bearings.
   2. Gear Boxes: Oil filled or sprayed with rust preventive protective coating.

C. Protection:
   1. Equipment: Protect equipment from deleterious exposure.
   2. Painted Surfaces: Protect against impact, abrasion, discoloration, and other damage.

1.08 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Equipment for project include:
      a. Installation in a wastewater treatment plant.
      b. Moderate quantities of commercial and industrial waste.
      c. Ambient Temperatures: 20 to 110 degrees Fahrenheit.
      d. Relative Humidities: 50 to 100 percent.
      e. Site Elevation: Approximately 15-20 feet above mean sea level.

1.09 SEQUENCING AND SCHEDULING

A. Equipment Anchoring: Obtain anchoring material and templates or setting drawings from equipment manufacturers in adequate time for anchors to be cast-in-place when concrete is placed.

B. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

C. General Start-Up and Testing of Equipment:
   1. Perform general start-up and testing procedures after operation and maintenance manuals for equipment have been received.
   2. Conduct functional testing of mechanical or electrical systems when each system is substantially complete and after general start-up and testing procedures have been successfully completed.
   3. Functional testing requirements as specified in Section 15958 and 16950 and the equipment sections.

1.10 MAINTENANCE

A. Special Tools:
   1. When specified, provide special tools required for operation and maintenance.

2. Mark or tag and list such tools in maintenance and operations instructions. Describe use of each tool.

B. Spare Belts:
   1. When spare belts are specified, furnish 1 spare belt for every different type and size of belt-driven unit.
      a. Where 2 or more belts are involved, furnish matched sets.
      b. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.
      c. Package in boxes labeled with identification of contents.

C. Spare Parts:
   1. Assume responsibility until turned over to OWNER.
   2. Store in enclosed facilities.
   3. Furnish itemized list and match identification tag attached to every part.
   4. List parts by generic title and identification number.
   5. Furnish name, address, and telephone number of supplier and spare parts warehouse.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ferrous Materials:
   1. Steel for Members used in Fabrication of Assemblies: ASTM A 36.
   2. Iron Castings: ASTM A 48, tough, close-grained gray iron, free from blowholes, flaws, and other imperfections.
   3. Galvanized Steel Sheet: ASTM A 526, minimum 0.0635 inch (16 gauge).
   4. Expanded Metal: ASTM A 36, 13 gauge, 1/2-inch flat pattern expanded metal.

B. Nonferrous Materials:
   1. Stainless Steel: Type 304 or 316 as specified. Provide L grade where welding required.
   2. Bronze in Contact with Liquid: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C83600, C92200 or C92700 in accordance with ASTM B 61, B 62, B 505, or B 584, when not specified otherwise.

C. Dielectric Materials for Separation of Dissimilar Metals:
   1. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials.

D. Anchors Bolts: As specified.

2.02 SHAFT COUPLINGS

A. General:
   1. Type and Ratings: Provide nonlubricated type, designed for not less than 50,000 hours of operating life.
   2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, and type of service.

3. Use: Use of couplings specified in this Section does not relieve CONTRACTOR of responsibility to provide precision alignment of driver-driven units as required by equipment manufacturer and alignment criteria specified elsewhere in this section.

B. Shaft Couplings - Close Coupled: Shaft couplings for close coupled electric motor driven equipment 1/2 horsepower or larger and subject to sudden torque reversals or shock loading:
   1. Manufacturers: One of the following or equal:
      a. T.B. Woods, Dura-Flex, L-Jaw C-Jaw or G-Jaw.
      b. Lovejoy, S-Flex.
   2. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
   3. Manufacture flexible component of coupling from synthetic rubber, or urethane.
   4. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
   5. Do not allow metal-to-metal contact between driver and driven equipment.
   6. Examples of loads where sudden torque reversals may be expected:
      a. Reciprocating pumps, blowers, and compressors.
      b. Conveyor belts.
      c. Reversing equipment.

C. Shaft Couplings - Direct Connected: Shaft couplings for direct connected electric motor driven equipment 1/2 horsepower or larger and subject to normal torque, non-reversing applications:
   1. Manufacturers: One of the following or equal:
      a. Falk, WA Torus.
      b. T.B. Woods, Dura-Flex, Sure-Flex or Form-Flex.
   2. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.
   3. Provide flexible connecting element of rubber and reinforcement fibers.
   4. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.

D. Spacer Couplings: Where cartridge type mechanical seals or non-split seals are specified, provide a spacer type coupling of sufficient length to remove the seal without disturbing the driver or driven equipment unless noted otherwise in the individual equipment specifications.

E. Specialized Couplings: Where requirements of equipment dictate specialized features, supply coupling recommended for service by manufacturer.

2.03 STUFFING BOX, SEAL CHAMBER, AND SHAFT SEALS

A. General:
   1. Unless otherwise noted in the equipment section, provide cartridge type, double mechanical shaft seals for pumps.
   2. Provide a stuffing box large enough for a double mechanical seal.
   3. Where packing is specified, provide stuffing box large enough to receive a double mechanical seal.
   4. Provide seal or packing flush connections, (3/4-inch size unless another size is indicated on the Drawings).

5. Provide and route leakage drain line to nearest equipment floor drain indicated on the Drawings.
6. For pumps with packing, design packing gland to allow adjustment and repacking without dismantling pump except to open up packing box.
7. Seal or packing flush requirements shall be in accordance with API Standard 682 requirements. Unless otherwise indicated, specified or required by the equipment and seal manufacturers, the following API flushing Plan arrangements shall be utilized as appropriate for the application:
    a. Single seal, clean water applications: Plan 11 (Discharge bypass to seal).
    b. Single seal, vertical pump applications: Plan 13 (Seal bypass to suction).
    c. Single seal, clean hot water (greater than 180 degrees Fahrenheit) applications: Plan 23 (Seal cooler and pumping ring).
    d. Single seal, solids, or contaminants containing water applications: Plan 32 (External seal water- see Carollo typical detail # M262).
    e. Double seal applications: Plan 54 (External seal water- see Carollo typical detail # M262).

B. Packing: When specified in the equipment section of the specifications, provide the following type of packing:
    1. Wastewater, water, and sludge applications:
        a. Asbestos free.
        b. PTFE (Teflon) free.
        c. Braided graphite.
        d. Manufacturers: One of the following or equal:
            1) Chesterton, 1400.
            2) John Crane Inc., equivalent product.
    2. Drinking water service:
        a. Approved by the FDA or NSF.
        b. Asbestos free.
        c. Material: Braided PTFE (Teflon).
        d. Manufacturers: One of the following or equal:
            1) Chesterton, 1725.
            2) John Crane, Inc., equivalent product.

C. Mechanical seals: Provide seal types specified in the equipment sections and as specified.
    1. Provide seal types meeting the following requirements:
        a. Balanced hydraulically.
        b. Spring: Stationary, out of pumping fluid, Hastelloy C; Type Elgiloy or 17-7 PH stainless steel for split seals.
        c. O-ring: Viton 747.
        d. Gland: Type 316L stainless steel.
        e. Set screws: Type 316L stainless steel.
        f. Faces: Reaction bonded, Silicon Carbide.
        g. Seal designed to withstand 300 pounds per square inch gauge minimum differential pressures in either direction; no requirement for seal buffer pressure to be maintained when pump is not operational even though process suction head may be present in pump.
    2. Cartridge type single mechanical: Manufacturers: One of the following or equal:
        a. Chesterton, S10.
        b. John Crane, 5610 Series.

3. Cartridge type double mechanical: Manufacturers: One of the following or equal:
    a. Chesterton, S20.
    b. John Crane, 5620 Series.
4. Split face single mechanical: Manufacturers: One of the following or equal:
    a. Chesterton, 442.
    b. John Crane, 3710.

2.04 GEAR REDUCTION UNITS

A. Type: Helical or herringbone, unless otherwise specified.

B. Design:
1. Made of alloys treated for hardness and for severe service.
2. AGMA Class II Service:
    a. Use more severe service condition when such is recommended by unit's manufacturer.
3. Cast iron housing with gears running in oil.
4. Anti-friction bearings.
5. Thermal horsepower rating based on maximum horsepower rating of prime mover not actual load.
6. Manufactured in accordance with applicable AGMA standards.

C. Planetary gear units are not to be used.

2.05 BEARINGS

A. Type: Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.

B. Oil Lubricated Bearings: Provide either pressure lubricating system or separate oil reservoir splash type system.
1. Size oil lubrication systems to safely absorb heat energy generated in bearings when equipment is operating under normal conditions and with the ambient temperature 15 degree Fahrenheit above the maximum ambient temperature specified elsewhere in this Section.
2. Provide an external oil cooler when required to satisfy the specified operating conditions. Provide air cooled system if a water cooling source is not indicated on the Drawings. Equip oil cooler with a filler pipe and external level gauge.

C. Grease Lubricated Bearings, Except Those Specified to Be Factory Sealed: Fit with easily accessible grease supply, flush, drain, and relief fittings.
1. Lubrication Lines and Fittings:
    a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
    b. Multiple Fitting Assemblies: Mount fittings together in easily accessible location.
    c. Use standard hydraulic type grease supply fittings.
        1) Manufacturers: One of the following or equal:
            a) Alenite.
            b) Zurk.

D. Ratings: Rated in accordance with ABMA 9 or ABMA 11 for L_{10} rating life of not less than 50,000 hours.

1. Higher ratings, when specified in other Sections, supersede preceding requirement.

2.06 SAFETY GUARDS

A. Drive Assemblies: Enclose sprockets, belts, drive chains, gearings, couplings, and other moving parts on drive assemblies in safety enclosures that are in compliance with applicable Laws and Regulations.

B. Shafts: Provide guards that protect personnel from rotating shafts or components within 7.5 feet of floors or operating platforms.

C. Guard Requirements:
   1. Allow visual inspection of moving parts without removal.
   2. Allow access to lubrication fittings.
   3. Prevent entrance of rain or dripping water for outdoor locations.
   4. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of one belt.

D. Materials:
   1. Sheet Metal: Carbon steel, 12 gauge minimum thickness, hot-dip galvanized after fabrication.
   2. Fasteners: Type 304 stainless steel.

2.07 SPRING VIBRATION ISOLATORS

A. Design Requirements:
   1. Telescopic top and bottom housing with vertical stabilizers to resist lateral and vertical forces.
   2. Use steel coil springs.

B. Performance Requirements: Minimum spring deflection of 1 inch under static load and capable of limiting transmissability to10 percent maximum at design operating load.

C. Manufacturers: One of the following or equal:
   1. California Dynamics Corporation, Type RJSD.
   2. Mason Industries, equivalent product.

D. Materials:
   1. Fabricate isolators using welded steel or shatterproof ductile iron in accordance with ASTM A 536 Grade CS-45-12.
   2. Spring Steel: ASTM A 125.

2.08 WARNING SIGNS

A. Provide for equipment that starts automatically or remotely.

B. Material and Size: Metal as specified.

C. Colors: Black lettering on yellow background.

D. Text: As specified.

2.09 FABRICATION

A. Nameplates:
   1. Engraved or stamped on Type 304 stainless steel and fastened to equipment at factory in an accessible and visible location.
   2. Indicate Following Information as Applicable:
      a. Manufacturer's name.
      b. Equipment model number and serial number.
      c. Maximum and Normal rotating speed.
      d. Horsepower.
      e. Rated capacity.
      f. Service class per applicable standards.
   3. Nameplates for Pumps: Include:
      a. Rated total dynamic head in feet of fluid.
      b. Rated flow in gallons per minute.
      c. Impeller, gear, screw, diaphragm, or piston size.
   4. Gear Reduction Units: Include:
      a. AGMA Class of service.
      b. Service factor.
      c. Input and output speeds.

B. Bolt Holes in Equipment Support Frames: Do not exceed bolt diameter by more than 25 percent, up to limiting maximum diameter oversize of 1/4 inch.

C. Shop Finishing:
   1. Provide factory and field coating as follows:
      a. Bases and Support Frames in Contact with Concrete or Other Material: Coat contacting surfaces with minimum of 2 coats of zinc chromate primer before installation or grouting.
      b. Shop Primer for Steel and Iron Surfaces, Unless Specified Otherwise:
         1) Manufacturers: One of the following or equal:
            a) Ameron, Amercoat 185 Universal Primer.
            b) Cook, 391-N-167 Barrier Coat.
            c) Kop-Coat, Pug Primer.
            d) Tnemec, 37-77 Chem-Prime.
            e) Valspar, 13-R-28 Chromox Primer.
      c. Coat machined, polished, and nonferrous surfaces which are not to be painted with rust-preventive compounds.
         1) Manufacturers: One of the following or equal:
            a) Houghton, Rust Veto 344.
            b) Rust-Oleum, R-9.
      d. Coating for Ferrous Metal Surfaces, Except Stainless Steel: High solids polyamine epoxy.
      e. Finish Painting of Motors: Shop finish paint with manufacturer's standard coating.

2.10 SOURCE QUALITY CONTROL

A. As specified in Section 15958 for testing requirements and the individual equipment sections of the Specifications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components for shipping damage, conformance to specifications, and proper torques and tightness of fasteners.

3.02 PREPARATION

A. Metal Work Embedded in Concrete:
   1. Accurately place and hold in correct position while concrete is being placed.
   2. Clean surface of metal in contact with concrete immediately before concrete is placed.

B. Concrete Surfaces Designated to Receive Grout:
   1. Heavy sandblast concrete surface in contact with grout.
   2. Clean surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bonding of grout.
   3. Concrete Saturation: Saturate concrete with water. Concrete shall be saturated surface damp at time grout is placed.

C. Field Measurements:
   1. Prior to fabrication of equipment, take measurements for installation of equipment and verify dimensions indicated on the Drawings. Ensure equipment and ancillary appurtenances fit within available space.

3.03 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions and recommendations.

B. Lubrication Lines and Fittings:
   1. Lines from Fittings to Point of Use: Support and protect.
   2. Fittings:
      a. Bring fittings to outside of equipment in manner such that they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
      b. Mount fittings together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
      c. Fittings for Underwater Bearings: Bring fittings above water surface and mount on edge of structure above.

C. Alignment of Drivers and Equipment:
   1. Where drive motors or other drivers are connected to driven equipment by flexible coupling, disconnect coupling halves and align driver and equipment after complete unit has been leveled on its foundation.
   2. Comply with procedures of appropriate Hydraulic Institute Standards, AGMA Standards, alignment tolerances of equipment manufacturers and the following requirements to bring components into angular and parallel alignment:
      a. Maximum Total Coupling Offset (not the per plane offset): Not to exceed 0.5 mils per inch of coupling length for spacer couplings based on coupling length (not dial separation).

b. Utilize jacking screws, wedges, or shims as recommended by the equipment manufacturer and as specified in the equipment sections.

3. Use reverse-indicator arrangement dial type or laser type alignment indicators: Mount indicators on the driver/coupling flange and equipment/coupling flange. Alignment instrumentation accuracy shall be sufficient to read angular and radial misalignment at 10 percent or less of the manufacturer's recommended acceptable misalignment.
4. Alignment and calculations shall include measurement and allowance for thermal growth, spacer coupling length, indicator separation and axial spacing tolerances of the coupling.
5. When alignment satisfies most stringent tolerance of system components, grout between base and foundation. Allow minimum 48 hours for grout to harden. After grout hardens, remove jacking screws, tighten anchor bolts and other connections, and recheck alignment. Correct alignment as required.
6. After operational testing is complete, dowel motor or drivers and driven equipment. Comply with manufacturer's instructions.

D. Special Techniques: Use applicable special tools and equipment, including precision machinist levels, dial indicators, and gauges as required in equipment installations.

E. Tolerances:
1. Completed Equipment Installations: Comply with requirements for intended use and specified vibration and noise tolerances.

F. Warning Signs: Mount securely with stainless fasteners at equipment that can be started automatically or from remote locations.

3.04 FIELD QUALITY CONTROL

A. Test equipment as specified in Section 15958 and the individual equipment Section of the Specifications.

3.05 MANUFACTURER'S REPRESENTATIVE

A. Field Checkout: Before field-testing and start-up, provide services of factory-trained field service representative to certify the equipment has been installed, aligned, and checked in accordance with the manufacturer’s instructions and the Specifications.

B. Testing: Provide services of factory trained representative to observe and advise the CONTRACTOR during field quality control testing.

C. Training: When training is specified, provide services of factory-trained representative to perform training as specified.

END OF SECTION

SECTION 15052

BASIC PIPING MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic piping materials and methods.

1.02 REFERENCES

A. American Society of Testing and Materials (ASTM):
   1. F 37 - Standard Test Methods for Sealability of Gasket Materials.

1.03 DEFINITIONS

A. Buried Pipe: Pipe that is buried in the soil, or cast in a concrete pipe encasement that is buried in the soil.

B. Exposed Pipe: Pipe that is located above ground, or pipe that is located inside a structure, supported by a structure, or case into a concrete structure.

C. Underground Piping: Piping actually buried in soil or cast in concrete.

D. Underwater Piping: Piping below tops of walls in basins or tanks containing water.

E. Wet Wall: Wall with water on at least 1 side.

1.04 SUBMITTALS

A. Product Data:
   1. Link -type seals.
   2. Gaskets.

PART 2 PRODUCTS

2.01 LINK TYPE SEALS

A. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
   2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
   3. Provide a nylon polymer pressure plate with 316 Stainless Steel hardware. Isolate pressure plate from contact with wall sleeve.

B. Manufacturers: One of the following or equal:
   1. Calpico, Incorporated.

2. Pipeline Seal and Insulator, Inc., Link-Seal.

2.02 GASKETS

A. Gaskets for Non-Steam Cleaned Ductile Iron and Steel Piping:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to or less than 250 degrees Fahrenheit, and raw sewage service.
   2. Gasket Material:
      a. Neoprene elastomer with minimum Shore A hardness value of 70.
      b. Reinforcement: Inserted 13-ounce nylon fabric cloth for pipes 20 inch or larger.
      c. Thickness: Minimum 3/32-inch thick for less than 10-inch pipe; minimum 1/8 inch thick for 10-inch and larger pipe.
   3. Manufacturers: One of the following or equal:
      a. Pipe less than 20 inches in diameter:
         1) Garlock, Style 7797.
         2) John Crane, similar product.
      b. Pipe 20 inches in diameter and larger:
         1) Garlock, Style 8798.
         2) John Crane, similar product.

B. Gaskets for Flanged Joints in Polyvinyl Chloride and Polyethylene Piping:
   1. Suitable for pressures equal to or less than 150-pounds per square inch gauge, with low flange bolt loadings, temperatures equal and less than 120 degrees Fahrenheit, and polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine including fluorochemicals and gaseous fluorine.
   2. Material: 0.125-inch thick Viton rubber.
   3. Manufacturers: One of the following or equal:
      a. Garlock.
      b. John Crane, similar product.

C. Gaskets for Flanged Joints in Ductile Iron or Steel Water Piping:
   1. Suitable for hot or cold water, pressures equal to or less than 150 pounds per square inch gauge, and temperatures equal to or less than 160 degrees Fahrenheit.
   2. Material:
      a. Neoprene elastomer, compressed, with non-asbestos fiber reinforcement.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Bluegard 3300.
      b. John Crane, similar product.

D. Gaskets for any other fluids or any other pressure or temperature conditions shall be suitable for the specific fluids and pressure and temperature conditions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Existing Conditions:

1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions that may affect construction of underground piping before starting excavation for new underground piping and appurtenances.
2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.02 INSTALLATION

A. General:
   1. Piping Drawings:
      a. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.
      b. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
         1) Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.
   2. Piping Alternatives:
      a. Provide piping as specified in this Section, unless indicated on the Drawings or specified otherwise.
      b. Alternative Pipe Ratings: Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price. Piping of different material may not be substituted in lieu of specified piping.
      c. Valves in Piping Sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.
      d. For flanged joints, where one of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.

B. Wall and Slab Penetrations:
   1. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, unless specified or otherwise indicated on the Drawings.
   2. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.
      a. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
      b. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
      c. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
      d. Seal spaces between pipes and sleeves with link-type seals when not otherwise specified or indicated on the Drawings.

e. Seal openings around piping running through interior walls and floors of chlorine rooms and chlorine storage rooms gastight with synthetic rubber sealing compound.

C. Exposed Piping:
1. Install exposed piping in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings.
a. Install piping runs plumb and level, unless otherwise indicated on the Drawings. Slope plumbing drain piping with a minimum of 1/4 inch per foot downward in the direction of flow. Slope digester gas piping to drip traps or low-point drains at a minimum of 1/2 inch per foot where condensate flows against the gas, or at a minimum of 1/4 inch per foot where condensate flows with gas.
2. Install exposed piping after installing equipment and after piping and fitting locations have been determined.
3. Support Piping
a. Do not transfer pipe loads and strain to equipment.
4. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
5. Assemble piping without distortion or stresses caused by misalignment.
a. Match and properly orient flanges, unions, flexible couplings, and other connections.
b. Do not subject piping to bending or other undue stresses when fitting piping. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
c. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
d. Alter piping assembly to fit, when proper fit is not obtained.
e. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

D. Buried Piping:
1. Bury piping with minimum 2-foot cover without air traps, unless otherwise indicated on the Drawings.
2. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.
3. Laying Piping:
a. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
b. Place piping with top or bottom markings with markings in proper position.
c. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
d. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
e. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.

E. Connections to Existing Piping:
   1. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings.
      a. Protect domestic water/potable water supplies from contamination.
         1) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
         2) Provide devices approved by OWNER of domestic water supply system to prevent flow from other sources into the domestic supply system.
   2. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
   3. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
   4. For flanged connections, provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

F. Connections to In-Service Piping:
   1. Where operation and maintenance of existing facilities require that a shutdown be made during hours other than normal working hours, perform the related work in coordination with the hours of actual shutdown.

G. Connections Between Ferrous and Nonferrous Metals:
   1. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
   2. Nonferrous metals include aluminum, copper, and copper alloys.

H. Flanged Connections Between Dissimilar Metals Such as Ductile Iron Pipe and Steel Pipe:
   1. Provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

3.03 CLEANING

A. Piping Cleaning:
   1. Upon completion of installation, clean piping interior of foreign matter and debris. Perform special cleaning when required by the Contract Documents.

3.04 PIPING SCHEDULE

A. Abbreviations:
   1. The following abbreviations used in the column of test method refer to the respective methods as specified in Section 15956.

AM	Air method
GR	Gravity method
HH	High head method
LH	Low head method
SC	Special case

2. Abbreviations to designate piping include the following:

ASPH	Asphaltic Base Coating
CE	Ceramic Epoxy
CI	Cast iron
CL	Class, followed by the designation
CM	Cement Mortar
CTE	Coal Tar Epoxy
DIP	Ductile iron piping
F	Flanged Joint
FBE	Fusion Bonded Epoxy
GA	Gauge, preceded by the designation
GE	Grooved end joint
HSE	High Solids Epoxy System
HSE/P	High Solids Epoxy and Polyurethane Coating System
MJ	Mechanical Joint
NPS	Nominal pipe size, followed by the number in inches
PJ	Push-On Joint
psi	pounds per square inch
psig	pounds per square inch gauge
PVC	Polyvinyl Chloride
SCH	Schedule, followed by the designation
SST	Stainless steel

PIPING SCHEDULE								
Pipe Service Abbrev.	**Service**	**Nominal Diameter (inches)**	**Materials**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**
GOF	Grit overflow	All	PVC	SCH 80	SW	50 psig/HH	None	None
GS	Grit slurry	All	PVC	SCH 80	SW	50 psig/HH	None	None
SW	Plant Service Water	1-3	PVC	SCH 80	SW	150 psig/HH	None	None
Notes: 1. All exposed piping shall be painted and/or coated in accordance with Section 09960.								

END OF SECTION

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SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Mechanical Identification including the following:
   1. Equipment nameplates.
   2. Pipe identification by color and legend.
   3. Underground Warning Tape
   4. Identification of equipment and components of systems with paint, brands, tags, and signboards.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit Following:
   1. Product data.
   2. Samples.
   3. Manufacturer's installation instructions.
   4. Submit following:
      a. Operation and Maintenance Data.
      b. Warranty.

PART 2 PRODUCTS

2.01 EQUIPMENT NAMEPLATES

A. Material and Fabrication:
   1. Stainless steel sheet engraved or stamped with text, holes drilled, or punch for fasteners.

B. Fasteners:
   1. Number 4 or larger oval head stainless steel screws or drive pins.

C. Text:
   1. Manufacturers name, equipment model number and serial number, identification tag number, and when appropriate, drive speed, motor horsepower with rated capacity, pump rated total dynamic head and impeller size.

2.02 PIPE IDENTIFICATION

A. Manufacturers:

1. One of the following or equal:
    a. Seton, Opti Code Pipe Markers.
    b. Lab Safety Supply.

B. Materials:
1. Pipe Markers: Self-adhesive vinyl, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; meet ANSI A13.1 requirements.
    a. Lettering:

Nominal Pipe Diameter	Lettering Size
Less than 1.5	1/2 inch
1.5 inches to 2 inches	3/4 inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

    b. Marker Colors:

Service	Lettering	Background
Flammables, chemicals, toxics	Black	Yellow
Water, nontoxic solutions or low hazard liquids	White	Green
Nonflammable or nontoxic gases	White	Blue
Fire quenching fluids (foam, fire water, CO_2 Halon)	White	Red

2. Coating: As specified in Section 09960.
3. Pipe Identification Tags: Aluminum or stainless steel with stamped-in 1/4 inch high identifying lettering.
4. Pipe Identification Tag Chains: Aluminum or stainless steel.
5. Snap-on Markers: Markers with 3/4 inch high letters for 3/4 to 4 inch pipe or covering, or 5 inch high letters for 5 inch or larger pipe or cover, as manufactured by one of following:
    a. Brady Bradysnap-On B-915.
    b. Seton Setmark.

2.03 UNDERGROUND WARNING TAPE

A. Manufacturer:
1. One of the following or equal:
    a. Seton Name Plate Company, Branford, CT.

B. Material:
1. Metallic detection tape; minimum 4 mil thick by 6 inches wide polyethylene film with wording, “Caution” with name of service followed by words, “Line Buried Below” repeated continuously along tape length, with alternate metallic and color strips. Colors as follows:

a. Water: Blue.
b. Telephone: Orange.
c. Sewer: Green.
d. Gas and Other Services: Yellow.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified.

3.02 PREPARATION

A. Prepare and coat surfaces as specified in Section 09960.

B. Prepare surface in accordance with product manufacturer's instructions.

3.03 PIPING IDENTIFICATION

A. Identify exposed piping, valves, and accessories, and piping, in accessible chases with lettering or tags designating service of each piping system with flow directional arrows and color code.

B. Color Code:
1. Coat piping scheduled to be color coded completely with specified colors.
2. Coat segments of pipe specified to be unpainted with specified coding color long enough to accommodate required lettering and arrows.

C. Coat piping specified to be coated to match adjacent surfaces, unless otherwise directed.

D. Lettering and Flow Direction Arrows:
1. Stencil lettering on painted bands or use snap-on markers on pipe to identify pipe. When stenciling, stencil 3/4 inch high letters on 3/4 through 4-inch pipe or coverings, or 5-inch high letters on 5-inch and larger pipe or coverings.
2. Provide lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee, and at intervals of not more than 50 feet in straight runs of pipe.

E. Where scheduled, space 6-inch wide bands along stainless steel pipe at 10-foot intervals and other pipe at 5-foot intervals.

F. Metal Tags:
1. Where outside diameter of pipe or pipe covering is 5/8 inch or smaller, provide metal pipe identification tags instead of lettering.
2. Fasten pipe identification tags to pipe with chain.
3. Where tags are used, color code pipe as scheduled.

G. Underground Warning Tape:

1. Place warning tape in pipe trench, 12 inches above the pipe.

3.04 APPLICATION

A. Identify piping with legend markers, directional arrow markers, and number markers; use self adhesive arrow roll tape to secure ends of piping markers and indicate flow direction.

B. Provide legend markers, directional arrow markers and number markers where piping passes through walls or floors, at piping intersections and at maximum 15 foot spacing on piping runs.

C. Provide piping marker letters and colors as scheduled.

D. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere.

END OF SECTION

SECTION 15094

PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals and install pipe hangers, supports, concrete inserts and anchor bolts including all metallic hanging and supporting devices for supporting exposed piping.

1.02 QUALIFICATIONS

A. Hangers and supports shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for pipe supports shall be five (5) times the ultimate tensile strength of the material.

B. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, the Contractor shall submit a certification stating that such requirements have been complied with.

1.03 SUBMITTALS

A. Submit to the Engineer for approval, as provided in the Contract Documents, shop drawings of all items to be furnished under this Section.

B. Submit to the Engineer, for approval, samples of all materials specified herein.

C. All pipe hangers, supports, hanger rods, clamps, concrete inserts and wall brackets, etc., whether specified or not, shall be submitted (together with load calculations) to the Engineer for approval, if requested.

PART 2 PRODUCTS

2.01 GENERAL

A. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, and fittings and to support and secure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. All pipe supports shall be approved prior to installation.

B. All materials used in manufacturing hangers and supports shall be capable of meeting the respective ASTM Standard Specifications with regard to tests and physical and chemical properties, and be in accordance with MSS SP-58.

C. Hangers and supports shall be spaced in accordance with ANSI B31.1.0 except that the maximum unsupported span shall not exceed ten (10) feet unless otherwise specified herein.

D. Unless otherwise specified herein, pipe hangers and supports shall be as manufactured by Grinnell Co., Inc., Carpenter and Patterson, Inc., or equal. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary. Any item comparable in type, style, quality, design and performance will be considered for approval.

2.02 PIPE HANGERS AND SUPPORTS FOR METAL PIPE

A. Suspended single pipes shall be supported by hangers suspended by steel rods from galvanized concrete inserts, beam clamps, or ceiling mounting bolts.

B. The following sizes are minimum requirements and are subject to the Engineer's approval:
   1. Hanger rods shall be rolled steel machine threaded with load ratings conforming to ASTM Specifications and the strength of the rod shall be based on root diameter. Hanger rods shall have the following minimum diameters:

Pipe Size (inches)	Minimum Rod Diameter (inches)
Less than 2 1/2	3/8
2 1/2 - 4	1/2
4	5/8
6	3/4
8 -12	7/8
14 - 18	1
20 - 30	1 1/4

   2. Where applicable, structural attachments shall be beam clamps. Beam clamps, for rod sizes 1/2-inch through 3/4-inch shall be equal to Grinnell Fig. No. 229, and for rod sizes 7/8-inch through 1-1/4 inches shall be equal to Grinnel Fig. No. 228, or equal.
   3. Concrete inserts for pipe hangers shall be continuous metal inserts designed to be used in ceilings, walls or floors, spot insets for individual pipe hangers, or ceiling mounting bolts for individual pipe hangers and shall be as manufactured by Unistrut Corp., Wayne, Michigan; Carpenter and Patterson, Inc., Richmond or equal and shall be as follows:
      a. Continuous concrete inserts shall be used where applicable and/or as shown on the Drawings and shall be used for hanger rod sizes up to and including 3/4-inch diameter. Inserts to be used where supports are parallel to the main slab reinforcement shall be Series P3200 by Unistrut Corp., Fig. 1480 Type 2 by Carpenter and Patterson, Inc. or equal. Inserts to be used where supports are perpendicular to the main slab reinforcement shall be Series P3300 by Unistrut Corp., Fig. 1480 Type I by Carpenter and Patterson, Inc., or equal.
      b. Spot concrete inserts shall be used where applicable and shall be used for hanger sizes up to and including 7/8-inch diameter. Inserts shall be Fig. 650 by Carpenter and Patterson, Inc. for hanger rod sizes 1/2-inch through

and including 3/4-inch and Fig. 266 by Carpenter and Patterson, Inc., for 7/8-inch hanger rods.

c. Ceiling mounting bolts shall be used where applicable and be for hanger rod sizes 1-inch through and including 1-1/4 inches shall be Fig. 104M as manufactured by Carpenter and Patterson, Inc. or equal.

d. All pipe hangers shall be capable of vertical adjustment under load and after erection. Turnbuckles, as required and where applied, shall be equal to Grinnell Fig. No. 230.

4. Wall or column supported pipes shall be supported by welded steel brackets equal to Grinnell Fig. 194, 195 and 199 as required, for pipe sizes up to and including 20-inch diameter. Additional wall bearing plates shall be provided where required.

   a. Where the pipe is located above the bracket, the pipe shall be supported by an anchor chair and U-bolt assembly supported by the bracket for pipes 4-inches and larger or by a U-bolt for pipes smaller than 4-inches. Anchor chairs shall be equal to Carpenter and Patterson Fig. 127. U-bolts shall be equal to Grinnell Fig. 120 and 137.

   b. Where the pipe is located below the bracket, the pipes shall be supported by pipe hangers suspended by steel rods from the bracket. Hangers and steel rods shall be as specified above.

   c. Wall or column supported pipes 2-inches and smaller may be supported by hangers equal to Carpenter and Patterson Figures 74, 179 or 237 as required.

5. Floor supported pipes 3-inches and larger in diameter shall be supported by either cast-in-place concrete supports or adjustable pipe saddle supports as directed by the Engineer. In general, concrete supports shall be used when lateral displacement of the pipes is probable (unless lateral support is provided), and adjustable pipe saddle type supports shall be used where lateral displacement of the pipes is not probable.

   a. Each concrete support shall conform to the details shown on the Drawings. Concrete shall be poured after the pipe is in place with temporary supports. Top edges and vertical corners of each concrete support shall have 1-inch bevels. Each pipe shall be secured on each concrete support by a wrought iron or steel anchor strap anchored to the concrete with cast-in-place bolts or with expansion bolts. Where directed by the Engineer, vertical reinforcement bars shall be grouted into drilled holes in the concrete floor to prevent overturning or lateral displacement of the concrete support. Unless otherwise approved by the Engineer, maximum support height shall be five (5) feet.

   b. Concrete piers used to support base elbows and tees shall be similar to that specified above.

      1) Piers may be square or rectangular.

   c. Each adjustable pipe saddle support shall be screwed or welded to the corresponding size 150 lb. companion flanges or slip-on welding flanges respectively. Supporting pipe shall be of Schedule 40 steel pipe construction. Each flange shall be secured to the concrete floor by a minimum of two (2) expansion bolts per flange. Adjustable saddle supports shall be equal to Grinnell Fig. No. 264. Where used under base fittings, a suitable flange shall be substituted for the saddle.

   d. Floor supported pipes less than 3-inches shall be supported by fabricated steel supports.

6. Vertical piping shall be supported as follows:

a. Where pipes change from horizontal to vertical, the pipes shall be supported on the horizontal runs within two feet of the change in direction by pipe supports as previously specified herein.
b. For vertical runs exceeding 15 feet, pipes shall be supported by approved pipe collars, clamps, brackets, or wall rests at all points required to insure a rigid installation.
c. Where vertical piping passes through a steel floor sleeve, the pipe shall be supported by a friction type pipe clamp which is supported by the pipe sleeve. Pipe clamps shall be equal to Grinnell Fig. 262.

7. Anchor bolts shall be equal to Kwik-Bolt as manufactured by Hilti Fastening Systems, or Wej-it manufactured by Wej-it Expansion Products, Inc.
8. All rods, hangers, inserts, brackets, and components shall be furnished with galvanized finish.

2.03 PIPE HANGERS AND SUPPORTS FOR PLASTIC PIPE

A. Single plastic pipes shall be supported by pipe supports as previously specified herein.

B. Multiple, suspended, horizontal plastic pipe runs, where possible, and rubber hose shall be supported by ladder type cable trays such as the Electray Ladder by Husky-Burndy, the Globetray by the Metal Products Division of United States Gypsum, or equal. Ladder shall be of mild steel construction. Rung spacing shall be approximately 18-inches for plastic pipe and 12-inches for rubber nose. Tray width shall be approximately 6-inch for single runs of rubber hose and 12-inches for double runs of rubber hose. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc. required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners equal to Globe Model M-CAC, Huskey-Burndy Model SCR or equal. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe.

C. Individual clamps, hangers, and supports in contact plastic pipe shall provide firm support, but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

PART 3 EXECUTION

3.01 INSTALLATION

A. All pipes, horizontal and vertical, shall be rigidly supported from the building structure by approved supports. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or specified herein. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless it is so indicated on the Drawings, or specifically directed or authorized by the Engineer.

B. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement, and pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces. Prior to installation, all pipe supports shall be approved by the Engineer.

C. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings, and sleeve type couplings and to minimize all pipe forces to pump housings. Pump housings shall not be utilized to support connecting pipes.

D. Pipe supports shall be provided as follows:
   1. Cast iron and ductile iron shall be supported at a maximum support spacing of 10-feet 0-inches with a minimum of one (1) support per pipe section at the joints.
   2. Supports for multiple PVC pipes shall be continuous wherever possible. Individually supported PVC pipes shall be supported as recommended by the manufacturer except that support spacing shall not exceed five (5) feet.

E. Pipe supports shall not result in point loadings, but shall distribute pipe loads evenly along the pipe circumference.

F. Effects of thermal expansion and contraction of the pipe shall be accounted for in pipe support selection and installation.

G. Inserts for pipe hangers and supports shall be installed on forms before concrete is poured. Before setting these items, all drawings and figures shall be checked which have a direct bearing on the pipe locations. Responsibility for the proper location of pipe supports is included under this Section.

H. Continuous metal inserts shall be embedded flush with the concrete surface.

3.02 PRIME COATING

A. Prior to prime coating, all pipe hangers and supports shall be thoroughly clean, dry, and free from all mill-scale, rust, grease, dirt, paint, and other foreign substances to the satisfaction of the Engineer.

B. All submerged pipe supports shall be prime coated with TNEMEC 69-1211 Epoxy Primer or equal. All other pipe supports shall be prime coated with TNEMEC 66-1211, or equal.

C. Finish coating shall be compatible with the prime coating used and shall be applied as specified in the Contract Documents.

END OF SECTION

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SECTION 15265

PLASTIC PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Plastic pipe, tubing, and fittings.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. B 16.12 - Cast Iron Threaded Screwed Drainage Fittings.

B. American Society for Testing and Materials (ASTM):
   1. D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load.
   2. D 1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
   3. D 1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   4. D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   5. D 1869 - Standard Specification for Rubber Rings for Asbestos-Cement Pipe.
   6. D 2321 - Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   7. D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   8. D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   9. D 2467 - Standard Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   10. D 2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
   11. D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   12. D 2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
   13. D 2657 - Heat Joining Polyolefin Pipe and Fittings.
   14. D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
   15. D 2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
   16. D 2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
   17. D 2855 - Standard Practice for Making Solvent-cemented Joints with Poly (Vinyl Chloride)(PVC) Pipe and Fittings.
   18. D 3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

19. D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
20. D 3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
21. D 3350 - Standard Specification for Polyethylene Plastic Pipes and Fittings Materials.
22. D 4101 - Specification for Propylene Plastic Injection and Extrusion Materials.
23. F 439 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
24. F 441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
25. F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
26. F 483 - Standard Test Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals.
27. F 493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
28. F 645 - Guide for Selection, Design and Installation of Thermoplastic Water Pressure Piping Systems.
29. F 679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
30. F 714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

C. American Water Works Association (AWWA):
   1. C900 - Polyvinyl/Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water Distribution.

D. Code of Federal Regulations:
   1. Title 49 - Transportation.

E. Plastics Pipe Institute (PPI).
   1. TR 31 - Underground Installation of Polyolefin Piping.

F. United States Department of Transportation:
   1. Materials Transportation Bureau.

1.03 ABBREVIATIONS

A. DR: Dimension Ratio.

B. ID: Inside Diameter of piping or tubing.

C. NPS: Nominal Pipe Size followed by the size designation.

D. NS: Nominal Size of piping or tubing.

E. PVC: Polyvinyl Chloride.

F. SDR: Standard Dimension Ratio; the Outside Diameter divided by the pipe wall thickness.

1.04 SUBMITTALS

A. Product Data: Describe materials, pipe, fittings, gaskets and solvent cement.

B. Manufacturer's Published Installation Instructions.

C. Certificates:
   1. Submit manufacturer's certificate attesting that plastic pipe, tubing, and fitting types meet specified requirements.
   2. Manufacturer's certification of date of manufacture of plastic pipe and tubing for each lot delivered.
   3. Copies of solvent cement manufacturer's report and certification in accordance with ASTM D 2564 for PVC piping, and ASTM F 493 for CPVC piping.

1.05 QUALITY ASSURANCE

A. Mark plastic pipe with nominal size, type, class, schedule, or pressure rating, manufacturer and all markings required by applicable ASTM and AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and Molding Material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except that fittings used in drain, waste and vent piping systems need not be pressure rated.

C. Unions 2-1/2 Inches and Smaller: Socket end screwed unions. Make unions 3 inches and larger of socket flanges with 1/8-inch full face soft neoprene gasket.

2.02 PVC PIPING, SCHEDULE TYPE

A. Materials:
   1. PVC Schedule Type Piping: Designation PVC 1120 in accordance with ASTM D 1785 and appendices thereto.
      a. Pipe and Fittings: Extruded from Type I, Grade 1, Class 12454-B material in accordance with ASTM D 1784.
      b. PVC Schedule Type Piping: Schedule 80 unless otherwise indicated on the Drawings.
   2. Fittings:
      a. Supplied by pipe manufacturer.
      b. Pressure Fittings: In accordance with ASTM D 2466 or ASTM D 2467.

c. DWV Fittings: In accordance with ASTM D 2665.
3. Solvent Cement: In accordance with ASTM D 2564.

2.03 PVC PIPING, CLASS TYPE

A. PVC Pipe, Class Type: In accordance with ASTM D 2241.
1. Thermoplastic Pipe Materials Designation Code: PVC 1120, 1220 or 2120.
2. PVC Compound: Class 12454-B in accordance with ASTM D 1784.
3. Standard Dimension Ratio: SDR not greater than 17.

B. Fittings: Ductile iron with transition gasket sized to accommodate the outside pipe diameter.

2.04 SOURCE QUALITY CONTROL

A. PVC Piping, Schedule Type:
1. Mark pipe and fittings in accordance with ASTM D 1785.

B. PVC Piping, Class Type:
1. Test pipe to withstand, without failure, 600 pounds per square inch, gauge, hydrostatic pressure for a minimum of 5 seconds.
2. Test integral bell with the pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Where not otherwise specified, install piping in accordance with ASTM F 645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.
3. Locate unions where required for adequate access and assembly of the piping system.
4. Provide serrated nipples for transition from plastic pipe to rubber hose.

B. Installation of PVC Piping, Schedule Type:
1. Solvent weld joints in accordance with ASTM D 2855.
2. Install piping in accordance with manufacturer's published instructions.

C. Installation of PVC Piping, Class Type:
1. Install piping in accordance with the Appendix of AWWA C 900 complemented with manufacturer's published instructions.

3.02 FIELD QUALITY CONTROL

A. Leakage Test for PVC Piping, Class Type:
1. Polyvinyl-Chloride (PVC) Piping, Class Type: Subject to visible leaks test and to pressure test with maximum leakage allowance, as specified in Section 15956.

2. Pressure Test with Maximum Leakage Allowance: Perform test after backfilling.
   a. Pressure: 125 pounds per square inch, gauge.
   b. Maximum leakage allowance as follows, wherein the value for leakage is in gallons per 100 joints per hour:

NPS, Inches	**1-1/2**	**2**	**2-1/2**	**3**	**4**	**6**	**8**	**10**	**12**
Leakage	0.41	0.52	0.63	0.76	0.98	1.45	1.88	2.35	2.80

3. Test Procedure: Pull the mandrel through the line under test by one person, by hand, with reasonable effort, without the aid of mechanical equipment.
4. Failing Test: Where the mandrel test is not successful, remove and replace the section of piping with the obstruction, and test the piping again, including visible leaks test, pressure test with maximum leakage allowance, mandrel tests, and other specified tests:
   a. Correction of excessive deflection or obstructions by methods other than removal of the affected piping and replacement of the removed piping with new piping will not be accepted.

END OF SECTION

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SECTION 15956

PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Test requirements for piping systems.

1.02 REFERENCES

A. Uniform Plumbing Code (UPC).

B. Uniform Mechanical Code (UMC).

1.03 TESTING REQUIREMENTS

A. General Requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 15052; are specified in the specifications covering the various types of piping; and are specified herein.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the Uniform Plumbing Code, and UL requirements.
   4. When testing with water, the specified test pressure is considered to be the pressure at the highest point of the piping section under test. Lower test pressure as necessary to prevent testing the lowest point above a safe test pressure.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for Testing, Cleaning, and Disinfecting:
   1. Water for testing, cleaning, and disinfecting will be provided by the OWNER.

D. Pipes to be Tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful Tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test Completion: Drain and leave piping clean after successful testing.

G. Test Water Disposal: Dispose of testing water in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site.

1.04 SUBMITTALS

A. Schedule and Notification of Tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of Readiness to Test: Immediately before testing, notify ENGINEER in writing of readiness, not just intention, to test piping. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.05 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

C. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

D. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping schedule.

B. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment or piping specialties in test sections if test pressure exceeds the valve, equipment or piping specialty safe test pressure allowed by the item's manufacturer.

4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
6. When Test Results Indicate Failure of Selected Sections, Limit Tests to Piping:
   a. Between valves.
   b. Between a valve and the end of the piping.
   c. Less than 500 feet long.
7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing Procedures:
1. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where noted on the Piping Schedule
2. Before pressurizing for the tests, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
3. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure Test with Maximum Leakage Allowance:
1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
2. Pressure test piping after completion of visible leaks test.
3. For piping systems using joint designs other than flanged threaded or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
   a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
   b. Successful completion of the pressure test with maximum leakage allowance shall have been achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
   c. When leakage is allowed, calculate the allowable leakage by the following formula:

      $L = S \times D \times P^{1/2} \times 133{,}200^{-1}$ wherein the terms shall mean:

      L = Allowable leakage in gallons per hour.

      S = Length of the test section in feet.

      D = Nominal diameter of the piping in inches.

      P = Average observed test pressure in pounds per square inches, gauge, at the lowest point of the test section, corrected for elevation of the pressure gauge.

      x = The multiplication symbol.

END OF SECTION

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SECTION 15958

MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Testing of mechanical equipment and systems.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01756 - Testing, Training, and Facility Start-Up.
      b. Section 15956 - Piping Systems Testing.
      c. Section 16405 - Electric Motor

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. S1.4 Specification for Sound Level Meters.

B. Hydraulic Institute (HI).

1.03 SUBMITTALS

A. Schedule of factory tests and field tests as specified in Section 01756 and this Section.

B. Test instrumentation calibration data.

C. Start-up plan as specified in Section 01756.

D. Test plan specified in this Section.

E. Test result reports.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 QUALITY CONTROL TESTING AND REPORTING

A. Scheduling and notification:
   1. Witnessed source quality control tests: Schedule test date and notify ENGINEER at least 30 days prior to start of test.
   2. Field quality control tests: Schedule test date and notify ENGINEER at least 7 days prior to start of test.

B. Testing levels:
   1. Test equipment based on test levels specified in the equipment section of this Project.
   2. Requirements for Test Levels 1 to 4 are defined below.
   3. Test levels apply for both Source (Factory) Quality Control Tests and Field Quality Control Tests as specified in the equipment sections of this Project.
   4. If testing is not specified in the equipment section, provide Level 1 testing.

C. Witnessing: Source Quality Control Tests not witnessed unless specified otherwise in the equipment section; Field Quality Control Tests shall be witnessed.

D. Instrumentation: Provide necessary test instrumentation which has been calibrated within 1 year from date of test to recognized test standards traceable to the National Institute of Standards and Technology, Washington, D.C. or approved source. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for Field Quality Control Tests.

E. Temporary facilities and labor: Provide necessary fluids, utilities, temporary piping, temporary supports, temporary access platforms or access means and other temporary facilities and labor necessary to safely operate the equipment and accomplish the specified testing. With OWNER's permission, some utilities may be provided by fully tested permanently installed utilities that are part of the Work.

F. Test fluids:
   1. Factory tests: Use water or air as appropriate at ambient conditions unless specified otherwise in the equipment section.
   2. Field tests: Use specified process fluid at available conditions.

G. Pressure testing: Hydrostatically pressure test pressure containing parts in the factory at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher. Submit pressure test reports before shipping.

H. Test measurement and result accuracy:
   1. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
   2. Do not adjust results of tests for instrumentation accuracy. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

I. Field testing:
   1. Submit test plan as specified in Section 01756 and this Section. Indicate test start time and duration, equipment to be tested, other equipment involved or required; temporary facilities required, number and skill or trade of personnel involved; safety issues and planned safety contingencies; anticipated effect on OWNER's existing equipment and other information relevant to the test. Provide locations of all instruments to be used for testing. Provide calibration records for all instrumentation.
   2. Perform general start-up and testing procedures as specified in Section 01756.
   3. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.

J. Reports: Submit reports for source and field-testing. Submit Source Quality Control Test result reports before shipping equipment to the field. Report features:
   1. Report results in a bound document in generally accepted engineering format with title page, written summary of results compared to specified requirements, and appropriate curves or plots of significant variables in English units.
   2. Include appendix with a copy of raw, unmodified test data sheets indicating test value, date and time of reading, and initials of person taking the data.
   3. Include appendix with sample calculations for adjustments to raw test data and for calculated results.
   4. Include appendix with the make, model, and last calibration date of instrumentation used for test measurements.
   5. Include in body of report a drawing or sketch of the test system layout showing location and orientation of the test instruments relative to the tested equipment features.

3.02 EQUIPMENT TESTING, GENERAL

A. Tests for pumps, all levels of testing:
   1. Test in accordance with applicable HI Standards in addition to the requirements in this and other Sections.
   2. Test tolerances: In accordance with appropriate HI Standards, except the following modified tolerances apply:
      a. From 0 to plus 5 percent of head at the specified flows rated design point flow.
      b. From 0 to plus 5 percent of flow at the rated design point head.
      c. No negative tolerance for the efficiency at the specified flows rated design point.
      d. No positive tolerance for vibration limits. Vibration limits and test methods in HI Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

B. Tests for drivers: Test motors as specified in Section 16405. Test other drivers as specified in the driver equipment section.

3.03 REQUIREMENTS FOR VIBRATION TESTING

A. Definitions:
   1. Peak-to-peak displacement: The root mean squared average of the peak-to-peak displacement multiplied by the square root of 2.
   2. Peak velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
   3. Peak acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
   4. High frequency enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency.
      a. Manufacturers: One of the following or equal:
         1) Rockwell Automation, Entek Group, "Spike Energy" analysis.
         2) CSI, "PeakVue."
   5. Low speed equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
   6. High speed equipment: Equipment and equipment components operating at or above 600 revolutions per minute.

B. Vibration instrumentation requirements:
   1. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12 bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, RS232C data output port, circuitry for integration of acceleration data to velocity or double integration to displacement.
      a. Manufacturers: One of the following or equal:
         1) Entek-IRD, Division of Rockwell Automation, Enpac 1200 with applicable data analysis software or Entek Model 838 analyzer with built in printer.
         2) Computational Systems Inc., (CSI) Division of Emerson Electric, Model 2120A, Data Collector/analyzer with applicable analysis software.
   2. Analyzer settings:
      a. Units: English, inches/second, mils, and gravitational forces.
      b. Fast fourier transform lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 revolutions per minute; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
      c. Sample averages: 4 minimum
      d. Maximum frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
      e. Amplitude range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
      f. Fast fourier transform windowing: Hanning Window.
      g. High pass filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.

3. Accelerometers:
    a. For low speed equipment: Low frequency, shear mode accelerometer, 500 millivolts per gravitational force sensitivity, 10 gravitational force range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount.
        1) Manufacturers: One of the following or equal:
            a) Wilcoxon Research, Model 797L.
            b) PCB, Model 393C.
    b. For high speed equipment: General purpose accelerometer, 100 millivolts per gravitational force sensitivity, 50 gravitational force range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder.
        1) Manufacturers: One of the following or equal:
            a) Wilcoxon Research, Model 793.
            b) Entek-IRD Model 943.

C. Accelerometer mounting:
    1. Use magnetic mounting or stud mounting.
    2. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
    3. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.

D. Vibration testing results presentation:
    1. Provide equipment drawing with location and orientation of measurement points indicated.
    2. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.
    3. When Vibration Spectra Data required:
        a. Plot peak vibration velocity versus frequency in cycles per minute.
        b. Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label probable cause of vibration peaks whether in excess of specification limits or not.
        c. Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
        d. Plot motor spectra on a log amplitude scale versus frequency.
    4. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
    5. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.04 TESTING LEVELS

A. Level 1 Quality Control Tests:
    1. Level 1 General Equipment Performance Test:

a. For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
b. Operate at rated design load conditions.
c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

2. Level 1 Pump Performance Test:
   a. Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16405 or the applicable equipment section. Use actual driver for field tests.
   c. Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.
3. Level 1 Vibration Test:
   a. Test requirement:
      1) Measure filtered vibration spectra versus frequency in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component.
      2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
   b. Equipment operating condition: Test at specified maximum speed.
4. Level 1 Noise Test:
   a. Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.

B. Level 2 Quality Control Tests:
1. Level 2 General Performance Test:
   a. For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.
   b. Operate at rated design load conditions.
   c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
2. Level 2 Pump Performance Test:
   a. Test 2 hours minimum for flow and head at the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16405. Use actual driver for field tests.

c. Test for flow and head at 2 additional conditions; 1 at 25 percent below the rated flow and 1 at 10 percent above the rated flow.
d. Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.

3. Level 2 Vibration Test:
   a. Test requirement:
      1) Measure filtered vibration spectra versus frequency and measure vibration phase in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.
      2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
   b. Equipment operating condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.
   c. Natural frequency test of field installed equipment:
      1) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears and supports.
      2) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.
      3) Perform with equipment and attached piping full of intended service or process fluid.
4. Level 2 Noise Test:
   a. Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.

C. Level 3 Quality Control Tests:
1. Level 3 General Equipment Performance Tests:
   a. For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
   b. Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
   c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration or temperatures are observed.
   d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
   e. Bearing temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 3 Pump Performance Test:
    a. Test 4 hours minimum for flow and head at or near the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
    b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16405. Use actual driver for field tests.
    c. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes; for factory testing, test at other speeds may be omitted if test driver at reduced speeds is used for rated condition testing.
    d. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment section) and record observations on noise levels.
3. Level 3 Vibration Test:
    a. Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.
    b. Perform High Frequency Enveloping Analysis for gears and bearings.
        1) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.
        2) Report results in units of acceleration versus frequency in cycles per minute.
    c. Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).
    d. Plot vibration spectra on 3 different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.
4. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at 4 locations approximately 90 degrees apart in plan view; report results for each of 8 octave band mid-points beginning at 63 hertz.

D. Level 4 Quality Control Tests:
1. Level 4 General Equipment Performance Test:
    a. For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.
    b. Operate at rated design load conditions for1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
    c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration or temperatures are observed.

d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
e. Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 4 Pump Performance Test:
   a. Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.
   b. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration and noise data at each test condition.
   c. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment section) and record observations on noise levels.
   d. Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
   e. Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
      1) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
      2) Perform efficiency testing with test fluids at maximum rated speed.
      3) Perform priming time testing with test fluids at maximum rated speed.
3. Level 4 Vibration Test: Same as Level 3 vibration test.
4. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

3.05 SOURCE QUALITY CONTROL

A. Test equipment as specified for each type of test at the test levels specified in equipment sections. Prepare and submit test reports as specified.

B. Inspection and balancing:
   1. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.
   2. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.

C. Critical speed of rotating equipment: Satisfy the following:
   1. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment's maximum operating speed.
   2. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment's lowest operating speed.
   3. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.

3.06 FIELD QUALITY CONTROL

A. Test equipment as specified for each type of test at the test levels specified in equipment sections. Prepare and submit test reports as specified. Comply with latest version of applicable standards.

B. For variable speed equipment, conduct test to establish performance over the entire speed range and at the average operating condition. Establish performance curves for:
   1. The speed corresponding to the rated maximum capacity.
   2. The speed corresponding to the minimum capacity.
   3. The speed corresponding to the average operating conditions.

3.07 VIBRATION ACCEPTANCE CRITERIA

A. Testing of rotating mechanical equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.

B. Vibration displacement limits: Unless otherwise specified, equipment operating at speeds 600 revolutions per minute or less is not to exhibit unfiltered readings in excess of following:

Operating Speed (revolutions per minute)	**Unfiltered (Overall) Peak-to-Peak Amplitude (mils)**
	All Rotating Equipment
0 - 300	6.5
301 - 600	4.5
Note: For all equipment, axial shaft displacements not to exceed 50 percent of the maximum radial shaft displacements shown in the table relative to the casing.	

C. Vibration velocity limits: Unless otherwise specified, equipment operating at speeds greater than 600 revolutions per minute is not to exceed the following peak velocity limits:

Item	**Unfiltered Overall Limit (inches per second)**	**Any Filtered Peak Limit (inches per second)**
Non-Clog Solids Handling	0.35	0.25

Item	Unfiltered Overall Limit (inches per second)	Any Filtered Peak Limit (inches per second)
Centrifugal Pumps		
Horizontal and Vertical In-Line Centrifugal Pumps (other than Non-Clog type)	0.18 (Input BHP 25 or less)	0.14 (Input BHP 25 or less)
	0.22 (Input BHP more than 25 but less than 100)	0.18 (Input BHP more than 25 but less than 100)
	0.25 (Input BHP 100 or more)	0.20 (Input BHP 100 or more)
Vertical Turbine, Mixed Flow, and Propeller Pumps	0.31 (Input BHP 100 or less)	0.22
	0.35 (Input BHP 125 or more)	0.25
Vertical Turbine, Mixed Flow, and Propeller Short Set Pumps	0.28 (Input BHP 100 or less)	0.21
	0.33 (Input BHP 125 or more)	0.24
Motors	See Applicable Motor Specification	
Gear Reducers, Radial	Not to exceed AGMA 6000-A88 limits	
Other Reducers, Axial	0.10	0.10
Centrifugal Fans and Blowers	0.15	0.10
Other Equipment, Radial	0.16	0.10
Other Equipment, Axial	0.10	0.10

D. Equipment operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.

E. Additional criteria:
   1. No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude component without manufacturer's detailed verification of origin and ultimate effect of such excitation.
   2. The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.
   3. For motors, the following shall be cause for rejection:
      a. Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that are more than 40 percent of the peak at rotational frequency.
      b. Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.

c. Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around 2 times the rotor bar pass frequency.
d. Phasing problems evidenced by 1/3 line frequency side band spectral peaks around the 2 times electrical line frequency peak.

4. The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.

3.08 NOISE REQUIREMENTS AND CONTROL

A. Make measurements in relation to reference pressure of 0.0002 microbar.

B. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.

C. Set sound level meter to slow response.

D. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

3.09 FUNCTIONAL AND OPERATIONAL TESTING OF EQUIPMENT

A. Functional testing as specified in Section 01756 and this Section.

B. General checkout: Prior to operating equipment, inspect, test, and check supporting systems, including but not limited to power systems, control systems, piping systems, lubrication systems, and safety systems.
1. Test and calibrate instrumentation and electrical devices.
2. Test and prepare piping as specified in Sections 15956.
3. As a minimum for control systems associated with the equipment, perform the following:
   a. Individual Loop Tests: Test from field device to intermediate terminations to controller and back to controlled element.
   b. End-to-end test: Simulate input at field device and observe control system response at the final field control element.
4. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.

C. Operation of related existing equipment: OWNER will operate related existing equipment or facilities necessary to accomplish the testing.

D. Acceptable tests: Demonstrate the equipment performance meets the requirements of this Section and the equipment section; when the equipment fails to meet the specified requirements, perform additional more detailed testing to determine the cause, correct, repair, or replace the causative components and repeat the testing that revealed the deficiency.

E. Operational testing: As specified in Section 01756.

END OF SECTION

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.02 DESIGN REQUIREMENTS

A. All electronic boards as part of electrical equipment shall meet the atmospheric conditions of the space the equipment is installed in. All electronic boards which are not installed in a conditioned environment shall be fungus-resistant.

B. All electrical equipment shall be rated for the conditions the equipment is installed in.

1.03 STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Perform all work; furnish and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:
   1. Local Laws and Ordinances.
   2. State and Federal Laws.
   3. National Electrical Code (NEC).
   4. State Fire Marshal.
   5. Underwriters' Laboratories (UL).
   6. National Electrical Safety Code (NESC).
   7. American National Standards Institute (ANSI).
   8. National Electrical Manufacturer's Association (NEMA).
   9. National Electrical CONTRACTOR'S Association (NECA) Standard of Installation.
   10. Institute of Electrical and Electronics Engineers (IEEE).
   11. Insulated Cable Engineers Association (ICEA).
   12. Occupational Safety and Health Act (OSHA).
   13. National Electrical Testing Association (NETA).
   14. American Society for Testing and Materials (ASTM).
   15. Florida Building Code, including Broward County amendments.

B. Conflicts, if any, which may exist between the above items, will be resolved at the discretion of the ENGINEER.

C. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

D. Obtain all permits and pay all fees required by any governmental agency having jurisdiction over the work. Arrange all inspections required by these agencies. On completion of the work, furnish satisfactory evidence to the ENGINEER that the work is acceptable to the regulatory authorities having jurisdiction.

1.04 ELECTRICAL COORDINATION

A. Work Provided Under this Contract:
   1. Perform demolition of existing equipment as shown on drawings and as stated in specifications. Turn over the removed items to Owner if requested by them or dispose as needed.
   2. Provide and install new breaker and modify the existing MCC-HW1 and MCC-HW2 at the Headworks building as described in the drawings and specifications for a complete working system in place**.**
   3. Provide and install all conduits, seal-offs, disconnects, junction boxes, conduit supports and wire as described in the drawings complete in place. This includes all instrumentation cables between the instruments and the control panel, and electrical equipment complete in place.
   4. Furnish and install new electrical equipment racks, supports, junction boxes, etc. as described in the drawing and specifications for a complete working system in place.
   5. Provide and install new conduits and cables for instrumentation system complete in place.
   6. Provide and install new light poles and receptacle system as per drawings and specification for a complete working system in place.
   7. Provide all incidental equipment, labor and material obviously required but not specified in the drawings or specifications to complete the installation as a total working system.
   8. Terminate new input-output (I/O) signals as stated in drawings N-1 thru N-3 and E-8 at the existing Headworks PLC control panel and update as-built I/O drawings.
   9. Provide all miscellaneous electrical including terminations, fittings, wiring, conduit, junction boxes, etc. not specified but obviously necessary for a complete working system in place.

B. Temporary Power:
   1. Provide temporary power for all office trailers and for all construction areas. Coordinate with local power and telephone utility for temporary construction power and telephone service during construction.

1.05 SUBMITTALS

A. Quality Control Submittals:
   1. Voltage Field Test Results.
   2. Voltage Balance Report.
   3. Equipment Line Current Report.
   4. Factory test certification and reports for all major electrical equipment.
   5. Site test certification and reports as specified in other Division 16, ELECTRICAL sections.

B. The following information shall be provided for all electrical equipment:

1. A copy of each specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation.
2. Electrical equipment submittals shall be made by specification section. Submit one package per specification section and do not group multiple specification sections under one submittal package.
3. Provide complete conduit and equipment layouts: a scaled plan layout of the electrical room(s) showing spatial relationships of all equipment as well as the overall size of the room. Minimum scale shall be ¼"=1'-0".
4. Provide a conduit plan for major power, instrumentation and control conduits, both interior and exterior, showing routing, size and stub up locations for buried or in slab conduits.

1.06 ENVIRONMENTAL CONDITIONS

A. All chemical rooms and areas shall be designated as corrosive.

B. All indoor chemical and process equipment areas shall be considered wet locations.

C. Electrical equipment in rooms designated as Classified by NFPA 70 (national electrical code) as Division 1 or Division 2 shall meet all requirements set forth for that classification as described in NEC article 500.

1.07 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The Electrical Drawings were developed from past record drawings and information supplied by the OWNER. Verify all scaled dimensions prior to submitting bids.

B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and electrical system which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the CONTRACTOR's failure to fulfill this requirement.

C. Carry out any work involving the shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the OWNER. Do such work when directed by the ENGINEER.

D. After award of Contract, locate all existing underground utilities at each area of construction activity. Protect all existing underground utilities during construction. Pay for all required repairs without increase in Contract cost, should damage to underground utilities occur during construction.

1.08 RESPONSIBILITY

A. The CONTRACTOR shall be responsible for:
   1. Complete systems in accordance with the intent of these Contract Documents.
   2. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under Division 16, ELECTRICAL.
   3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

1.09 INTENT OF DRAWINGS

A. Electrical plan Drawings show only general location of equipment, devices, and raceway, unless specifically dimensioned. The CONTRACTOR shall be responsible for the proper routing of raceway, subject to the approval of the ENGINEER.

B. All electrical equipment sizes and characteristics have been based on manufacturer Square D. If the CONTRACTOR chooses to and is allowed to substitute, the CONTRACTOR shall be responsible for fitting all the equipment in the available space as shown on the Drawings.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

B. Equipment Finish:
   1. Provide manufacturers' standard finish and color, except where specific color is indicated.
   2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.02 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panel boards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.03 CHECKOUT AND STARTUP

A. Startup:
   1. Demonstrate satisfactory operation of all 480-volt electrical equipment. Participate with other trades in all startup activities.
   2. Assist the Instrumentation and Control (I&C) Contractor in verifying signal integrity of all control and instrumentation signals.

END OF SECTION

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SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American National Standards Institute (ANSI):
      a. C55,1, Standard for Shunt Power Capacitors.
      b. C62.11, Standard for Metal-Oxide Surge Arrestors for AC Circuits.
      c. Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
   2. American Society for Testing and Materials (ASTM):
      a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
      c. A570, Standard Specification for Steel, Sheet, and Strip, Carbon, Hot-Rolled, Structural Quality.
   3. Federal Specifications (FS):
      a. W-C-596, Connector, Receptacle, Electrical.
      b. W-S-896E, Switches, Toggle, Flush Mounted.
   4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
      c. CP I, Shunt Capacitors.
      d. ICS 2, Industrial Control Devices, Controllers, and Assemblies.
      e. KS 1, Enclosed Switches.
      f. LA I, Surge Arrestors.
      g. PB 1, Panelboards.
      h. ST 20, Dry-Type Transformers for General Applications.
      i. WD I, General Requirements for Wiring Devices.
   6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   7. Underwriters Laboratories, Inc. (UL):
      a. 67, Standard for Panelboards.
      b. 98, Standard for Enclosed and Dead-Front Switches.
      c. 198C, Standard for Safety High-Intermpting-Capacity Fuses, Current-Limiting Types.
      d. 198E, Standard for Class Q Fuses.
      e. 486E, Standard for Equipment Wiring Terminals.
      f. 489, Standard for Molded Case Circuit Breakers and Circuit Breaker Enclosures.
      g. 508, Standard for Industrial Control Equipment.
      h. 810, Standard for Capacitors.
      i. 943, Standard for Ground-Fault Circuit Interrupters.

j. 1059, Standard for Terminal Blocks.
k. 1561, Standard for Dry-Type General-Purpose and Power Transformers.

1.02 SUBMITTALS

A. Shop Drawings:
1. Device boxes for use in hazardous areas.
2. Junction and pull boxes used at, or below, grade.
3. Hardware.
4. Terminal junction boxes.
5. Panelboards and circuit breaker data.
6. Fuses.
7. Contactors.
8. Transformers.
9. All other miscellaneous material part of this project.
10. Wire pulling compound.

1.03 QUALITY ASSURANCE

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

1.04 SPARE PARTS

A. Furnish, tag, and box for shipment and storage the following spare parts:
1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

PART 2 PRODUCTS

2.01 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:
1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, cast ferrous metal, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs (Cast Mounting) Manufacturer:
a. Crouse-Hinds; Type FS or FD.
b. Appleton; Type FS or FD.

C. Cast Aluminum:
1. Material:
a. Box: Cast, copper-free aluminum.
b. Cover: Gasketed, weatherproof, cast copper-free aluminum with stainless steel screws.

2. Hubs: Threaded.
3. Lugs: Cast mounting.
4. Manufacturers:
    a. Crouse-Hinds; Type FS-SA or FD-SA.
    b. Appleton; Type FS or FD.

D. PVC-Coated Sheet Steel:
1. Type: One-piece.
2. Material: Zinc- or cadmium-plated.
3. Coating: All surfaces; 40-mil PVC.
4. Manufacturer: Appleton.

E. Nonmetallic:
1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.
3. Manufacturer: Carlon; Type FS or FD, with Type E98 or E96 covers.

2.02 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article OUTLET AND DEVICE BOXES.

B. Large Sheet Steel Box: NEMA 250, Type 1.
1. Box: Code-gauge, galvanized steel.
2. Cover: Full access, screw type.
3. Machine Screws: Corrosion-resistant.

C. Large Stainless Steel Box: NEMA 250, Type 4X.
1. Box: 14-gauge, ASTM A240, Type 316 stainless steel.
2. Cover: Hinged with screws.
3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
4. Manufacturers:
    a. Hoffman Engineering Co.
    b. Robroy Industries.

D. Large Nonmetallic Box:
1. NEMA 250, Type 4X.
2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat. Do not use nonmetallic box for direct sunlight application.
3. Cover: Hinged with screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Conduit hubs and mounting lugs.
6. Manufacturers:
    a. Crouse-Hinds; Type NJB.
    b. Carlon; Series N, C, or H.
    c. Robroy Industries.

2.03 WIRING DEVICES

A. Switches:
1. NEMA WD I and FS W-S-896E.

2. Specification grade, totally-enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.
5. Color:
    a. Office Areas: Ivory.
    b. Other Areas: Brown.
6. Switches with Pilot Light: 125-volt, neon light with red jewel, or lighted toggle when switch is ON.
7. Manufacturers:
    a. Bryant.
    b. Leviton.
    c. Hubbell.
    d. Pass and Seymour.
    e. Arrow Hart.

B. Receptacle, Single and Duplex:
1. NEMA WD 1 and FS W-C-596.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Color:
    a. Office Areas: Ivory.
    b. Other Areas: Brown.
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
7. Manufacturers:
    a. Bryant.
    b. Leviton.
    c. Hubbell.
    d. Pass and Seymour.
    e. Sierra.
    f. Arrow Hart.

2.04 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Plastic:
1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.
2. Color: To match associated wiring device.
3. Mounting Screw: Oval-head metal, color matched to plate.

C. Metal:
1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

D. Cast Metal:
   1. Material: Malleable ferrous metal, with gaskets.
   2. Screw: Oval-head stainless steel.

E. Engraved:
   1. Character Height: 3/16 inch.
   2. Filler: Black.

F. Weatherproof:
   1. For Receptacles: Gasketed, cast metal or stainless steel, with individual cap over each receptacle opening.
   2. Mounting Screw: Stainless steel.
      a. Cap Spring: Stainless steel.
      b. Manufacturers:
         1) General Electric.
         2) Bryant.
         3) Hubbell.
         4) Sierra.
         5) Pass and Seymour.
         6) Crouse-Hinds; Type WLRD or WLRS.
         7) Bell.
         8) Arrow Hart.
   3. For Switches: Gasketed, cast metal incorporating external operator for internal switch.
      a. Mounting Screw: Stainless steel.
      b. Manufacturers:
         1) Crouse-Hinds; DS-181 or DS-185.
         2) Appleton; FSK-LVTS or FSK-IVS.

G. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

2.05 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB I, NFPA 70, and UL 67, including panelboards installed in motor control equipment.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Rating: If not otherwise shown in plans. Applicable to a system with available short-circuit current of 25,000 amperes rms symmetrical at 208Y/120 or 120/240 volts and 65,000 amperes rms symmetrical at 480Y/277 volts.

E. Where ground fault interrupter circuit breakers are indicated or required by code: 5 mA trip, 10,000 amps interrupting capacity circuit breakers.

F. Cabinet: As shown on plans.

G. Bus Bar:
   1. Material: Copper, full sized throughout length.
   2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
   3. Neutral: Insulated, rated 150 percent of phase bus bars with at least one terminal screw for each branch circuit.
   4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
   5. Lugs and Connection Points:
      a. Suitable for either copper or aluminum conductors.
      b. Solderless main lugs for main, neutral, and ground bus bars.
      c. Subfeed or through-feed lugs as shown.
   6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

H. Circuit Breakers:
   1. NEMA AB 1 and UL 489.
   2. Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
   3. Noninterchangeable, in accordance with NFPA 70.
   4. Locking: Provisions for handle padlocking, unless otherwise shown.
   5. Type: Bolt-on circuit breakers in all panelboards.
   6. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
   7. Do not substitute single-pole circuit breakers with handle ties for multipole breakers.
   8. Do not use tandem or dual circuit breakers in normal single-pole spaces.
   9. Ground Fault Interrupter:
      a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).
      b. Sensor with same rating as circuit breaker and a push-to-test button.

I. Manufacturers:
   1. Square D;
   2. Eaton;
   3. Or approved equal.

2.06 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA AB I, UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: As shown or as required.

C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Multipole breakers to automatically open all poles when an overload occurs on one-pole.

G. Enclosure: NEMA 250, Type 12, Industrial Use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multipole circuit breakers are shown.

2.07 NONFUSED DISCONNECT SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: NEMA 250, Type 12, industrial use, 4X- outdoors, wet locations and corrosive areas, unless otherwise shown.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

2.08 FUSE, 0 TO 600 VOLTS

A. Current-limiting, with 200,000 ampere rms interrupting rating.

B. Provide to fit mountings specified with switches and features to reject Class H fuses.

C. Motor and Transformer Circuits, 0- to 600-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-1, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPS-RK.
      b. Littlefuse; Type LLS-RK.

D. Motor and Transformer Circuits, 0- to 250-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-1, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPN-RK.
      b. Littlefuse; Type LLN-RK.

E. Feeder and Service Circuits, 0- to 600-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-I, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPS-RK.

b. Littlefuse; Type LLS-RK.

F. Feeder and Service Circuits, O- to 250-Volt:
1. Amperage: 0 to 600.
2. UL 198E, Class RK-I, dual element, with time delay.
3. Manufacturers:
a. Bussmann; Type LPN-RK.
b. Littleluse; Type LLN-RK.

G. Feeder and Service Circuits, 0- to 600-Volt:
1. Amperage: 601 to 6,000.
2. UL 198C, Class L, double O-rings and silver links.
3. Manufacturers:
a. Bussmann; Type KRP-C.
b. Littlefuse; Type KLPC.

2.09 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. Contact Rating: NEMA ICS 2, Type A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Lights: LED Push-to-test.

D. Pushbutton Color:
1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbuttons and selector switches lockable in the OFF position where indicated.

F. Legend Plate:
1. Material: Aluminum.
2. Engraving: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, indicating specific function.
3. Letter Height: 7/64 inch.

G. Manufacturers:
1. Heavy-Duty Type:
a. General Electric.
b. Square DT.
c. Cutler-Hammer.

2.10 TERMINAL BLOCK (0 TO 600 VOLTS)

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of all control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between the compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:
   1. Capable of wire connections without special preparation other than stripping.
   2. Capable of jumper installation with no loss of terminal or rail space.
   3. Individual, rail mounted.

I. Marking system allowing use of preprinted or field-marked tags.

J. Manufacturers:
   1. Weidmuller.
   2. Ideal.
   3. Electrovert.

2.11 MAGNETIC CONTROL RELAY

A. NEMA ICS 2, Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control with field convertible contacts.

B. Time Delay Relay Attachment:
   1. Pneumatic type, timer adjustable from 0.2 to 60 seconds (minimum).
   2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

D. Manufacturers:
   1. Cutler-Hammer; Type M-600.
   2. General Electric; Type CR120B.

2.12 RESET TIMER

A. Drive: Synchronous motor, solenoid operated clutch.

B. Mounting: Semiflush, panel.

C. Contacts: 10-amp, 120-volt.

D. Manufacturers:
   1. Eagle Signal; Bulletin 125.
   2. Automatic Timing and Controls; Bulletin 305.

2.13 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0 to 99,999.9 hours, nonreset type.

C. Mounting: Semiflush, panel.

D. Manufacturers:
   1. General Electric; Type 240, 2-1/2-inch Big Look.
   2. Eagle Signal; Bulletin 705.

2.14 SUPPORT AND FRAMING CHANNELS

A. Material:
   1. Dry indoors - galvanized.
   2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

B. Finish:
   1. Dry indoors - galvanized..
   2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

C. Inserts: Continuous.

D. Beam Clamps: Gray cast iron.

E. Manufacturers:
   1. B-Line.
   2. Unistrut.

2.15 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: White, engraved to a black core.

D. Engraving:
   1. Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
   2. Panelboards: Panelboard designation, service voltage, and phases.

E. Letter Height:
   1. Pushbuttons/Selector Switches: 1/8 inch.
   2. Panelboards: 1/4 inch.

2.16 SURGE PROTECTION DEVICE (SPD)

A. This section describes the material and installation requirements for transient voltage surge suppression (TVSS) or Surge Protection devices (SPD) in switchboards, panelboards, and motor control centers for the protection of all AC electrical circuits.

B. SPD shall be listed and component recognized in accordance with UL 1449 and UL 1283.

C. SPD shall be installed and warranted by and shipped from the electrical distribution equipment manufacturer’s factory.

D. SPD shall provide surge current diversion paths for all modes of protection; L-L, L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

E. SPD shall be modular in design. Each module shall be fused with a surge rated fuse.

F. A UL approved disconnect switch shall be provided as a means of disconnect in the switchboard device only.

G. SPD shall meet or exceed the following criteria:
   1. Maximum surge current capability (single pulse rated) shall be:
      a. Service entrance switchboard 300kA
      b. Branch panelboards 150kA
      c. Motor control centers 80kA
   2. UL 1449 Listed and Recognized Component Suppression Voltage Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	400V	400V	400V
480Y/277	800V	800V	800V

H. SPD shall have a minimum EMI/RFI filtering of -44dB at 100kHz with an insertion ration of 50:1 using MIL STD. 220A methodology.

I. SPD shall be provided with 1 set of NO/NC dry contacts.

J. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period. Warranty will be the responsibility of the electrical distribution equipment manufacturer.

K. Approve manufactures are:
   1. Cutler Hammer CPS Series
   2. General Electric Tranquell Series
   3. Siemans TPS Series
   4. Square D Company XTE Series

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with NECA 5055.

3.02 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:
   1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.

a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.

2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:
1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by ENGINEER.
3. Light Switch: Install on lock side of doors.
4. Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.

D. Mounting Height:
1. General:
   a. Measured to centerline of box.
   b. Where specified heights do not suit building construction or finish, mount as directed by ENGINEER.
2. Light Switch: 48 inches above floor.
3. Thermostat: 54 inches above floor.
4. Telephone Outlet: 6 inches above counter tops or 15 inches above floor.
5. Wall Mounted Telephone Outlet: 52 inches above floor.
6. Convenience Receptacle:
   a. General Interior Areas: 15 inches above floor.
   b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of splashback, or 6 inches above countertops without splashback.
   c. Industrial Areas, Workshops: 48 inches above floor.
   d. Outdoor, All Areas: 24 inches above finished grade.
7. Special-Purpose Receptacle: 54 inches above floor or as shown.

E. Install plumb and level.

F. Flush Mounted:
1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.

I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

J. Provide plaster rings where necessary.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. Install stainless steel mounting hardware in industrial areas.

M. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

N. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

O. Box Type (Steel Raceway System):
   1. Exterior Locations:
      a. Exposed Raceways: Cast metal.
      b. Concealed Raceways: Cast metal.
      c. Concrete Encased Raceways: Cast metal.
      d. Class I, II, or III Hazardous Areas: Cast metal.
   2. Interior Dry Locations:
      a. Exposed Rigid Conduit: Cast metal.
      b. Exposed EMT: Sheet steel.
      c. Concealed Raceways: Sheet steel.
      d. Concrete Encased Raceways: Cast metal.
      e. Lighting Circuits, Ceiling: Sheet steel.
      f. Class I, II, or III Hazardous Areas: Cast metal.
   3. Interior Wet Locations:
      a. Exposed Raceways: Cast metal.
      b. Concealed Raceways: Cast metal.
      c. Concrete Encased Raceways: Cast metal.
      d. Lighting Circuits, Ceiling: Sheet steel.
      e. Class I, II, or III Hazardous Areas: Cast metal.
   4. Cast-In-Place Concrete Slabs: Sheet steel.

P. Box Type (Rigid Aluminum Raceway System): Cast aluminum.

Q. Box Type (Nonmetallic Raceway System):
   1. Corrosive Locations: Nonmetallic.
   2. Exposed Raceways: Nonmetallic.
   3. Concealed Raceways: Nonmetallic.
   4. Concrete Encased Raceways: Nonmetallic.

R. Box Type, Corrosive Locations (PVC-Coated Rigid Galvanized Steel Raceway System): PVC coated cast metal..

3.03 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Installed boxes shall be accessible.

F. Do not install on finished surfaces.

G. Install plumb and level.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.

J. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. At or Below Grade:
   1. Install boxes for below grade conduits flush with finished grade in locations outside of paved areas, roadways, or walkways.
   2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
   3. Obtain ENGINEER's written acceptance prior to installation in paved areas, roadways, or walkways.
   4. Use boxes and covers suitable to support anticipated weights.

M. Flush Mounted:
   1. Install with concealed conduit.
   2. Holes in surrounding surface shall be no larger than required to receive box.
   3. Make edges of boxes flush with final surface.

N. Mounting Hardware:
   1. Noncorrosive Interior Areas: Galvanized.
   2. All Other Areas: Stainless steel.

O. Location/Type:
   1. Finished, Indoor, Dry: NEMA 250, Type 1.
   2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
   3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
   4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.
   5. Unfinished, Indoor and Outdoor, Hazardous: NEMA 250, Type 7 and Type 9, where indicated.
   6. Underground Conduit: Concrete Encased.
   7. Corrosive Locations: Nonmetallic.

3.04 WIRING DEVICES

A. Switches:
   1. Mounting Height: See Paragraph OUTLET AND DEVICE BOXES.

2. Install with switch operation in vertical position.
3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:
1. Install with grounding slot down except where horizontal mounting is shown, in which case install with neutral slot up.
2. Ground receptacles to boxes with grounding wire only.
3. Weatherproof Receptacles:
   a. Install in cast metal box.
   b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for "downstream" conventional receptacles.
5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

C. Multioutlet Surface Raceway System:
1. Install in accordance with manufacturer's instructions.
2. Wire alternate outlets to each circuit where two-circuit, three-wire supply is shown.

3.05 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to the box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Engrave with designated titles.

F. Types (Unless Otherwise Shown):
1. Office: Stainless Steel.
2. Exterior: Weatherproof.
3. Interior:
   a. Flush Mounted Boxes: Stainless Steel.
   b. Surface Mounted, Cast Metal Boxes: Cast metal.
   c. Surface Mounted, Sheet Steel Boxes: Stainless Steel.
   d. Surface Mounted, Nonmetallic Boxes: Plastic.

3.06 PUSHBU'ITON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Heavy-Duty, oil-tight Type: Locations (Unless Otherwise Shown): Nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Heavy-Duty, Watertight, and Corrosion-Resistant Type:

1. Locations (Unless Otherwise Shown): Nonhazardous, outdoor, or normally wet areas.
2. Mounting: NEMA 250, Type 4X enclosure.

3.07 TERMINAL JUNCTION BOX

A. Install in accordance with Paragraph JUNCTION AND PULL BOXES.

B. Label each block and terminal with permanently attached, nondestructible tag.

C. Do not install on finished outdoor surfaces.

D. Location:
1. Finished, Indoor, Dry: NEMA 250, Type 1.
2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.08 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

3.09 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moistureproof, flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and three-phase units, 15 to 112 kVA.

3.10 SUPPORT AND FRAMING CHANNEL

A. Furnish zinc-rich primer; paint cut ends prior to installation, where applicable.

B. Install where required for mounting and supporting electrical equipment and raceway systems.

3.11 MOTOR SURGE PROTECTION

A. Ground in accordance with NFPA 70.

B. Low Voltage: Ground terminals to equipment bus.

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Association of State Highway and Transportation Officials (AASHTO): Division I, Standard Specifications for Highway Bridges, Fourteenth Edition.
   2. American National Standards Institute (ANSI):
      a. C80.1, Rigid Steel Conduit-Zinc Coated.
      b. C80.3, Electrical Metallic Tubing-Zinc Coated.
      c. CS0.5, Rigid Aluminum Conduit.
      d. C80.6, Intermediate Metal Conduit (IMC)-Zinc Coated.
   3. American Society for Testing and Materials (ASTM):
      a. A123 El, Standard Specification for Zinc-Coated (Galvanized) Coatings on Iron and Steel Products.
      b. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
   5. National Electrical Manufacturers Association (NEMA):
      a. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
      b. TC 2, Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
      c. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
      d. TC 6, PVC and ABS Plastic Utilities Duct for Underground Installation.
      e. VE 1, Metallic Cable Tray Systems.
   6. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
   7. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Safety Flexible Metal Conduit.
      b. 6, Standard for Safety Rigid Metal Conduit.
      c. 360, Standard for Safety Liquid-Tight Flexible Steel Conduit.
      d. 514B, Standard for Safety Fittings for Conduit and Outlet Boxes.
      e. 514C, Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
      f. 651, Standard for Safety Schedule 40 and 80 PVC Conduit.
      g. 651A, Standard for Safety Type EB and Rigid PVC Conduit and HDPF Conduit.
      h. 797, Standard for Safety Electrical Metallic Tubing.
      i. 870, Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings.
      j. 1242, Standard for Safety Intermediate Metal Conduit.
      k. 1660, Standard for Safety Liquid-Tight Flexible Nonmetallic Conduit.

1.02 SUBMITTALS

A. Shop Drawings:
   1. Manufacturer's Literature for applicable conduit type:
      a. Rigid galvanized steel conduit.
      b. Electric metallic tubing.
      c. Rigid aluminum conduit.
      d. PVC Schedule 40 conduit.
      e. PVC-coated rigid galvanized steel conduit.
      f. Flexible metal, liquid-tight conduit.
      g. Flexible, nonmetallic, liquid-tight conduit.
      h. Conduit fittings.
      i. Wireways.
   2. Precast Manholes and Handholes:
      a. Dimensional drawings and descriptive literature.
      b. Traffic loading calculations.
      c. Accessory information.
   3. Cable Tray Systems:
      a. Dimensional drawings, calculations, and descriptive information.
      b. NEMA load/span designation and how it was selected.
      c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.
      d. Location and magnitude of maximum simple beam deflection of tray for loading specified.
      e. Layout drawings and list of accessories being provided.
   4. Conduit Layout:
      a. Plan and section type, showing arrangement and location of conduit and duct bank required for:
         1) Low and medium voltage feeder and branch circuits.
         2) Instrumentation and control systems.
         3) Communications systems.
         4) Empty conduit for future use.
      b. Reproducible mylar; scale not greater than 1 inch equals 20 feet.
         1) Equipment and machinery proposed for bending metal conduit.
         2) Method for bending PVC conduit less than 30 degrees.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):
   1. Meet requirements of ANSI C80.1 and UL6.
   2. Material: Hot-dip galvanized, with chromated protective layer.

B. Electric Metallic Tubing (EMT):
   1. Meet requirements of ANSI C80.3 and UL 797.

2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.

C. Rigid Aluminum Conduit:
1. Meet requirements of ANSI C80.5 and UL 6.
2. Material: Type 6063, copper-free aluminum alloy.

D. PVC Schedule 40 Conduit:
1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

E. PVC-Coated Rigid Galvanized Steel Conduit:
1. Meet requirements of NEMA RN 1.
2. Material:
a. Conduit: Meet requirements of ANSI C80.1 and UL 6
b. PVC Coating: 40 mils nominal thickness, bonded to metal.

F. Flexible Metal, Liquid-Tight Conduit:
1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

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

2.02 FITTINGS

A. Rigid Galvanized Steel and Intermediate Metal Conduit:
1. General:
a. Meet requirements of UL 514B.
b. Type: Threaded, galvanized. Set screw fittings not permitted.
2. Bushing:
a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
b. Manufacturers:
1) Thomas & Betts; Type BIM.
2) O.Z./Gedney; Type HB.
3. Grounding Bushing:
a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
b. Manufacturers:
1) Appleton; Series GIB.
2) O.Z. Gedney; Type HBLG.
4. Conduit Hub:
a. Material: Malleable iron with insulated throat.
b. Manufacturers:
1) O.Z. Gedney; Series CH.

2) T & B; Series 370.

5. Conduit Bodies:
   a. Material: Malleable iron, sized as required by NFPA 70.
   b. Manufacturers (For Normal Conditions):
      1) Appleton; Form 35 threaded Unilets.
      2) Crouse-Hinds; Form 7 or 8 threaded condulets.
      3) Killark; Series O Electrolets.
   c. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting Manufacturers:
   a. Appleton; Type EYF, EYM, or ESU.
   b. Crouse-Hinds; Type EYS or EZS.
   c. Killark; Type EY or EYS.
8. Drain Seal Manufacturers:
   a. Appleton; Type SF.
   b. Crouse-Hinds; Type EYD or EZD.
9. Drain/Breather Fitting Manufacturers:
   a. Appleton; Type ECDB.
   b. Crouse-Hinds; ECD.
10. Expansion Fitting Manufacturers:
    a. Deflection/Expansion Movement:
       1) Appleton; Type DF.
       2) Crouse-Hinds; Type XD.
    b. Expansion Movement Only:
       1) Appleton; Type XJ.
       2) Crouse-Hinds; Type XJ.
11. Cable Sealing Fittings:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. For Conductors With OD of 1/2 Inch or Less: Neoprene bushing at connector entry.
    c. Manufacturers:
       1) Crouse-Hinds; CGBS.
       2) Appleton; CG-S.

B. Electric Metallic Tubing:
   1. Meet requirements of UL 514B.
   2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
   3. Compression Ring: Stainless steel.
   4. Coupling Manufacturers:
      a. Appleton; Type 95T.
      b. Crouse-Hinds; Type CPR.
   5. Connector Manufacturers:
      a. Appleton; Type 86T.
      b. Crouse-Hinds; Type CPR.

C. Rigid Aluminum Conduit:
   1. General:
      a. Meet requirements of UL 514B.

b. Type: Threaded, copper-free. Set screw fittings not permitted.

2. Insulated Bushing:
   a. Material: Cast aluminum, with integral insulated throat, rated for 150 degrees C.
   b. Manufacturer: O.Z. Gedney; Type AB.
3. Grounding Bushing:
   a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.
   b. Manufacturer: O.Z. Gedney; Type ABLG.
4. Conduit Hub:
   a. Material: Cast aluminum, with insulated throat.
   b. Manufacturers:
      1) O.Z. Gedney; Type CHA.
      2) T & B; Series 370AL.
5. Conduit Bodies:
   a. Manufacturers (For Normal Conditions):
      1) Appleton; Form 85 threaded Unilets.
      2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
      3) Killark; Series O Electrolets.
   b. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting Manufacturers:
   a. Appleton; Type EYF-AL or EYM-AL.
   b. Crouse-Hinds; Type EYS-SA or EZS-SA.
   c. Killark; Type EY or EYS.
8. Drain Seal Manufacturers:
   a. Appleton; Type EYDM-A.
   b. Crouse-Hinds; Type EYD-SA or EZD-SA.
9. Drain/Breather Fitting Manufacturers:
   a. Appleton; Type ECDB.
   b. Crouse-Hinds; ECD.
10. Expansion Fitting Manufacturers:
    a. Deflection/Expansion Movement: Steel City; Type DF-A.
    b. Expansion Movement Only: Steel City; Type AF-A.
11. Cable Sealing Fittings: To form watertight nonslip cord or cable connection to conduit.
    a. Bushing: Neoprene at connector entry.
    b. Manufacturer: Appleton CG-S.

D. PVC Conduit and Tubing:
   1. Meet requirements of NEMA TC-3.
   2. Type: PVC, slip-on.

E. PVC-Coated Rigid Galvanized Steel Conduit:
   1. Meet requirements of UL 514B.
   2. Type: Rigid galvanized steel, PVC coated by conduit manufacturer.
   3. Overlapping pressure sealing sleeves.
   4. Conduit Hangers, Attachments, and Accessories: PVC-coated.

F. Flexible Metal, Liquid-Tight Conduit:
   1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
   2. Insulated throat and sealing O-rings.
   3. Long design type extending outside of box or other device at least 2 inches.
   4. Manufacturer: T & B; Series 5300.

G. Flexible, Nonmetallic, Liquid-Tight Conduit: Meet requirements of UL 514B.
   1. Type: One-piece fitting body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
   2. Manufacturers:
      a. Carlon; Type LT.
      b. Kellems; Polytuff.
      c. T & B; LT Series.

H. Watertight Entrance Seal Device:
   1. New Construction:
      a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
      b. Manufacturer: O.Z./Gedney; Type FSK or WSK, as required.
   2. Gored-Hole Application:
      a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
      b. Manufacturer: O.Z./Gedney; Series CSM.

I. Hazardous Locations: Approved for use in the atmosphere involved.
   1. Manufacturer: Crouse-Hinds; Type ECGJH.

J. Corrosive Locations:
   1. Material: 40-mil PVC-coated rigid steel.
   2. Manufacturers:
      a. Robroy Industries.
      b. Carlon.
      c. Crouse-Hinds.

2.03 WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, with removable, hinged cover.

C. Rating: Outdoor raintight if outdoor, and indoor if indoor.

D. Finish: Gray, baked enamel.

E. Manufacturers:
   1. Square D.
   2. B-Line Systems, Inc.

2.04 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO Division 1, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6- or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage:
   1. Slope floors toward drain points, leaving no pockets or other non-draining areas.
   2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

E. Raceway Entrances:
   1. Provide on all four sides.
   2. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.
   3. At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:
   1. Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
   2. Location:
      a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
      b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:
   1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
   2. Wall Attachment:
      a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
      b. Insert Spacing: Maximum 3-foot on center entire inside perimeter of manhole.
      c. Arrange so that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:
   1. Material: Machined cast iron.
   2. Cover Type: Indented, solid top design, with two drop handles each.
   3. Cover Loading: AASHTO Division I, H-20.
   4. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
      a. Above 600 Volts: ELECTRIC HV.
      b. 600 Volts and Below: ELECTRIC LV.
      c. TELEPHONE.

I. Handhole Frames and Covers:
   1. Material: Steel, hot-dipped galvanized.
   2. Cover Type: Solid, bolt-on, of checkered design.
   3. Cover Loading: H-20.

4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
    a. 600 Volts and Below: ELECTRIC LV.
    b. TELEPHONE.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:
1. U.S. Precast.
2. Brooks Products, Inc.
3. Penn-Cast Products, Inc.
4. Concrete Conduit Co.
5. Associated Concrete Products, Inc.
6. Utility Vault Co.
7. Pipe,Inc.

2.05 ACCESSORIES

A. Duct Bank Spacers:
1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturer: Underground Device, Inc.; Type WUNPEECE.

B. Identification Devices:
1. Raceway Tags:
    a. Material: Permanent, nylon.
    b. Shape: Round.
    c. Raceway Designation: Pressure stamped, embossed, or engraved.
    d. Tags relying on adhesives or taped-on markers not permitted.
2. Warning Tape:
    a. Material: Polyethylene, 4-mil gauge.
    b. Color: Red.
    c. Width: Minimum 6-inch.
    d. Designation: Warning on tape that electric circuit is located below tape.
    e. Manufacturers:
        1) Blackburn, Type RT.
        2) Griffolyn Co.
3. Buried Raceway Marker:
    a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
    b. Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES. in letters 1/4-inch high.
    c. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

C. Raceway Coating:
1. Material: Bitumastic or plastic tape coating.
2. Manufacturers:
    a. Koppers bitumastic; No. 505.
    b. Scotchwrap; No. 51, plastic tape.

D. Wraparound Duct Band:
   1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
   2. Manufacturer: Raychem; Type TWDB.

PART 3 EXECUTION

3.01 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors. Reference Section 16120, CONDUCTORS, concerning conduit sizing for aluminum conductors.

B. All installed Work shall comply with NECA 5055.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Aluminum Conduit: Do not install in direct contact with concrete. Use unistrut or back and strap (clamp back strap) for installation on concrete wall or surface.

G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

M. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

N. Install watertight fittings in outdoor, underground, or wet locations.

O. Paint threads, before assembly of fittings, of galvanized conduit or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

P. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

Q. Do not install raceways in concrete equipment pads, foundations, or beams.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

T. Use long radius elbow for conduit with fiber optic cable, indicated or not on the drawings.

3.02 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum cover 1-1/2 inches.

B. Provide support during placement of concrete to ensure raceways remain in position.

C. Floor Slabs:
   1. Outside diameter of conduit not to exceed one-third of the slab thickness.
   2. Separate conduit by minimum six times conduit outside diameter, except at crossings.

3.03 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed:
   1. Rigid Aluminum.

C. Interior, Exposed:
   1. Rigid Aluminum.
   2. Electric metallic tubing for ceiling portion of lighting circuits in a conditioned environment.

D. Interior, Concealed (Not Embedded in Concrete):
   1. Rigid Aluminum.
   2. PVC Schedule 40.

E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: PVC Schedule 40.

F. Concrete Slab on Top: PVC Schedule 40.

G. Under Slabs-On-Grade: PVC Schedule 40.

H. Corrosive Areas: PVC Schedule 40.

I. Lightning Protection: PVC Schedule 40.

J. Class 1 Division 2 Area: Rigid Aluminum.

3.04 CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:
   1. Conduit Size 4 Inches or Less: Flexible metal, liquid-tight conduit.
   2. Conduit Size Over 4 Inches: Nonflexible.
   3. Corrosive Areas: Flexible, nonmetallic, liquid or PVC-coated metallic, liquid-tight.
   4. Length: 18-inch minimum, 60-inch maximum, of sufficient length to allow movement or adjustment of equipment.

B. Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Transition From Underground or Concrete Embedded to Exposed: PVC Coated Rigid galvanized steel conduit.

E. Under Equipment Mounting Pads: Rigid galvanized steel conduit.

F. Exterior Light Pole Foundations: Rigid galvanized steel conduit.

3.05 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit in contact with concrete floor slabs to a point 2 inches above concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:
   1. General: Seal raceway at the first box or outlet with minimum 2 inches thick expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
   2. Concrete Roof or Membrane Waterproofed Wall or Floor:
      a. Provide a watertight seal.
      b. Without Concrete Encasement: Install watertight entrance seal device on each side.
      c. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
      d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.

e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

3. Heating, Ventilating, and Air Conditioning Equipment:
   a. Penetrate equipment in area established by manufacturer.
   b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
   c. Seal penetration with silicone type sealant.
4. Corrosive-Sensitive Areas:
   a. Seal all conduit passing through chlorine and ammonia room walls.
   b. Seal all conduit entering equipment panel boards and field panels containing electronic equipment.
   c. Seal penetration with silicone type sealant.
5. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.
6. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
   a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
   b. Fill space between raceway and sleeve with an expandable plastic compound on each side.
7. Manholes and Handholes:
   a. Metallic Raceways: Provide insulated grounding bushings.
   b. Nonmetallic Raceways: Provide bell ends flush with wall.
   c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.06 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 40 percent extra space for future conduit.

C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
   1. Wood: Wood screws.
   2. Hollow Masonry Units: Toggle bolts.
   3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
   4. Steelwork: Machine screws.

D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.07 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:
   1. Bends 30-Degree and Larger: Provide factory-made elbows.
   2. 90-Degree Bends: Provide rigid steel elbows.
   3. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.08 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.09 PVC CONDUIT

A. Solvent Welding:
   1. Provide manufacturer recommended solvent; apply to all joints.
   2. Install such that joint is watertight.

B. Adapters:
   1. PVC to Metallic Fittings: PVC terminal type.
   2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belied-End Conduit: Bevel the unbelled end of the joint prior to joining.

3.10 PVC-COATED RIGID STEEL CONDUIT

A. Install in accordance with manufacturer's instructions.

B. Provide PVC boot to cover all exposed threading.

3.11 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

3.12 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Sheet Metal Boxes, Cabinets, and Enclosures:
   1. Rigid Galvanized Conduit:
      a. Provide one lock nut each on inside and outside of enclosure.
      b. Install grounding bushing.
      c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
      d. Install insulated bushing on ends of conduit where grounding is not required.
      e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   2. Electric Metallic Tubing: Provide gland compression, insulated connectors.
   3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
   4. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
   5. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
   6. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.

C. Motor Control Center, Switchboard, Switchgear, and Free-Standing Enclosures: Terminate conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.13 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:
   1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
   2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Installation with Other Piping Systems:
   1. Crossings: Maintain minimum 12-inch vertical separation.
   2. Parallel Runs: Maintain minimum 12-inch separation.
   3. Installation over valves or couplings not permitted.

I. Metallic Raceway Coating: At couplings and joints and along entire length, apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

J. Concrete Encasement: As specified in Section 03300, CAST-IN-PLACE CONCRETE.
   1. Concrete Color: Gray, dust top of concrete ductbank with powdered red concrete dye before concrete sets and trowel dry onto top of ductbank.

K. Backfill:
   1. As specified in Section 01045, CUTTING AND PATCHING
   2. Do not backfill until inspected by ENGINEER.

3.14 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade back to original state.

B. Do not install until final raceway grading has been determined.

C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

D. Grounding: As specified in Section 16450, GROUNDING.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be i-inch minimum height.

3.15 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Paragraph IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.16 IDENTIFICATION DEVICES

A. Raceway Tags:
   1. Identify origin and destination.
   2. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.
   3. Provide nylon strap for attachment.

B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

C. Buried Raceway Markers:
   1. Install at grade to indicate direction of underground raceways.
   2. Install at all bends and at intervals not exceeding 100 feet in straight runs.
   3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.17 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up damage to coating on PVC-coated conduit with patching compound approved by manufacturer.

END OF SECTION

SECTION 16120

CONDUCTORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American National Standards Institute (ANSI): 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   2. American Society for Testing and Materials (ASTM):
      a. A167, Standard Specification for Stainless and Heat Resisting Chromium-Nickel-P1ated Steel Plate, Sheet, and Strip.
      b. B3, Standard Specification for Soft or Annealed Copper Wire.
      c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
      d. B263, Standard Test Method for Determination of Cross- Sectional Area of Stranded Conductors.
   3. Association of Edison Illuminating Companies (AEIC):
      a. CS 5, Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 35 kV.
      b. CS 6, Ethylene- Propylene-Rubber-Insulated Shielded Power Cables Rated 5 Through 69 kV.
   4. Insulated Cable Engineer's Association, Inc. (ICEA): T-29-250, Procedure for Conducting Vertical Cable Tray Flame Test With a Theoretical Heat Input of 210,000 Btu/hour.
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 48, Standard Test Procedures and Requirements or High-Voltage Alternating Current Cable Terminations.
      b. 404, Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V through 46,000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V through 500,000V.
   6. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.
   7. National Electrical Manufacturers' Association (NEMA):
      a. CC 1, Electric Power Connectors for Substations.
      b. WC 3, Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      c. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      d. WC 7, Crosslinked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      e. WC 8, Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      f. WC 55, Instrumentation Cables and Thermocouple Wire.
   8. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   9. Underwriters Laboratories, Inc. (UL):
      a. 13, Standard for Safety Power-Limited Circuit Cables.

b. 44, Standard for Safety Rubber-Insulated Wires and Cables.
c. 62, Standard for Safety Flexible Cord and Fixture Wire.
d. 486A, Standard for Safety Wire Connector and Soldering Lugs for Use with Copper Conductors.
e. 486B, Standard for Safety Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.
f. 510, Standard for Safety Insulating Tape.
g. 854, Standard for Safety Service-Entrance Cables.
h. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces.
i. 1072, Standard for Safety Medium-Voltage Power Cables.
j. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
k. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Shop Drawings:
1. Wire and cable descriptive product information.
2. Wire and cable accessories descriptive product information.
3. Cable fault detection system descriptive product information.
4. Manufactured wiring systems descriptive product information.
5. Manufactured wire systems rating information.
6. Manufactured wire systems dimensional drawings.
7. Manufactured wire systems special fittings.
8. Busway descriptive product information.
9. Busway rating information.
10. Busway dimensional drawings.
11. Busway special fitting information.
12. Busway-equipment interface information for equipment to be connected to busways.

B. Quality Control Submittals:
1. Certified Factory Test Report for conductors 600 volts and below.
2. Certified Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:
1. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Stranded copper.

2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Stranded copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW insulation.

D. Direct Burial and Aerial Conductors and Cables:
1. Type USE/RHH/RHW insulation, UL t(54 listed, Type RHW-2/USE-2.
2. Conform to physical and minimum thickness requirements of NEMA WC 3.

E. Flexible Cords and Cables:
1. Type SOW-A50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 8.

F. Cable Tray Conductors and Cables: Type TC.

2.02 600-VOLT RATED CABLE

A. General:
1. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Wire and Connectors:
1. Cable shall be rated for 600 volts and shall meet the requirements below:
2. Conductors shall be stranded
3. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.
4. Type of wire shall be XHHW or THHN, rated 75 degrees C suitable for wet locations except where required otherwise by the drawings.
5. No wire smaller than No. 12 gauge shall be used unless specifically indicated.
6. Conductor metal shall be copper.
7. All conductors shall be megger tested after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance.

C. Type l-Multiconductor Control Cable:
1. Conductors:
a. No. 14 AWG, seven-strand copper.
b. Insulation: 15-mil PVC with 4-mil nylon.
c. UL 1581 listed as Type THHN/THWN rated VW-l.
d. Conductor group bound with spiral wrap of barrier tape.
e. Color Code: In accordance with NEMA WC 5, Method 1, Sequence K-2.
2. Cable: Passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (inches)	Jacket Thickness (mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	00.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. Rome Cable.

D. Type 2-Multiconductor Power Cable:
1. Conductors:
   a. Class B stranded, coated copper.
   b. Insulation: Chemically crosslinked ethylene-propylene with Hypalon jacket.
   c. UL 1581 listed as Type EPR, rated VW-1.
   d. Color Code: Conductors, size No. 8 AWG and smaller, colored conductors, NEMA WC5 Method 1, color 5 per Article POWER CONDUCTOR COLOR CODING. Conductors, size No. 6 AWG and larger, NEMA WC5, Method 4.
2. Cable pass the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. of Conductors	Max.Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2 3 4	0.42 0.45 0.49	45 45 45
10	10	2 3 4	0.54 0.58 0.63	60 60 60
8	10	3 4	0.66 0.72	60
6	8	3 4	0.74 0.81	60
4	6	3 4	0.88 0.97	60 80
2	6	3 4	1.01 1.11	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.46	80
4/0	4	3 4	1.56 1.78	80

4. Manufacturers:
    a. Okonite Co.
    b. Pome Cable.

E. Type B-No. 16 AWG, Twisted, Shielded Pair (TSP), Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
    1. Outer Jacket: 45-mil nominal thickness.
    2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
    3. Dimension: 0.31-inch nominal OD.
    4. Conductors:
        a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8
        b. 20 AWG, seven-strand tinned copper drain wire.
        c. Insulation: 15-mil nominal PVC.
        d. Jacket: 4-mil nominal nylon.
        e. Color Code: Pair conductors black and red.
    5. Manufacturers:
        a. Okonite Co.
        b. Alpha Wire Corp.
    6. The following test shall be performed on instrumentation and control system cables. All tests shall be end-to-end test of installed cables with the ends supported in free air, not adjacent to any ground object. All test data shall be recorded on forms acceptable to the Engineer. Complete records of all tests shall be made and delivered to the Engineer.
        a. Continuity tests shall be performed by measuring wire/shield loop resistances of signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall carry by more than $\pm$2 ohms from the calculated average loop resistance valve.
        b. Insulation resistance tests shall be performed by using a 500 volt megohmeter to measure the insulation resistance between each channel wire and channel shield, between individual channel shields in a multi-channel cable, between each individual channel and the overall cable shield in multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 10 megohms shall be unacceptable.

F. Type B1-No. 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
    1. Outer Jacket: 45-mil nominal.
    2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
    3. Dimension: 0.32-inch nominal OD.
    4. Conductors:
        a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
        b. 20 AWG, seven-strand, tinned copper drain wire.
        c. Insulation: 15-mil nominal PVC.
        d. Jacket: 4-mil nylon.
        e. Color Code: Triad conductors black, red, and white.

5. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.

G. Type B2-No. 18 AWG, Multi-Twisted, Shielded Pairs with a Common, Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 55 requirements.
1. Conductors:
    a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8
    b. Tinned copper drain wires.
    c. Pair drain wire size AWG 20, group drain wire size AWG 18.
    d. Insulation: 15-mil PVC.
    e. Jacket: 4-mil nylon.
    f. Color Code: Pair conductors black and red with red conductor numerically printed for group identification.
    g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
3. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.50	45
8	0.68	60
12	0.82	60
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

4. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.

H. Type B3-No. 18 AWG, Multi-twisted Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 55.
1. Conductors:
    a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
    b. Tinned copper drain wire size 18 AWG
    c. Insulation: 15-mil nominal PVC.
    d. Jacket: 4-mil nylon.
    e. Color Code: Pair conductors black and red, with red conductor numerically printed for group identification.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
3. Cable Sizes:

Number Of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.46	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.06	80
36	1.21	80
50	1.42	80

4. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.

I. Ethernet Cat. 6e UTP Cable (Copper):
1. Section applies to all Ethernet Cable (Copper) except for Fiber Optic cable.
2. Conductor Physical Characteristics: 4 twisted pairs (8 conductors), 23 AWG solid bare Copper with Polyolefin Insulation. Overall Nominal Diameter: 0.235 inch. Operating Temperature Range: -20'C to +75'C. Model Number – 7881A, Belden Inc.
3. NEC/UL specification CMR, UL444, UL verified category 6.
4. Manufacturer:
   a. Belden Inc.

2.03 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.04 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:
1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arcs and Fireproofing:
   a. 30-mil, elastomer
   b. Manufacturers and Products:
      1) Scotch; Brand 77, with Scotch Brand 69 glass cloth tape binder.
      2) Plytnount; Plyarc 30, with Plymount Plyglas glass cloth tape binder.

B. Identification Devices:
1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:
   1. Nylon, Self-Insulated Crimp Connectors:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) Burndy; Insulink.
         3) ILSCO.
   2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) Burndy; Insulink.
         3) ILSCO.

D. Cable Lugs:
   1. In accordance with NEMA CC I.
   2. Rated 600 volts of same material as conductor metal.
   3. Insulated, Locking-Fork, Compression Lugs:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) ILSCO; ILSCONS.
   4. Un-insulated Crimp Connectors and Terminators:
      a. Manufacturers and Products:
         1) Square D; Versitide.
         2) Thomas & Betts; Color-Keyed.
         3) ILSCO.
   5. Un-insulated, Bolted, Two-Way Connectors and Terminators:
      a. Manufacturers and Products:
         1) Thomas & Betts; Locktite.
         2) Burndy; Quiklug.
         3) ILSCO.

E. Cable Ties: Nylon, adjustable, self-locking, and reusable.
   1. Manufacturers and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyofin.
   1. Manufacturers and Product: Thomas & Betts; SHRINK-KON.

2.05 PULLING COMPOUND

A. Nontoxic, non-corrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:
   1. Ideal Co.; Yellow 77.
   2. Polywater, Inc.
   3. Cable Grip Co.

2.06 WARNING TAPE

A. As specified in Section 16110, RACEWAYS.

2.07 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and Below: Test in accordance with UL 44 and 854 Standards.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation to be in accordance with NECA 5055.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

F. Bundling: Where single conductors and cables in manholes, hand holes, vaults, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

I. Cable Tray Installation:
   1. Install wire and cable parallel and straight in tray.
   2. Bundle, in groups, all wire and cable of same voltage having a common routing and destination; use cable ties, at maximum intervals of 8 feet.
   3. Clamp cable bundles prior to making end termination connections.
   4. Separate cables of different voltage rating in same cable tray with barriers.
   5. Fasten wires, cables, and bundles to tray with nylon cable straps at the following maximum intervals:
      a. Horizontal Runs: 20 feet.
      b. Vertical Runs: 5 feet.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:
   1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
   2. No. 8 AWG and Smaller: Provide colored conductors.
   3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation. Coordinate with AHJ and local codes and adjust the color accordingly.		

   4. Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, hand holes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:
   1. Assign circuit name based on device or equipment at load end of circuit.
   2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:
   1. Conductors No. 3 AWG and Smaller: Identify with sleeves.
   2. Cables, and Conductors No. 2 AWG and Larger:
      a. Identify with marker plates.
      b. Attach marker plates with nylon tie cord.
   3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by ENGINEER.

C. Connections and Terminations:
   1. Install wire nuts only on solid conductors.
   2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.
   3. Install un-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
   4. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
   5. Install un-insulated bolted, two-way connectors for motor circuit conductors No. 12 and larger.
   6. Tape insulates all un-insulated connections.
   7. Place no more than one conductor in any single-barrel pressure connection.
   8. Install crimp connectors with tools approved by connector manufacturer.
   9. Install terminals and connectors acceptable for type of material used.
   10. Compression Lugs
      a. Attach with a tool specifically designed for purpose.
      b. Tool shall provide complete controlled crimp and shall not release until crimp is complete.
      c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:
   1. Indoors: Use general purpose, flame retardant tape.
   2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

F. Cap spare conductors and conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:
   1. Remove surplus wire, bridle and secure.
   2. Where conductors pass through openings or over edges in sheet metal, remove bums, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:
   1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
   2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
   3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.

4. Where connections of cables installed under this section are to be made under PROCESS INSTRUMENTATION AND CONTROL SYSTEMS, leave pigtails of adequate length for bundled connections.
5. Cable Protection:
    a. Under Infinite Access Floors: May be installed without bundling.
    b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2-inch in diameter.
    c. Maintain integrity of shielding of instrumentation cables.
    d. Ensure grounds do not occur because of damage to jacket over the shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.05 FIELD QUALTTY CONTROL - LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:
1. Inspect Each Individual Exposed Power Cable No. 6 and Larger For:
    a. Physical damage.
    b. Proper connections in accordance with single-line diagram.
    c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
    d. Color coding conformance with specifications.
    e. Proper circuit identification.
2. Mechanical Connections For:
    a. Proper lug type for conductor material.
    b. Proper lug installation.
    c. Bolt torque level in accordance with NETA ATS, Table 10. 1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
    a. Proper shield grounding.
    b. Proper terminations.
    c. Proper circuit identification.
4. Control Cables For:
    a. Proper termination.
    b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:
1. Insulation Resistance Tests:
    a. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
    b. Evaluate ohmic values by comparison with conductors of same length and type.
    c. Investigate values less than 50 megohms.
    d. Utilize 1,000V dc megohmmeter for 600V insulated conductors.
2. Continuity test by ohmmeter method to ensure proper cable connections.

END OF SECTION

SECTION 16405

ELECTRIC MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Anti-Friction Bearing Manufacturers' Association (AFBMA):
      a. 9, Load Ratings and Fatigue Life for Ball Bearings.
      b. 11, Load Rating and Fatigue Life for Roller Bearings.
   2. American National Standards Institute (ANSI): C50.41, Polyphase Induction Motors for Power Generating Stations.
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
      a. 85, Test Procedure for Airborne Sound Measurements on Rotating Machines.
      b. 112, Standard Test Procedures for Polyphase Induction Motors and Generators.
      c. 114, Standard Test Procedures for Single-Phase Induction Motors.
      d. 620, Guide for Construction and Interpretation of Thermal Limit Curves for Squirrel-Cage Motors Over 500 Horsepower.
      e. 841, Recommended Practice for Chemical Industry Severe-Duty Squirrel-Cage Induction Motors, 600V and Below.
   4. National Electrical Manufacturers Association (NEMA):
      a. MG 1, Motors and Generators.
      b. MG 13, Frame Assignments for Alternating Current Integral Horsepower Induction Motors.
      c. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   5. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
   6. Underwriters Laboratories (UL):
      a. 547, Thermal Protectors for Electric Motors.
      b. 674, Electric Motors and Generators Used in Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. CISD-TEFC: Chemical industry, severe-duty enclosure.

B. DIP: Dust-ignition-proof enclosure.

C. EXP: Explosion-proof enclosure.

D. ODP: Open drip-proof enclosure.

E. TEFC: Totally enclosed, fan cooled enclosure.

F. TENV: Totally enclosed, non-ventilated enclosure.

G. WPI: Open weather protected enclosure, Type I.

H. WPII: Open weather protected enclosure, Type II.

I. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Descriptive information.
   2. Nameplate data in accordance with NEMA MG 1.
   3. Additional Rating Information:
      a. Service factor.
      b. Locked rotor current.
      c. No load current.
      d. Safe stall time for motors 200 horsepower and larger.
      e. Multispeed load classification (e.g., variable torque).
      f. Adjustable frequency drive motor load classification (e.g., variable torque) and minimum allowable motor speed for that load classification.
   4. Enclosure type and mounting (e.g. horizontal, vertical).
   5. Dimensions and total weight.
   6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
   7. Bearing type.
   8. Bearing lubrication.
   9. Bearing life.
   10. Space heater voltage and watts.
   11. Description and rating of motor thermal protection.
   12. Motor sound power level in accordance with NEMA MG 1.
   13. Maximum brake horsepower required by the equipment driven by the motor.
   14. Description and rating of submersible motor moisture-sensing system.

B. Quality Control Submittals:
   1. Factory test reports, certified.
   2. Manufacturer's Certificate of Proper Installation, 100 horsepower and larger.
   3. Operation and Maintenance Manual.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. General Electric.

B. Reliance.

C. Magnetek.

D. Siemens.

E. U.S.Motors.

F. Westinghouse.

G. Toshiba.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, use a single supplier to provide a drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. Frame assignments in accordance with NEMA MG 13.

E. Provide motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

F. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

G. Lifting lugs on all motors weighing 100 pounds or more.

H. Operating Conditions:
   1. Maximum ambient temperature not greater than 50 degrees C.
   2. Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.
   3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specifications.

B. Constant Speed Applications: Brake horsepower of the driven equipment at any head capacity point on the pump curve not to exceed motor nameplate horsepower rating, excluding any service factor.

C. Adjustable Frequency, Adjustable Speed Applications: Driven equipment brake horsepower at any head capacity point on the pump curve not to exceed motor nameplate horsepower rating, excluding any service factor.

2.04 SERVICE FACTOR

A. 1.15 minimum at rated ambient temperature, unless otherwise indicated.

2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60-Hz.

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specifications:

Size	Voltage	Phases
1/2 hp and smaller	115	1
3/4 hp through 400 hp	460	3
450 hp and larger	4,000	3

C. Suitable for full voltage starting.

D. One hundred horsepower and larger also suitable for reduced voltage starting with 65 or 80 percent voltage tap settings on reduced inrush motor starters.

E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 horsepower, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:
   1. Efficiency:
      a. Tested in accordance with NEMA MG 1, paragraph 12.54.1. Tested efficiency shall meet or exceed listed in NEMA MG 1 Table 12-10.
      b. Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.
   2. Power Factor: Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code F or lower if motor horsepower not covered by NEMA MG 1 tables.

B. Safe stall time 15 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

B. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.

C. Three-Phase and Integral Horsepower Motors, Unless Otherwise Indicated in Motor-Driven Equipment Specifications: Class F with Class B rise at nameplate horsepower and designated operating conditions, except EXP and DIP motors which must be Class B with Class B rise. Insulation shall be chemical and humidity resistant.

2.09 ENCLOSURES

A. All enclosures to conform to NEMA MG 1.

B. Unless otherwise noted, all motors shall be TEFC and shall be furnished with a drain hole with porous drain/weather plug.

C. Explosion-Proof (EXP):
   1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class 1, Division 1, Group C and D hazardous locations.
   2. Drain holes with drain and breather fittings.
   3. Integral thermostat opening on excessive motor temperature in accordance with UL 547 and NFPA 70.
   4. Thermostat leads to terminate in a terminal box separate from main terminal box.

D. Dust-Ignition-Proof (DIP):
   1. TEFC listed to met UL 674 and NFPA 70 requirements for Class II, Division 1, Group E, F, G.
   2. Integral thermostat opening on excessive motor temperature in accordance with UL 547 and NFPA 70.
   3. Thermostat leads to terminate in a terminal box separate from main terminal box.

E. Submersible: In accordance with Paragraph SPECIAL MOTORS.

F. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Paragraph SPECIAL MOTORS.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for all motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1-11.06 and 20.62 and NFPA 70, Article 430:

Voltage	Horsepower	Percentage
Below 600	15 thru 125	500
Below 600	150 thru 300	275
Below 600	350 thru 600	225
Above 600	All Sizes	200

E. Terminal for connection of equipment grounding wire in each terminal box.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:
   1. 3/4 horsepower and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
   2. 1 Through 400 horsepower: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
   3. Above 400 horsepower: Regreasable antifriction bearings in labyrinth sealed end bells with removable grease relief plugs.
   4. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in AFBMA 9 and 11.

B. Vertical Motors:
   1. Thrust Bearings:
      a. Antifriction bearing.
      b. Manufacturer's standard lubrication 100 horsepower and smaller.
      c. Oil lubricated 125 horsepower and larger.
      d. Minimum 100,000 hours L-10 bearing life.
   2. Guide Bearings:
      a. Manufacturer's standard bearing type.
      b. Manufacturer's standard lubrication 100 horsepower and smaller.
      c. Oil lubricated 125 horsepower and larger.
      d. Minimum 100,000 hours L-1O bearing life.

C. Regreasable Antifriction Bearings:
   1. Readily accessible, grease injection fittings.
   2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:
   1. Oil reservoirs with sight level gauge.
   2. Oil fill and drain openings with opening plugs.
   3. Provisions for necessary oil circulation and cooling.

2.12 NOISE

A. Measured in accordance with IEEE 85 and NEMA MG 1 and be less than levels in 12.53.3 at no load.

B. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1-12.06 and 1-12.07.

2.14 EQUIPMENT FINISH

A. External Finish: Prime and finish coat manufacturer's standard. Field painting in accordance with Section 09960.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen over Air Openings: Stainless steel on motors with ODP, WPI, and WPII enclosures meeting requirements for Guarded Machine in NEMA MG 1.

B. Winding Thermal Protection:
   1. Thermostats:
      a. Motors for constant speed and adjustable speed application 50 and larger.
      b. Bi-metal disk or rod type thermostats embedded in stater windings (normally closed contact).
      c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature. (Manual reset will be provided at motor controller.)
   2. Motor Space Heaters: All motors 50 horsepower and larger except if otherwise noted, shall be furnished with 120V ac space heaters. The rating of the space heaters shall be determined in accordance with the motor manufacturer's standard for particular frame size and type. Coordinate the power requirements of the space heater with the manufacturer of motor starters or adjustable frequency drive for sizing of the control transformer. Space heater wire leads shall be brought out in the conduit box on the motor and clearly identified.

2.16 SPECIAL MOTORS

A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.

B. Chemical Industry, Severe-Duty (CISD-TEFC):
   1. In accordance with IEEE 841.
   2. TEFC in accordance with NEMA MG 1.
   3. Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.
   4. Motor Frame, End Shields, Terminal Box(es), and Fan Cover: Cast iron.
   5. Ventilating Fan: Corrosion-resistant, non-sparking, external.
   6. Drain and Breather Fittings: Stainless steel.
   7. Nameplate: Stainless steel.
   8. Gaskets between terminal box halves and terminal box and motor frame.
   9. Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.
   10. Double shielded bearings.
   11. 125,000 hours minimum L-10 bearing life for direct-connected loads.
   12. External Finish: Double-coated epoxy enamel.
   13. Coated rotor and stator air gap surfaces.
   14. Insulation System, Windings, and Connections:
      a. Class F insulation, Class B rise or better at 1.0 service factor.
      b. Multiple dips and bakes of nonhygroscopic polyester varnish.
   15. Service Factor:
      a. At 40 Degrees C Ambient: 1.15.
      b. At 65 Degrees C Ambient: 1.00.

16. Safe Stall Time Without Injurious Heating: 20 seconds minimum.
17. Motor shall be equal to U.S. Motors Severe Duty Premium Efficient Motors. Provide motors with insulated bearing to prevent ground current damage.

C. Severe-Duty Explosion-Proof: Meet requirements for EXP enclosures and CISD-TEFC motors.

D. Severe-Duty, Dust-Ignition-Proof: Meet requirements for DIP enclosures and CISD-TEFC motors.

E. Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in the motor-driven equipment specifications.

F. Submersible Pump Motors:
1. Manufacturers:
   a. Myers.
   b. Flygt.
2. At 100 Percent Load:

Horsepower	Guaranteed Minimum Efficiency	Guaranteed Minimum Power Factor
5 thru 10	80	82
10.1 thru 50	85	82
50. 1 thru 100	87	82
Over 100	89	82

3. Insulation System: Manufacturer's standard Class B or Class F.
4. Motor capable of running dry continuously.
5. Enclosure.
   a. Hermetically sealed, watertight, for continuous submergence up to 65-foot depth.
   b. Listed to meet UL 674 and NFPA 70 requirements for Class 1, Division 1, Group D hazardous atmosphere.
   c. Seals: Tandem mechanical.
6. Bearing and Lubrication:
   a. Permanently sealed and lubricated, replaceable antifriction guide and thrust bearings.
   b. Minimum 15,000 hours L-10 bearing life.
7. Inrush kVA/horsepower no greater than NEMA MG 1 and NFPA 70, Code F.
8. Winding Thermal Protection:
   a. Thermal sensor and switch assemblies, one each phase embedded in stator windings and wired in series.
   b. Switches normally closed, open upon excessive winding temperature, and automatically reclose when temperature has cooled to safe operating level.
   c. Switch contacts rated at 5 amps, 120 volts ac.
9. Motor Seal Failure Moisture Detection:
   a. Probes or sensors to detect moisture beyond seals.

b. Probe or sensor monitoring module for mounting in motor controller, suitable for operation from 120-volt ac supply.
c. Monitoring module with control power transformer, probe test switch and test light, and two independent 120-volt ac contacts, one opening and one closing when the flux of moisture is detected.

10. Bearing Overtemperature Protection for Motors Larger than 100 Horsepower:
    a. Sensor on lower bearing housing monitoring bearing temperature.
    b. Any monitoring relay necessary to provide 120-volt ac contact opening on bearing overtemperature.
11. Winding thermal protection, moisture detection, and bearing overtemperature specified above may be monitored by a single device providing two independent 120-volt ac contacts, one closing and one opening on malfunction.
12. Connecting Cables:
    a. One cable containing power, control, and grounding conductors.
    b. Each cable suitable for hard service, submersible duty with watertight seal where cable enters motor.
    c. Length: 30 feet minimum, coordinate proper length
    d. UL 1 listed and sized in accordance with NFPA 70.

G. Inclined Motors:
1. Motors suitable for operation only in horizontal position not acceptable.
2. Bearings designed for thrust imposed by driven equipment and by motor rotor when motor is in inclined position.
3. Lubrication system designed to provide adequate bearing lubrication when motor is in inclined position.

2.17 FACTORY TESTING

A. Tests:
1. In accordance with IEEE 112 for polyphase motors and IEEE 114 for single-phase motors.
2. Routine (production) tests on all motors in accordance with NEMA MG 1, plus no load power at rated voltage and polyphase, rated voltage measurement of locked rotor current. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency at 50, 75, and 100 percent of rated horsepower:
    a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, paragraphs 12.54 and 12.57.
    b. For motors 500 horsepower and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
4. Power factor:
    a. Speed.
    b. Current at rated horsepower.
    c. kW input at rated horsepower.
    d. On motors of 100 horsepower and smaller, furnish a certified copy of a motor efficiency test report on an identical motor.

B. Test Report Forms:
1. Routine Tests: IEEE 112, Form A-1.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts. Provide anchor bolts meeting manufacturer's recommendations and of sufficient size and number for the specified seismic conditions.

3.02 FIELD QUALITY CONTROL

A. General: Inspection and testing limited to motors rated 5 horsepower and larger.

B. Visual and Mechanical Inspection:
   1. Proper electrical and grounding connections.
   2. Shaft alignment.
   3. Blockage of ventilating air passageways.
   4. Operate Motor and Check For:
      a. Excessive mechanical and electrical noise.
      b. Overheating.
      c. Correct rotation.
      d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
      e. Excessive vibration.
   5. Check operation of space heaters.

C. Electrical Tests:
   1. Insulation Resistance Tests:
      a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
         1) Motors above 200 horsepower for l0-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
         2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
      b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
   2. Calculate polarization index ratios for motors above 200 horsepower. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
   3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
   4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.
   5. Overpotential Tests:
      a. Applied dc voltage in accordance with IEEE 95.
      b. Limited to 4,000-volt motors rated 1,000 horsepower and greater.
      c. Test results evaluated on pass/fail basis.

3.03 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative at site for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 75 horsepower.

B. Manufacturer's Certificate of Proper Installation.

3.04 SUPPLEMENTS

A. Table supplements, following "END OF SECTION," are a part of this Specification.

END OF SECTION

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
1	1800	80.0	81.5			Mfr.'s Std.	Mfr.'s Std.		
	1200	78.5	79.3			Mfr.'s Std.	Mfr.'s Std.		
1.5	3600	79.3	81.5			Mfr.'s Std.	Mfr.'s Std.		
	1800	79.3	82.0			Mfr.'s Std.	Mfr.'s Std.		
	1200	82.5	84.0		82.0	Mfr.'s Std.	Mfr.'s Std.		Mfr.'s Std.
2	3600	82.0	84.0			Mfr.'s Std.	Mfr.'s Std.		
	1800	81.5	83.7			Mfr.'s Std.	Mfr.'s Std.		
	1200	85.5	85.5	83.7	83.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	82.9	82.5	82.9	81.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
3	3600	82.0	84.0	82.0	82.0	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	84.8	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	87.5	88.1	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	84.1	82.9	84.1	82.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
5	3600	84.8	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	86.5	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	87.5	88.1	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	86.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
7.5	3600	86.5	88.1	84.8	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	88.5	88.5	88.4	87.5	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	86.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
10	3600	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	89.5	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
15	3600	88.5	89.8	88.4	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	91.0	91.0	90.9	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	90.2	90.2	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
20	3600	91.0	90.6	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	91.7	91.7	91.7	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.0	90.6	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
25	3600	91.7	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.7	91.0	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
30	3600	91.7	91.4	89.5	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.7	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	91.7	91.7	90.9	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
40	3600	91.7	91.7	90.2	89.3	86.6	86.1	87.0	89.0
	1800	93.6	93.0	92.8	91.7	78.2	78.2	83.0	84.5
	1200	92.4	92.4	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.0	90.9	90.2	70.0	70.5	70.0	70.5
50	3600	92.0	92.0	90.2	89.3	85.1	86.7	89.0	89.0
	1800	93.6	93.0	92.8	91.7	79.5	79.4	82.5	82.5
	1200	92.4	92.4	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.7	90.9	90.9	78.5	72.9	78.5	80.0
60	3600	92.7	93.0	91.7	90.9	85.8	88.3	87.5	89.0
	1800	93.6	94.1	93.5	92.8	80.5	79.9	80.5	80.5
	1200	93.0	93.0	92.8	91.7	81.5	81.5	81.5	81.5
	900	92.4	91.7	91.7	90.9	79.5	73.2	79.5	79.5
70	3600	93.6	93.6	91.7	91.7	87.1	88.5	88.5	88.5
	1800	94.5	94.5	93.5	93.5	81.0	81.5	81.0	81.5
	1200	93.6	93.5	93.5	92.8	82.0	82.0	82.0	82.0
	900	92.8	92.4	92.8	91.7	80.5	74.5	80.5	81.0
100	3600	93.6	93.3	91.7	90.7	87.0	88.2	87.0	88.5
	1800	95.1	94.5	94.0	93.5	81.0	81.0	81.0	81.0
	1200	93.6	93.6	92.8	92.8	82.1	81.7	85.5	85.5
	900	93.5	92.4	92.8	91.7	77.0	77.3	77.0	80.0
125	3600	93.6	93.7	91.7	91.7	86.4	89.1	87.0	90.5
	1800	94.5	94.7	93.5	92.8	85.4	85.5	87.5	86.0
	1200	93.6	94.1	93.5	92.8	82.7	82.3	85.5	85.5

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
	900	93.5	93.0	92.8	92.4	78.5	78.5	78.5	78.5
150	3600	93.6	93.7	92.4	91.7	86.5	90.0	86.5	90.5
	1800	95.0	95.2	94.5	94.0	82.5	85.0	84.5	85.0
	1200	94.5	94.5	93.5	94.0	81.5	81.5	81.5	81.5
	900	93.5	93.0	92.8	92.4	78.0	78.5	78.0	78.5
200	3600	94.3	94.3	92.4	93.0	87.8	89.4	91.0	91.0
	1800	95.0	95.2	94.0	94.0	85.2	86.5	87.0	87.0
	1200	94.5	94.5	93.5	93.5	79.0	82.5	79.0	82.5
250	3600	94.3	94.7	91.7	92.4	85.0	86.5	85.0	96.5
	1800	85.4	95.4	94.5	94.5	79.0	79.0	79.0	79.0
	1200	95.0	94.5	94.5	93.5	82.0	82.0	82.0	82.0
300	3600	93.7	94.3			89.8	89.9		
	1800	95.4	95.2	94.5	94.0	80.0	80.0	800	80.0
	1200	93.7	93.7			84.5	90.1		
350	3600	94.3	94.7			89.4	85.9		
	1800	94.7	94.7			85.9	85.9		
400	3600	94.3				88.4			
	1800	9437				86.8			
450	3600	94.7				89.1			
500	3600	94.7				88.3			

SECTION 16450

GROUNDING

PART 1 GENERAL

1.01 SCOPE

A. Provide and install grounding system as shown on drawings and as specifies herein complete in place.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American National Standards Institute (ANSI): C2, National Electrical Safety Code (NESC).
   2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

B. Submittals
   1. 1. Shop Drawings:
      a. a.Product Data:
         1) Exothermic weld connectors.
         2) Mechanical connectors.
         3) Compression connectors.

C. UL Compliance
   1. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PART 2 PRODUCTS

2.01 GROUND ROD

A. Material: Copper clad.

B. Diameter: Minimum 5/8 inch.

C. Length: 20 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 16120, CONDUCTORS.

2.03 CONNECTORS

A. Exothermic Weld Type:
   1. Outdoor Weld: Suitable for exposure to elements or direct burial.
   2. Indoor Weld: Use low-smoke, low-emission process.
   3. Manufacturers:

a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
b. Thermoweld.

B. Compression Type:
1. Compress deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels pre-filled with oxide inhibiting and anti-seizing compound and sealed.
5. Manufacturers:
a. Burndy Corp.
b. Thomas and Betts Co.
c. Ilso Corp.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.
1. Manufacturers:
a. Burndy Corp.
b. Thomas and Betts Co.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers:
1. Christy Co.; No. G5.
2. Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 EXECUTION

3.01 GENERAL

A. Grounding shall comply with NFPA 70 and ANSI C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

F. Shielded Control Cables:
1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum I inch at termination to field instrument and apply heat shrink tube.
3. Do not ground control cable shield at more than one point.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to non-current carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to non-current carrying grounding bus.

C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

3.05 GROUNDING WELLS

A. Install inside buildings, asphalt, and paved areas.

B. Install riser ring and cover flush with surface.

C. Place 9 inches crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:
   1. Above grade Connections: Use exothermic weld, mechanical, or compression-type connectors.
   2. Below grade Connections: Install exothermic weld type connectors.
   3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
   4. Notify Engineer before backfilling ground connections.

B. Exothermic Weld Type:
   1. Wire brush or file contact point to bare metal surface.
   2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
   3. Avoid using badly worn molds.
   4. Mold to be completely filled with metal when making welds.
   5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:
   1. Install in accordance with connector manufacturer's recommendations.
   2. Install connectors of proper size for grounding conductors and ground rods specified.
   3. Install using connector manufacturer's compression tool having proper sized dies and proof of calibration within the last 12 months.

D. Mechanical Type:
   1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
   2. Install in accordance with connector manufacturer's recommendations.
   3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each.

B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all non-current carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of substation transformers to substation grounding grid and system grounding network.

C. Bond neutrals of pad-mounted transformers to four locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

3.11 INSTRUMENT GROUND - SURGE SUPPRESSION

A. Connect all instrument surge protection with #6 insulated copper groundwire (in conduit where above grade) to closest plant ground system

3.12 BONDING

A. Bond to Main Conductor System:

B. All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.

C. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.

D. Provide air terminals as required.

E. Bond steel columns or major framing members to grounding system per National Electrical Code.

F. Bond each main down conductor to grounding system.

G. All conduits terminations in panels shall be grounded using appropriate ground bushing and conductor to nearest ground point.

3.13 GROUNDING SYSTEM

A. Grounding Conductor:

B. Completely encircle building structure.

C. Bury minimum 30 inches below finished grade.

D. Minimum 2 feet distance from foundation walls.

E. Interconnect ground rods by direct-buried copper cables.

F. Connections:
   1. Install ground cables continuous between connections.
   2. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and non-accessible connections.
   3. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
   4. Use bolded offset parapet bases or through-roof concealed base assemblies for air terminal connections.
   5. Provide interconnections with electrical and telephone systems and all underground water and metal pipes.
   6. Provide electric service arrestor ground wire to building water main.

3.14 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection:
   1. Equipment and circuit grounds in motor control centers, panelboards, switchboards, and switchgear assemblies for proper connection and tightness.
   2. Ground bus connections in motor control centers, panelboards, switchboards, and switchgear assemblies for proper termination and tightness,
   3. Effective transformer core and equipment grounding.
   4. Accessible connections to grounding electrodes for proper fit and tightness.
   5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:
   1. Fall-Of-Potential Test:
      a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
      b. Main ground electrode system resistance to ground to be no greater than 5 ohms.
   2. Two-Point Direct Method Test:
      a. In accordance with IEEE 81, Section 8.2. 1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
      b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

END OF SECTION

SECTION 16480

LOW VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American National Standard Institute (ANSI):
      a. C2, National Electrical Safety Code (NESC).
      b. C57.12.28, Switchgear and Transformers - Pad-Mounted Equipment-Enclosure Integrity.
      c. Z55, Gray Finishes for Industrial Apparatus and Equipment.
   2. National Electrical Manufacturers Association (NEMA):
      a. AB 1 Molded Case Circuit Breakers.
      b. ICS 1, General Standards for Industrial Control and Systems.
      c. ICS 2, Standards for Industrial Control Devices, Controllers, and Assemblies.
      d. ICS 2.3, Instructions for Handling, Installation, Operation, and Maintenance of Motor Control Centers
      e. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
      f. 250-1997, Enclosures for Electrical Equipment (1,000 volts maximum).
   3. National Fire Protection Association (NFPA): 70-90, National Electrical Code. (NEC) Latest Edition.
   4. Underwriters Laboratories, Inc. (UL):
      a. 98, Standard for Safety Enclosed and Dead-Front Switches, Eleventh Edition.
      b. 489, Standard for Safety Molded Case Circuit Breakers and Circuit Breaker Enclosures, Seventh Edition.
      c. 845, Standard for Safety Motor Control Centers, Third Edition.
      d. 508A Industrial Control Equipment.
   5. Uniform Building Code (UBC): Section 2312, Earthquake Requirements.
   6. InterNational Electrical Testing Association (NETA) Acceptance Testing Specifications, latest edition.
   7. Institute of Electrical and Electronics Engineers (IEEE):
      a. 112, latest revision, Standard Test Procedure for Polyphase Induction Motors and Generators
      b. 43, latest edition, Recommended Practice for Testing Insulation Resistance of Rotating Machinery

1.02 SUBMITTALS

A. Shop Drawings:
   1. Itemized bill of material.
   2. Descriptive information.
   3. Dimensional drawings.
   4. Conduit entrance locations/provisions.
   5. Bus data including horizontal and vertical bus capacities, voltage rating and interrupting capacity. Include materials of construction

6. Protective Devices: Copies of time-current characteristics.
7. Anchoring instructions and details.
8. Typed tabulation:
    a. Motor name; tag (equipment) numbers as shown on Drawings.
    b. Motor horsepower.
    c. Nameplate full load current.
    d. Measured load current and voltage.
    e. Heater catalog number.
    f. Protective device trip settings.
9. Attach above typed, tabulated data to a copy of starter manufacturer's overload heater selection tables for the starters provided.
10. Control Diagrams:
    a. NEMA ICS 2, Section 322.08 Type I.
    b. Wiring Type B.
    c. In addition to standard NEMA control diagrams, provide the following:
        1) Remote control devices.
        2) Remote indication and/or pilot lights.
        3) Interconnections and interlocking circuits between starter and remote equipment.
        4) Remote sensors.
        5) Tag numbers associated with all control devices and equipment.
        6) Clearly identify items provided by others.
11. One-line diagrams.
12. Schematic (elementary) diagrams. Custom schematics shall be furnished.Diagrams shall include all remote devices. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the CONTRACTOR stamped "REJECTED-RESUBMIT."
13. Outline diagrams.
14. Interconnection diagrams.
15. Enclosure NEMA rating and color.
16. Ground bus size and material of construction.
17. Main incoming line entry provision (top or bottom).
18. Control unit nameplate schedule.
19. All circuit breaker types, frames and settings.
20. All starter NEMA sizes, auxiliary contact provisions, coil voltage Relays, timers, pilot devices, control transformer VA and fuse sizes.
21. Short circuit rating of the complete assembly.
22. Replacement parts lists and operation and maintenance procedures.
23. Plan and elevation dimensional views of each MCC section.

B. Quality Control Submittals:
    1. Manufacturer's installation instructions.
    2. Operation and Maintenance Manual.
    3. Factory test reports, certified.

1.03 UL COMPLIANCE

A. Products manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL Listing Mark. Where shown or required motor control centers shall be suitable for service entrance.

1.04 PACKING AND SHIPPING

A. Shipping Splits: Established by CONTRACTOR to facilitate ingress of equipment to final installation location within the building.

1.05 RESPONSIBILITIES

A. The information provided on the drawings is for guidance only and does not limit the equipment size. When motors furnished differ from the expected rating indicated the CONTRACTOR shall make the necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate the motors actually installed.

1.06 INSPECTION COORDINATION

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cutler-Hammer.

B. Square D.

C. General Electric

D. Or approved equal.

2.02 MOTOR CONTROL

A. General:
   1. Provide each motor with a suitable controller and devices that will function as specified for the respective motors and meeting NEMA ICS 2, (class A), the NEC, and UL.
   2. Like Items of Equipment: Same manufacturer as low voltage switchboard and panelboards for standardization. Devices of the same type shall be products of the same manufacturer. This requirement applies to all control devices, and insofar as practical, to equipment manufactured on a production basis. It also applies without exception to equipment custom fabricated for this project.
   3. Make adjustments as necessary to wiring, conduit; disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.
   4. Overload Protection:
      a. Each motor shall have a direct current sensing solid-state overload protection in all ungrounded phases. This protection shall have current overload relays sensitive to motor current, and mounted within the motor controller. Reset of the protection shall be manually activated with

externally operated reset button. All overload protection devices shall be the inverse time limit type and match the motor characteristic.

5. Control Transformer:
   a. Two winding, 120-volt secondary, primary voltage to suit.
   b. Two current-limiting fuses for primary circuit.
   c. One fuse in secondary circuit.
   d. Mount within starter unit.
6. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C capacity.
7. Lifting lugs on all equipment and devices weighing over 100 pounds.
8. Anchor Bolts: Galvanized, sized by equipment manufacturer.
9. Operating Conditions:
   a. Ambient Temperature: Maximum 40 degrees C.
   b. Equipment to be fully rated without any derating for operating conditions listed above.
10. Enclosures: In accordance with NEMA 250 and ANSI C57.12.28.
11. Equipment Finish:
   a. Electro-coating process applied over a rust-inhibiting phosphated base coating.
   b. Exterior Color: Manufacturer's standard.
12. All manual starters and combination motor starters shall be lockable in the off position.

B. Manually Operated Starter, Fractional Horsepower:
1. Rating: 16 amperes continuous at 277 volts maximum.
2. Single-phase, non-reversing, full voltage with overload protection.
3. Toggle operated, keyed where shown.
4. Enclosure: NEMA 250, Type 4, unless shown otherwise.
5. Neon Light: Red.
6. Handle guard/lock-off attachment.

C. Manually Operated Starter, Integral Horsepower:
1. Rating: Horsepower rated to maximum of 10 horsepower at 600 volts with overload protection.
2. Single or three-phase, non-reversing, full voltage.
3. Control: Toggle or pushbutton.
4. Enclosure: NEMA 250, Type 4, unless shown otherwise.
5. Red pilot light in series with an auxiliary contact.
6. Locking in OFF position.
7. Two spare auxiliary, field-convertible contacts.

D. Combination Full-Voltage, Magnetic Starter:
1. Rating: Horsepower rated at 600 volts, UL labeled for 100,000 amperes with overload protection.
2. Three-phase, non-reversing, full voltage.
3. Control: As shown.
4. Disconnect Type: Motor circuit protector.
5. Enclosure: As shown.
6. Pilot Lights: As shown.
7. Pad-lockable operating handles.

2.03 MOTOR CONTROL CENTERS

A. General:
   1. In accordance with NEMA ICS 2 and UL 845.
   2. The motor control centers shall be 600-volt class suitable for operation on a three-phase, 60-Hz system. The system operating voltage and number of wires shall be as indicated, on project drawings.
   3. MCC designated as service entrance rated shall include provision for termination of an incoming neutral conductor in conformance to NEC requirements.
   4. Short Circuit Rating: Amperes rms symmetrical as shown on Drawings for entire motor control center as a complete assembly.
   5. All controllers, main and branch circuit breakers, wire connections, and other devices to be front mounted and accessible unless otherwise noted.
   6. NEMA ICS 2, Section 322.08.
      a. Class: IIS.
      b. Type: B. Diagrams and wiring.
      c. Provide blank spaces on interconnection diagrams to add control conductor code designations during installation of equipment.
   7. Size and Arrangement
      a. Motor control centers shall be of mechanical groupings of control center units, assembled into a lineup of control center sections. Each control section shall be nominally 90-inches tall by minimum 20-inches deep.
      b. MCC's shall be designed to not exceed the space requirements as indicated on the Contract Drawings, including spaces, spares, and future compartments. MCC's shall be subject to rejection for exceeding the lengths indicated where allotted space is critical.
      c. Equipment within the MCC may be rearranged at the discretion of the manufacturer, providing the MCC provides the spares, space, and future provisions indicated.
      d. All switches and circuit breakers used as switches shall be located so that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, will not be more than 6-feet 7-in.

B. Enclosure:
   1. Type: NEMA 250, Type 1, gasketed.
   2. Construction:
      a. Sheet steel reinforced with channel or angle irons.
      b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
      c. Removable top cover plates and bottom cover plates.
      d. Removable plates on end panels for future bus extension.
      e. Structural members shall be fabricated of not less than 12 gauge steel and side and top panels and doors shall be not less than 14 gauge steel.
   3. Section Mounting: Removable formed-steel channel sills and lifting angles.
   4. Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.
   5. Vertical Wiring Compartment: Full height, isolated from unit starters with separate door.
   6. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.

7. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.
8. Door Interlocking: Interlock starter and feeder doors mechanically so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access at any time.
9. External disconnect handles, pad-lockable in OFF position.
10. Cable Entrance: Main leads enter as shown on the Drawings. Control and feeder circuits enter from top and bottom.
11. Spaces designated as "SPACE" or "BLANK" shall include blank hinged doors and vertical bus bars.
12. Control units inside compartments shall be clearly identified with tags or stencil markings.
13. Each control unit including spares, spaces and blanks, lights, and devices shall be identified by an engraved nameplate. Identification shall include circuit number as indicated.
14. Each motor control center shall be fitted with the manufacturer's nameplate which shall include the NEMA Standard electric rating and other pertinent data, including manufacturer, sales order number, date of manufacture, and place of manufacture.
15. Where "L" or "U" shaped MCC layouts are indicated, corner compartments shall have similar current and short circuit ratings as functional compartments.
16. Fans, heat exchangers, transformers, capacitors, junction boxes, or other devices may not be mounted on the outside of the motor control center enclosure.
17. Finish for motor control center shall be light grey, ANSI 61. The panels shall be given 2 coats of primer inside and out and 2 coats of enamel finish. External colors other than ANSI 61 will not be acceptable.
18. Each section shall be dead-front and dead-back construction. Rear access shall not be necessary for inspection and maintenance. The structure arrangement shall be for front only mounting of units.
19. Power cables to the motor control center shall be either top or bottom feed as indicated on the project drawings. Provide all necessary lugs, clamps, and supports to terminate incoming power cables.

C. Bus:
1. Horizontal Power Bus:
    a. Three-phase tin-plated, copper, entire width of control center, rated as indicated.
    b. Silver-plated at joints.
    c. Construct to allow future extension of additional sections.
    d. Pressure type solderless lugs for each incoming line cable.
    e. Isolated from top horizontal wireway.
    f. Provide Belleville washers on bus connection bolts.
2. Vertical Power Bus:
    a. Three-phase tin-plated, copper, full height of section, rated as required by the load but not less than 300 amperes, minimum.
    b. Silver-plated at joints.
    c. Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.
    d. Insulated and isolated barrier complete with shutters.
    e. Provide Belleville washers on bus connection bolts.
3. Neutral Bus: None.

4. Ground Bus:
    a. Copper, tin-plated, 33 percent minimum of phase bus ampacity, entire width of control center.
    b. Provide Belleville washers on bus connection bolts.
5. Bus Bracing: 65,000 amperes rms symmetrical.

D. Motor Controller Unit:
1. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.
2. Each motor starter unit shall consist of a combination magnetic contactor and short circuit protective device. Short circuit protective device shall be an instantaneous, magnetic only circuit breaker or thermal magnetic circuit breaker as defined in the project one line diagrams. All circuit breakers provided as part of a motor starter unit shall be capable of being padlocked in the open position. Reset of thermal overload elements shall be possible with unit door closed. Three phase overload trip units shall be furnished to suit the full load current of the equipment installed. Overload relays shall be solid state type capable of detecting phase loss and ground faults and shall meet NEMA class 20 tripping characteristics.
3. Magnetic starters shall have auxiliary contacts as required by electrical motor control diagrams, including N-O and N-C contacts as indicated, plus one each spare N-O and N-C contact. As a minimum, provide one normally open and one normally closed auxiliary contact.
4. Each starter unit shall have its own control power transformer. It shall have a 115-volt grounded secondary. One secondary fuse and 2 primary fuses shall be provided. Control power transformers shall be sized to accommodate the control devices indicated. Minimum transformer size is 50 VA. Local control devices shall be mounted independently of the cover door. All starters shall have a local "running" lamp and a "off" light to indicate the presence of control power when the motor is not running. Indicating lights shall be push-to-test type. Starters shall be provided with elapsed time meters, hand/off/auto selector switches, and other devices as indicated. All cubicle control wires shall be terminated at a pull apart disconnecting terminal block at the cubicle.
5. The motor control center manufacturer shall be responsible for identifying each control wire within each motor starter unit with wrap-around permanent plastic markers. Each control wire shall be identified at both ends. Markers shall be produced from a device specifically made to produce tags, such as manufactured by Brady Corporation or Thomas & Betts. Hand lettered markers are not acceptable.
6. Motor starters shall be designed to NEMA ratings. Starters designed to IEC ratings or with dual IEC/NEMA ratings will not be acceptable, either as part of any MCC, as remote starters, or as part of any equipment package.
7. Construction:
    a. Draw out combination type with stab connections for starters NEMA ICS, Size 4 and smaller. The fixed-type unit assembly shall be constructed so that it can be easily removed from its panel after disconnecting the wires to the terminal block and withdrawing from the primary bus. Removal of a unit assembly shall be possible without rear access and without disturbing any other unit in the motor control center.

b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 5 and larger.
c. Readily interchangeable with starters of similar size.
d. Pull-apart unit control wiring terminal boards on all units.

E. Starters:
1. NEMA ICS 2, Section 322.08 standard rating, except none smaller than NEMA ICS, Size 1.
2. Rating: Horsepower rated at 600 volt, UL labeled for 65,000 amperes with overload protection.
3. Three-phase, non-reversing, unless otherwise shown.
4. Disconnect Type: Motor circuit protector.
5. Combination Full Voltage, Magnetic Starter:
   a. Control: As shown.
   b. Pilot Lights: Red-ON and Green-OFF.
6. Combination Reduced Voltage Auto-Transformer Starters:
   a. Reduced voltage auto-transformer starters shall consist of a molded-case motor circuit protector in combination with a closed transition type auto-transformer starter with 50 percent, 65 percent, and 80 percent taps, and shall be set on the 65 percent tap.
   b. The starter shall have three phase solid state overload relays capable of sensing phase loss and ground fault with manual reset.
   c. The auto-transformer shall include a thermal switch wired to protect itself from overheating.
   d. Timing of the starting period shall be controlled by an adjustable accelerating relay. Requirements set forth in paragraph 2.03 for enclosures and devices apply herein.
7. Solid State Reduced Voltage Starters:
   a. Solid state reduced voltage starters shall meet the requirements of UL 508 and shall consist of an incoming power circuit breaker, a power section; logic board, isolation contactor, and paralleling full load bypass contactor.
   b. Soft Starters shall conform to the following:
      1) The SCR-based power section shall consist of 6 back-to-back SCRs, two SCRs per phase, and shall be rated for a minimum peak inverse voltage rating of 2.5 times line voltage, 1200 PIV for 480 volts. Units using triacs or SCR/diode combinations shall not be acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt characteristics of the electrical system.
      2) Starters shall include the following logic and control functions:
         a) Adjustable maximum starting current from 200 percent to 500 percent
         b) Ramp time adjustment from 1 to 40 seconds
         c) Adjustable linear voltage deceleration
         d) Kick start
         e) Phase loss protection
         f) Adjustable Undervoltage/ overvoltage protection
         g) Current unbalance protection
         h) Instantaneous overcurrent detection.
         i) Phase rotation protection (prevents starting)
         j) Shorted SCR detection.

k) Selectable Class 10, 20, 30 electronic overload protection. Heat sink over temperature protection shall be provided.
l) Dry contacts for remote indication of RUN and TRIP status
m) Battery “back up” of set starter parameters.
n) Event recorder.
o) Elapsed time meter.
p) LCD status display.

3) The paralleling bypass contactor shall energize when the motor reaches full speed. The contactor shall be fully rated for across-the-line starting duty. The effect of the bypass contactor during normal operation is the elimination of heat buildup resulting from the voltage drop across the SCR’s. The bypass contactor may also be used as a means of starting the motor should problems be encountered with the soft starter. A door mounted selector switch shall be furnished such that the starting means can be selected as being either via the soft starter or via the bypass contactor as across-the-line.
4) An isolation contactor shall be supplied. The isolation contactor shall remove three phase power from the input side of the solid state controller when the bypass contactor is selected for across-the-line starting
5) The starter shall be housed in an appropriate NEMA rated enclosure as directed by project drawings. Heaters and cooling fans shall be provided if required to maintain the equipment within the manufacturer’s environmental guidelines.
6) The enclosure shall be of two-door compartment type construction. The left hand compartment shall contain the starter power section and any equipment rated at line voltage. The right hand compartment shall include only that equipment rated at 120 VAC or less including the starter’s CPU PC card and LCD display. The enclosure shall include a partition dividing the two compartments. Each compartment shall be designed to provide a barrier between the equipment at line voltage and the equipment at 120 VAC or less
7) The starter shall be provided with a control power transformer sized to accommodate all controls indicated on the Contract Drawings. An input power circuit breaker shall be provided. Lug termination of the incoming power conductors shall not be permitted. The starter and circuit breaker shall be rated for 65 KAIC RMS at 480V.
8) The starter shall have door mounted indication of run, phase rotation, phase loss, undervoltage, current unbalance, and current trip.
9) Door mounted LCD / keyboard display assembly designed to:
a) Set or examine operating parameters.
b) Provide starter status information.
c) Provide real-time information about line current, voltage, and frequency.
d) Provide a means to start and stop the starter

c. Pad-lockable operating handle when de-energized.
d. Unit door interlocked to prevent opening when disconnect is in closed position.
e. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.

f. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

8. Two Speed Starters:
   a. Two Speed Starters shall be of the two-winding type unless otherwise indicated.
   b. Requirements set forth in paragraph 2.03 for enclosures and devices apply herein.
9. Disconnecting Device:
   a. In each starter, control circuit disconnect to de-energize circuits in unit which are not de-energized by starter power disconnect device.
   b. Pad-lockable in OPEN position.
10. Circuit Breaker:
   a. Meeting the requirements of NEMA AB1 and UL 489.
   b. Molded case with manufacturer's recommended trip setting for maximum motor protection.
   c. Magnetic trip only.
   d. Tripping indicated by operating-handle position.
   e. Interrupting capacity required for connection to system with short circuit capacity indicated.
11. Fused Switch:
   a. Heavy-duty, motor rated load-break, quick-make, quick-break type meeting the requirements of UL 98 and NEMA KS 1.
   b. Current-limiting fuses, with rejection clips.
12. Load Detector Relay:
   a. Manual reset with adjustable differential.
   b. Manufacturer:
      1) Cutler-Hammer; Type D60LA.
      2) Allen-Bradley; Bulletin 2100.
13. Motor Overload Protection:
   a. Direct current sensing solid-state overload protection in all ungrounded phases.
   b. Manual-reset overload relays.
14. Motor Thermal Protector Interface: Manual-reset interposing relay for connection to motor-mounted thermal protector system.
15. Ground Fault Protection: Where indicated and as specified in paragraph Feeder Units and Main Protective Device, except provide instantaneous operation device.
16. Capacitor Connection: Terminals to allow easy connection of power factor correction capacitors on source side of starter overload relays on starters where capacitor connection is shown.

F. Control Unit:
1. Disconnecting Device: Capable of de-energizing external source control circuits in unit.
2. Control Devices: As indicated and as specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.
3. Control Wiring:
   a. Minimum wire size 14 AWG copper.
   b. Permanent sleeve type markers with wire numbers applied to each end of wires.
   c. Terminate wires using insulated locking fork or ring type crimp terminals.
   d. Terminate current transformer leads on shorting type terminal blocks.

G. Incoming Line Terminal:
   1. Construction: As specified in Paragraph Motor Controller Unit.
   2. Incoming Service Feeder: Cable entering section as shown.
   3. Maximum short-circuit rating of 65,000 amperes.
   4. Mechanical type CU-/AL lugs for 75 degrees C cable.

H. Feeder Unit and Main Protective Device:
   1. Construction: As specified in Paragraph Motor Controller Unit.
   2. Incoming Service Feeder: Cable entering section as shown.
   3. Molded Case Circuit Breaker:
      a. In accordance with NEMA AB 1 and UL 489.
      b. Main and feeder protective device.
      c. UL labeled as suitable for service entrance.
      d. Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.
      e. Indicate tripping by operating-handle position.
      f. Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.
      g. Circuit breakers having a frame size of 150 amperes or less shall be molded-case type with thermal magnetic non-interchangeable, trip-free, sealed trip units.
      h. Circuit breakers with a frame size of 225 amperes to 1,200 amperes shall be molded case with interchangeable thermal and adjustable magnetic trip or RMS sensing electronic trip elements.
      i. The interrupting capacity of all main, and feeder branch circuit breakers shall be a minimum of 65,000 RMS symmetrical amperes. Service disconnects rated 1000A or more shall provide ground fault protection of equipment.
   4. Ground Fault Protection:
      a. Suitable for 480-volt, three-phase, three-wire, solidly grounded wye system.
      b. Ground sensors to encircle all phase conductors and neutral conductor where used and connected to ground relays with adjustable pickup settings and time-current characteristics indicated.
      c. Circuit breaker shunt trip and relay operating from fused 120-volt ac control source within control center.
      d. Manufacturers:
         1) Ground Fault System ITE; Ground Shield.
         2) General Electric; Ground Break.
   5. Phase Monitoring Relay:
      a. Three-phase monitoring relay to protect against low voltage, voltage unbalance, and phase reversal.
      b. Manufacturer: Furnas; Class 47.

I. Instruments:
   1. Provide solid state type metering where indicated. Include CT's and PT's of ratios as indicated.
      a. Solid state “metering” shall include but not be limited to the following functions:
         1) Metering: Device shall monitor Voltage (VLL/VLN), Current (Amps per phase), Real Power (W), Reactive Power (VAR) and Apparent

Power (VA). Device shall have data gathering ability for analysis. The device(s) shall conform to the requirements of UL 508.

2) Alarms: Device shall utilize assignable output relays to trigger alarms for specific applications. Alarm messages shall be displayed on the front panel of the device. Alarm outputs via dry contacts shall alarm Over/Under Current, Over/Under Voltage, Current Unbalance/Neutral Current, Phase Sequence, Over/Under Frequency, Power Factor and Switch Inputs.

3) Communications: Device shall be able to communicate with current and future process control systems using standard protocols such as Devicenet, Ethernet, Modbus, Profibus, or as called for on project drawings. Front and rear panel communications ports shall be available for information access. Display of monitored values shall be available both locally and remotely.

J. Pushbuttons, selector switches, and pilot lights shall be the heavy-duty, oil-tight type, sized to 30 mm. Miniature style devices are not acceptable. All devices shall conform to the requirements of UL 508.
   1. Lens colors for “run”, “stop”, “on”, “off”, “open”, and “closed” shall be coordinated with the District’s requirements.
   2. Pilot lights shall be LED, push-to-test type.
   3. Provide hazardous location type pilot devices in classified locations per the NEC.

K. Elapsed Time Meters: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

L. Time Delay Relays: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

M. Relays shall be 3 PDT with 10 amp contacts, plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips.

N. Reset Timers: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

O. Nameplates:
   1. Laminated plastic; white, engraved to black core.
   2. Provide for each motor control center and each unit.
   3. Engrave with inscription shown on single-line diagram.
   4. Provide blank nameplates on spaces for future units.
   5. Attach with stainless steel pan head screws on face of control center.

P. Factory Testing: NEMA ICS 1, Section 109.

2.04 SPARE PARTS

A. The CONTRACTOR shall furnish the following for each MCC as a minimum:
   1. One unit control transformer or power supply of each size furnished in magnetic starters or solid state reduced voltage starter installed in MCC.

B. Spare parts shall be identified by MCC number, type, size, and manufacturer

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with NEMA ICS 2.3, Submittal Drawings, and Manufacturer's Instructions and Recommendations.

B. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Install equipment plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

E. Grout mounting channels into floor or mounting pads.

F. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.

G. Motor control centers shall be installed on 3-1/2-inch concrete pads. After leveling and shimming, the CONTRACTOR shall anchor motor control centers to concrete pads, and shall grout so that no space exists between the pad and support beams.

H. The CONTRACTOR shall:
   1. Torque all bus bar bolts to manufacturer's recommendations. Tighten all sheet metal and structure assembly bolts.
   2. Adjust all Motor Circuit Protector (MCP) devices to the instantaneous trip setting position recommended for the actual horsepower and full load amps of the motor. Verify that overload devices are proper for equipment installed; make necessary changes in overload devices as required for motors having power factor correcting capacitors.
   3. After equipment is installed, touch up scratches and verify that nameplate, and other identification is accurate.
   4. Provide high voltage switchboard matting in front of the MCC. The mat shall be 1/4-inch thick and 36-inches wide.

3.02 TESTING

A. Factory Test: All motor control centers, micro processor based soft starters and their components shall be given manufacturer's standard electrical and mechanical production tests and inspections. The tests shall include electrical continuity check, dielectric tests for each circuit, and inspection for proper functioning of all components including controls, protective devices, metering, and alarm devices.

B. Field Test MCC:
   1. Visual and mechanical inspection after installation
      a. Inspect for physical damage, proper anchorage, and grounding
      b. Verify that the ratings of the solid state overload relays match the motor full-load current nameplate data.
      c. Check tightness of bolted connections.

C. Electrical Tests
   1. Insulation tests
      a. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute. Test voltage and minimum acceptable resistance shall be in accordance with manufacturer's recommendations.
      b. Measure insulation resistance of each starter section phase to phase and phase to ground with the starter contacts closed and the protective device open. Test voltage and minimum acceptable resistance shall be in accordance with the manufacturer's recommendations.
      c. Measure insulation resistance of each control circuit with respect to ground
   2. Verify proper operation of control logic in all modes of control.

3.03 CIRCUIT BREAKERS

A. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.

B. Adjust to approximately Il times motor rated current.

C. Determine motor rated current from motor nameplate following installation.

3.04 OVERLOAD RELAY

A. Adjust overload relays after the actual nameplate full-load current rating of motor has been determined.

3.05 MOTOR DATA

A. Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
   1. Motor served by tag number and equipment name.
   2. Nameplate horsepower.
   3. Motor code letter.
   4. Full load amperes.
   5. Service factor.
   6. Installed overload relay heater catalog number.

3.06 MANUFACTURERS' SERVICES

A. Furnish manufacturer's representative in accordance for the following services at jobsite or classroom as designated by OWNER, for minimum person-days listed below, travel time excluded:
   1. One (1) person-day for installation assistance, and inspection of installation.
   2. One (1) person-day for functional and performance testing.
   3. One (1) person-day for plant startup.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install lighting fixtures, and accessories for all lighting systems, complete and operable, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Electrical General Provisions.

1.03 REFERENCES

1. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section:
2. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL):
5. 595, Standard for Safety Marine-Type Electric Lighting Fixtures.
6. 844, Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
7. 924, Standard for Safety Emergency Lighting and Power Equipment.
8. ANSI C82.1-1977 Specifications for Fluorescent Lamp Ballasts
9. ANSI C84.4-1978 Specifications for High Intensity Discharge Lamp Ballast (Multiple Supply Type)
10. Standards of the Certified Ballast Manufacturers Association

1.04 SUBMITTALS

A. The Contractor shall submit the following in accordance with the requirements of the Section entitled "Submittals."

1. Shop drawings and catalog data:
    a. Interior Luminaires:
        1) Catalog data sheets and pictures.
        2) Luminaire finish and metal gauge.
        3) Lens material, pattern, and thickness.
        4) Candle power distribution curves in two or more planes.
        5) Candle power chart 0 to 90 degrees.
        6) Lumen output chart.
        7) Average maximum brightness data in foot-lamberts.
        8) Coefficients of utilization for zonal cavity calculations.
        9) Mounting or suspension details.
        10) Heat exchange and air handling data.

b. Exterior Luminaires:
    1) Catalog data sheets and pictures.
    2) Luminaire finish and metal gauge.
    3) Lens material, pattern, and thickness.
    4) IES lighting classification and isolux diagram.
    5) Fastening details to wall or pole.
    6) Ballast type, location, and method of fastening.
    7) For light poles, submit wind loading, complete dimensions, and finish.
c. Lamps:
    1) Voltages.
    2) Colors.
    3) Approximate life (in hours).
    4) Approximate initial lumens.
    5) Lumen maintenance curve.
    6) Lamp type and base.
    7) Copy of lamp order, including individual quantities, for Project.
d. Ballasts:
    1) Type.
    2) Wiring diagram.
    3) Nominal watts and input watts.
    4) Input voltage and power factor.
    5) Starting current, line current, and re-strike current values.
    6) Sound rating.
    7) Temperature rating.
    8) Efficiency ratings.
    9) Low temperature characteristics.
    10) Emergency ballasts rating and capacity data.
e. Photo-Time Control:
    1) Wiring diagram.
    2) Contact ratings.
f. Photocells:
    1) Voltage, and power consumption.
    2) Capacity.
    3) Contacts and time delay.
    4) Operating levels.
    5) Enclosure type and dimensions.
    6) Temperature range.

2. Complete literature for each fixture substitution. Photoelectric data shall include coefficients of utilization, average brightness, candle power distribution curves, and lumen output chart. Substitutions for specified fixtures shall be based upon quality of construction, light distribution, appearance, and maintenance. Other makes of fixtures than those specified will be approved by the Engineer provided they are judged equal in all respects to the type specified
3. For exterior pole mounted applications, submit calculations signed and sealed by a professional structural engineer registered in the State of Florida, certifying that the outdoor pole and fixture installation, including pole, fixture, base and installation method will meet the appropriate wind loading criteria given by the Florida Building Code for the wind zone in which the assembly will be installed.

1.05 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.06 QUALITY ASSURANCE

A. Exterior lighting system operation shall be demonstrated during the hours of darkness to indicate that fixtures are properly focused, photo-cell operation is correct, and that fixture switching functions as intended. Similar requirements shall apply to interior lighting. Through demonstration, the Contractor shall also verify that panel schedules properly indicate the lighting outlets connected to each circuit.

B. Lighting demonstration shall occur within 2 weeks prior to project acceptance.

C. Lighting fixtures shall be stored in their original cartons from the manufacturers until the time of installation. Fixtures poles shall be stored on blocks above grade until the time of installation.

1.07 CLEANUP

A. Fixture lenses, diffusers and reflects shall be cleaned just prior to the time specified for the system demonstrations.

B. Contractor shall re-lamp all lighting fixtures with new lamps 30 days prior to acceptance.

C. Fixture trim, including poles and support brackets, where finish has been damaged, shall be refinished.

PART 2 PRODUCTS

2.01 FIXTURES - GENERAL

A. All fixtures shall be pre-wired with leads for connection to building circuits.

B. All fluorescent and HID fixtures shall be provided with internal fuses, whether indicated on the lighting fixture schedule or not.

2.02 EXTERIOR FIXTURES

A. Exterior fixtures and pole assemblies, in combination with their method of installation, shall be capable of meeting the wind loading criteria for the wind zone of installation as defined in the Florida Building Code. The wind loading requirement shall apply to the entire assembly including foundation (or base) and earthen materials used to secure the foundation or base. The calculation required under section 1.04.A.3 shall include this analysis.

B. Exterior fixtures shall have corrosion-resistant hardware and hinged doors or lens retainer. Fixtures specified to be furnished with integral photo-electrical control shall be of the fixture manufacturer's standard design.

2.03 INTERIOR FIXTURES

A. Interior fluorescent fixtures without diffusers shall be furnished with end plates. Where diffusers are required, they shall be of high molecular strength acrylic. Minimum thickness of the acrylic shall be 0.125 inches for all diffusers, except that those on 4 foot square fixtures

2.04 LUMINAIRES

A. Specific requirements relative to execution of Work of this section are located in the Luminaire Schedule on Drawings.

B. Feed-through type or separate junction box.

C. Ballasts: Two-lamp when possible.

D. Tandem wired for three-lamp, fluorescent fixtures.

E. Wire Leads: Minimum 18 AWG.

F. Component Access: Accessible and replaceable without removing luminaire from ceiling.

G. Soffit Installations:
   1. UL Labeled: SUITABLE FOR DAMP LOCATIONS.
   2. Ballast: Removable, pre-wired.

H. Exterior Installations:
   1. UL Labeled: SUITABLE FOR WET LOCATIONS.
   2. Ballast: Removable, pre-wired.
   3. When factory-installed photocells are provided, entire assembly shall have UL label.

I. Emergency Lighting:
   1. Power Pack: Self-contained, 120-volt transformer, inverter/charger, sealed nickel cadmium battery, and indicator switch in accordance with UL 924.
   2. Lighted push-to-test indicator.
   3. Capable of providing full illumination for 1-1/2 hours in emergency mode.
   4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
   5. Capable of protecting against excess charging and discharging.

J. Lamps
   1. Fluorescent:
      a. Type Efficiency: Energy.
      b. Color: Cool white.
   2. High Intensity Discharge:
      a. Type: Metal Halide.
      b. Color: Color corrected.
   3. Manufacturers:
      a. General Electric.
      b. Sylvania.
      c. North American Phillips.

K. Ballasts
   1. General:
   2. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
   3. Certified by electrical testing laboratories to conform to Certified Ballast Manufacturer's specifications.
   4. Fluorescent:
      a. Type: High power factor, energy efficient, rapid-start and instant-start type ballast, compatible with lamps specified.
      b. Sound Rating: Minimum A, maximum allowable noise level of 30 decibels measured 2 feet from installed fixture.
      c. Class: P.
      d. Automatic resetting, thermo-protector to prevent case temperature from exceeding 110 degrees C in the event of a short circuit.
   5. High Pressure Sodium:
      a. High power factor, normal ambient, 180 degrees C insulation class, with capacitor and igniter.
      b. Type:
         1) Autotransformer for 50-watt lamps.
      c. Constant wattage autotransformer for lamps 70 watts and above.
      d. Manufacturers:
         1) Magnetek Jefferson.
         2) Advance Transformer.
         3) Universal.
   6. Metal Halide:
      a. The Metal Halide Electronic Ballast shall not have more than +/- 0.5% variation in output power with a +/- 10% variation in input line voltage and shall not have more than +/- 3% variation in output power within all ranges of accepted ANSI lamp voltages.
      b. Electronic Ballast shall have a 'square wave' output whose frequency does not exceed 200 Hz and be equipped with a safety shutdown feature to prevent excessive pulsing of failed lamps.
      c. Electronic Ballast shall comply with FCC Part 18C, Class A. Furthermore, the manufacturer must show documentation showing that the ballast meets or exceeds the non-consumer limits for EMI & RFI.
      d. Electronic Ballast shall:
         1) Have a Total Harmonic Distortion (THD) of less than 10%.
         2) Have a Lamp Crest Factor of less than 1.3.
         3) Have a Power Factor of 95% or greater.
         4) Be sound rated "A."
         5) Be thermally protected to shut off when Temperatures reach unacceptable levels.
      e. The Electronic Ballast shall be UL Listed and shall carry a Five (5) Year Warranty.
      f. For down light fixtures, the Metal Halide Electronic Ballast shall be marked "Suitable for recessed use."
      g. The specified lamps shall be approved or warranted by the lamp manufacturer for use on the designated Metal Halide Electronic Ballast.
      h. The minimum rating of the Power Supply Electrolytic Capacitor(s) shall be 5000 hours at 105 degrees Celsius.

L. Lighting Control
   1. Photocell:
      a. Automatic ON/OFF switching photo control.
      b. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
      c. Setting: ON at dusk and OFF at dawn.
      d. Time delay feature to prevent false switching.
      e. Field adjustable to control operating levels.
      f. Manufacturers:
         1) Tork.
         2) Paragon.

M. Poles
   1. Rating (with Luminaire): Shall meet Florida Building Code and ASCE 7-98 requirements for wind zone of installation.
   2. Material: Extruded aluminum or concrete.

PART 3 EXECUTION

3.01 LIGHTING FIXTURES

A. Lighting fixtures shall be furnished complete with lamps at each outlet in accordance with the Fixture Schedule.

B. Lighting fixtures shall be installed plumb and square with building and wall intersections. Pendant-mounted fixtures, which are mounted from sloping ceilings, shall be suspended by ball hangers. Fixtures installed in machinery rooms shall be located after machines have been installed. In all cases, fixture locations shall be coordinated with work of other trades to prevent obstruction of light from the fixtures. Fixtures shall be installed in accordance with the architectural reflected ceiling drawings. Unless otherwise indicated, fixtures shall be centered on ceiling tiles. All fixtures and outlets shall be rigidly supported from the building structure or rigid conduit.

C. Recessed fixtures shall be installed light-tight to the ceiling and shall be provided with auxiliary safety supports attached directly to the building structure. Said safety supports shall consist of #10 AWG soft drawn galvanized wires.

3.02 LUMINAIRES

A. General:
   1. Install in accordance with manufacturer's recommendations.
   2. Provide proper hangers, pendants, and canopies as necessary for complete installation.
   3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount.
   4. Install plumb and level.
   5. Mounting heights shown for wall mounted or pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
   6. Install each luminaire outlet box with galvanized stud.

B. Pendant Mounted:
   1. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
   2. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
   3. Provide twin-stem hangers on single luminaires.

C. Pole Mounted:
   1. Provide precast concrete base or pre-cast concrete pole as described in the drawings.
   2. Provide branch circuit in-line fuses in pole base handhole.

D. Swinging Type:
   1. Provide, at each support, safety cable capable of supporting four times the vertical load from the structure to the luminaire.

E. Finished Areas:
   1. Install symmetrically with tile pattern.
   2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
   3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.
   4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
   5. Junction Boxes:
      a. Flush and Recessed Luminaires: Locate minimum 1 foot from luminaire.
      b. In concealed locations, install junction boxes to be accessible by removing luminaire.
      c. Wiring and Conduit:
      d. Provide wiring of temperature rating required by luminaire.
      e. Provide flexible steel conduit.
      f. Provide plaster frames when required by ceiling construction.
   6. Independent Supports:
      a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
      b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
      c. Fasten chain or wire to each end of luminaire.

F. Unfinished Areas: Locate luminaires to avoid either conflict with other building systems or blockage of luminaire light output.
   1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.
   2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

G. Lamps
   1. Provide in each fixture, the number and type for which the fixture is designed, unless otherwise noted.

H. Ballasts
   1. Install in accordance with manufacturer's recommendations.
   2. Utilize all ballast mounting holes to fasten securely within luminaire.
   3. Replace noisy or defective ballasts.

I. Lighting Control
   1. Outdoor Luminaires: Photocells with time clocks will switch lights ON at dusk and OFF at a set time.

J. Cleaning Following Construction
   1. Remove all labels and other markings, except UL listing mark.
   2. Wipe luminaires inside and out to remove construction dust.
   3. Clean luminaire plastic lenses with anti-static cleaners only.
   4. Touch up all painted surfaces of luminaires and poles with matching paint ordered from manufacturer.
   5. Replace all defective lamps at time of Substantial Completion.

3.03 COORDINATION

A. The Contractor shall coordinate lighting fixture locations with all other disciplines. In case light fixtures are covered by pipe or other equipment, fixtures shall be moved with no cost to the Owner to provide for lighting level on the floor as indicated.

END OF SECTION

SECTION 16950

ELECTRICAL TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Acceptance testing of electrical system, wiring, equipment, and grounding.

1.02 REFERENCES

A. National Electrical Testing Association (NETA):
   1. ATS-2009: Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.

B. ANSI: Test Procedures for Electrical Equipment.

C. ASTM: American Society for Testing and Materials.

D. ANSI/IEEE: Recommended Practices for Testing: Machinery, Ground Impedance, Cables and Terminations.

1.03 SUBMITTALS

A. Pre-Test Submittals:
   1. Testing service qualifications.
   2. Test personnel qualifications (resumes).
   3. Equipment testing schedule.
   4. Test data forms, custom edited for difference types of electrical equipment.

B. Post-Test Submittals: Summary Test Report consists of the following:
   1. Summary of testing for the project.
   2. Description of the equipment tested.
   3. Description of the test and test procedures.
   4. Test results for each apparatus and motorized equipment.
   5. Conclusions and recommendations.
   6. Completed test forms, including witness's signatures.
   7. List of test equipment and calibration documents.
   8. Date and time.
   9. A copy of this specification section with each paragraph check marked indicating compliance or marked with explicit deviations.

C. Submit Equipment Testing Schedule no later than 7 days prior to scheduled date of testing.

D. Project Record Documents: Note or indicate wiring deviations from Contract Documents on Project Record Documents.

1.04 QUALITY ASSURANCE

A. Prequalified Testing Services:
   1. Provide the services of certified electricians to perform testing of conductor insulation.
   2. Provide adequate test instruments for testing of conductor's insulation.
   3. Submit certification data and experience of personnel for required testing.

B. Testing service or testing personnel may be accepted or rejected based upon, but not limited to, the testing equipment intended to be used, the qualifications of the firm, and personnel.

C. Test Equipment Traceability:
   1. Testing firm shall have a calibration program to maintain test instrumentation and equipment within rated accuracy, including stickers with calibration dates record.
   2. Equipment and instruments used to evaluate electrical performance shall be calibrated to a standard traceable to the National Institute of Standards and Technology.
   3. Test equipment operating instructions and procedures shall be with the test equipment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 SAFETY AND PRECAUTIONS

A. Testing firm shall perform tests following a safe practice in accordance with OSHA and accident prevention procedures by National Safety Council and applicable codes.

B. Tests shall be performed with apparatus de-energized, except as necessary for equipment performance and functional test.

3.02 EXAMINATION

A. Verify that electrical work is free from improper grounds, short circuits, and overloads.

B. Verify correctness of wiring first by visual comparison of the conductor connections with connection diagrams.

C. Make individual circuit continuity checks by using electrical circuit testers.

D. Verify correctness of wiring by actual electrical operation of electrical and mechanical devices in both manual and automatic modes of operation.

3.03 VERIFICATION OF EQUIPMENT RATINGS

A. Prior to perform acceptance testing, the testing personnel shall inspect and verify adequate short circuit rating of electrical equipment.

3.04 ACCEPTANCE TESTING

A. General Requirements:
   1. Perform testing and allow OWNER and ENGINEER to witness testing.
   2. Perform tests to assure that electrical equipment will operate within industry and manufacturer's published tolerances, and will perform safely. Record test result data, to be used as a baseline for future tests.
   3. Test motorized equipment to verify conformance with the Contract Documents and for acceptance.
   4. Equipment for which acceptable test data has not been submitted, or has been submitted but rejected, shall be deemed as not meeting Contract requirements.

B. Equipment and Materials Inspection and Test Procedures. Complete test reports for each individual piece of equipment and systems:
   1. Panelboard Assemblies (Low Voltage):
      a. Visual and Mechanical Inspection:
         1) Compare equipment nameplate and data with drawings and specifications.
         2) Inspect physical, electrical, and mechanical condition.
         3) Confirm correct application of manufacturer’s recommended lubricants.
         4) Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.
         5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
         6) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
            a) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
            b) Make key exchange with devices operated in off-normal positions.
         7) Clean panelboard.
      b. Electrical Tests:
         1) Perform ground-resistance tests.
         2) Perform resistance tests through ball bus joints with a low-resistance ohmmeter.
         3)
   2. Metering :
      a. Visual and Mechanical Inspection
         1) Compare equipment nameplate and data with drawings and specifications.
         2) Inspect physical and mechanical condition.
         3) Verify tightness of electrical connections.
   3. Motor Starters: Low Voltage:
      a. Visual and Mechanical Inspection:

1) Compare equipment nameplate and data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

b. Electrical Tests:
1) Insulation Tests:
a) Measure insulation-resistance of each combination starter, phase-to-phase and phase-to-ground, with the starter contacts closed and the protective device open.
b) Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

c. Test Values:
1) Bolt-torque levels shall be in accordance with data specified by manufacturer.
2) Insulation-resistance values.
3) Overload trip times shall be in accordance with manufacturer's published data.

4. Circuit Breakers: Low-Voltage Molded Case - 100 Amp or Larger Only:
a. Visual and Mechanical Inspection:
1) Compare equipment nameplate and data with drawings and specifications.
2) Inspect circuit breaker for correct mounting.
3) Operate circuit breaker to insure smooth operation.
4) Inspect case for cracks or other defects.
5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

b. Electrical Tests:
1) Perform an insulation-resistance test at 1,000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
2) Perform adjustments for the final settings in accordance with the coordination study.
3) Perform long-time delay time-current characteristics tests by passing 300 percent through each pole separately unless series testing is required to defeat ground fault functions.
4) Determine short-time pickup and delay by primary current injection.
5) Determine ground-fault pickup and time delay by primary current injection.
6) Determine instantaneous pickup current by primary injection using run-up or pulse method.
7) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

c. Test Values:
1) Bolt-torque levels shall be in accordance with data specified by manufacturer.

2) Compare microhm or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than 25 percent. Investigate any value exceeding manufacturer's recommendations.
3) Insulation resistance shall not be less than 100 megohms.
4) Trip characteristics of breakers shall fall within manufacturer's published time-current tolerance bands, including adjustment factors.

5. Rotating Machinery: AC Motors:
   a. Visual and Mechanical Inspection:
      1) Compare equipment nameplate and data with Drawings and Specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect for correct anchorage, mounting, grounding, connection, and lubrication.
      4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
      5) When applicable, perform special tests such as air gap spacing and pedestal alignment.
      6) Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.
   b. Electrical Tests: Induction Motors:
      1) Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.
         a) Motors larger than 200 horsepower: Test duration shall be for ten minutes. Calculate polarization index.
         b) Motors 200 horsepower and less: Test duration shall be for one minute. Calculate the dielectric-absorption ratio.
      2) Test motor starter in accordance with Section 7.16 of these specifications.
      3) Verify that resistance temperature detector (RTD) circuits conform to drawings. Verify that metering or relaying devices using the RTD's have the correct rating.
      4) Verify that the motor space heater is functional.
      5) Perform a rotation test to insure correct shaft direction.
      6) Measure running current and evaluate relative to load conditions and nameplate full-load amperes.
6. Low-Voltage Surge Protection Devices (TVSS):
   a. Visual and Mechanical Inspection:
      1) Compare equipment nameplate and data with drawings and specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect for correct mounting and adequate clearances.
      4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
      5) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
7. Dry Type Transformers:
   a. Air-Cooled, 600 Volt and Below (50 kVA Single-Phase, 50 kVA Three-Phase and Smaller):
      1) Compare equipment nameplate and data with the Drawings and Specifications.

2) Inspect physical and mechanical condition.
3) Verify that resilient mounts are free and that any shipping brackets have been removed.
4) Perform insulation-resistance test. Calculate polarization index. Measurements shall be made from winding-to-winding and each winding-to-ground. Test voltages and minimum resistance.
5) Verify that winding turns-ratio measurements and polarities are in accordance with nameplate.
6) Verify that as-left tap connections are as specified.

8. Grounding Systems:
   a. Visual and Mechanical Inspection
      1) Verify ground system is in compliance with drawings and specifications.
   b. Electrical Tests:
      1) Perform fall-of-potential test or alternative in accordance with IEEE Standard 81-1991 on the main grounding electrode or system.
      2) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
   c. Test Values:
      1) The resistance between the main grounding electrode and ground should be no greater than five ohms for commercial or industrial systems and one ohm or less for generating grounds unless otherwise specified.
      2) Investigate point-to-point resistance values which exceed 0.5 ohm.
9. Low-Voltage Cables: 600 Volt:
   a. Visual and Mechanical Inspection:
      1) Compare cable data with drawings and specifications.
      2) Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
      3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
      4) Inspect compression-applied connectors for correct cable match and indentation.
      5) Verify cable color coding with applicable engineer's specifications and National Electrical Code standards.
   b. Electrical Tests:
   c. Perform an insulation resistance test on all cables.
10. Lighting System Controllers:
    a. Perform lighting system controller function tests upon completion of equipments, to prove correct interaction of switches, controllers, and photocells.

3.05 SUMMARY TEST REPORT

A. Upon completion of testing of all electrical equipment, submit summary test report.

END OF SECTION

SECTION 15265

PLASTIC PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Plastic pipe, tubing, and fittings.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. B 16.12 - Cast Iron Threaded Screwed Drainage Fittings.

B. American Society for Testing and Materials (ASTM):
   1. D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load.
   2. D 1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
   3. D 1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   4. D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   5. D 1869 - Standard Specification for Rubber Rings for Asbestos-Cement Pipe.
   6. D 2321 - Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   7. D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   8. D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   9. D 2467 - Standard Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   10. D 2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
   11. D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   12. D 2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
   13. D 2657 - Heat Joining Polyolefin Pipe and Fittings.
   14. D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
   15. D 2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
   16. D 2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
   17. D 2855 - Standard Practice for Making Solvent-cemented Joints with Poly (Vinyl Chloride)(PVC) Pipe and Fittings.
   18. D 3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

19. D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
20. D 3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
21. D 3350 - Standard Specification for Polyethylene Plastic Pipes and Fittings Materials.
22. D 4101 - Specification for Propylene Plastic Injection and Extrusion Materials.
23. F 439 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
24. F 441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
25. F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
26. F 483 - Standard Test Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals.
27. F 493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
28. F 645 - Guide for Selection, Design and Installation of Thermoplastic Water Pressure Piping Systems.
29. F 679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
30. F 714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

C. American Water Works Association (AWWA):
   1. C900 - Polyvinyl/Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water Distribution.

D. Code of Federal Regulations:
   1. Title 49 - Transportation.

E. Plastics Pipe Institute (PPI).
   1. TR 31 - Underground Installation of Polyolefin Piping.

F. United States Department of Transportation:
   1. Materials Transportation Bureau.

1.03 ABBREVIATIONS

A. DR: Dimension Ratio.

B. ID: Inside Diameter of piping or tubing.

C. NPS: Nominal Pipe Size followed by the size designation.

D. NS: Nominal Size of piping or tubing.

E. PVC: Polyvinyl Chloride.

F. SDR: Standard Dimension Ratio; the Outside Diameter divided by the pipe wall thickness.

1.04 SUBMITTALS

A. Product Data: Describe materials, pipe, fittings, gaskets and solvent cement.

B. Manufacturer's Published Installation Instructions.

C. Certificates:
   1. Submit manufacturer's certificate attesting that plastic pipe, tubing, and fitting types meet specified requirements.
   2. Manufacturer's certification of date of manufacture of plastic pipe and tubing for each lot delivered.
   3. Copies of solvent cement manufacturer's report and certification in accordance with ASTM D 2564 for PVC piping, and ASTM F 493 for CPVC piping.

1.05 QUALITY ASSURANCE

A. Mark plastic pipe with nominal size, type, class, schedule, or pressure rating, manufacturer and all markings required by applicable ASTM and AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and Molding Material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except that fittings used in drain, waste and vent piping systems need not be pressure rated.

C. Unions 2-1/2 Inches and Smaller: Socket end screwed unions. Make unions 3 inches and larger of socket flanges with 1/8-inch full face soft neoprene gasket.

2.02 PVC PIPING, SCHEDULE TYPE

A. Materials:
   1. PVC Schedule Type Piping: Designation PVC 1120 in accordance with ASTM D 1785 and appendices thereto.
      a. Pipe and Fittings: Extruded from Type I, Grade 1, Class 12454-B material in accordance with ASTM D 1784.
      b. PVC Schedule Type Piping: Schedule 80 unless otherwise indicated on the Drawings.
   2. Fittings:
      a. Supplied by pipe manufacturer.
      b. Pressure Fittings: In accordance with ASTM D 2466 or ASTM D 2467.

c. DWV Fittings: In accordance with ASTM D 2665.
3. Solvent Cement: In accordance with ASTM D 2564.

2.03 PVC PIPING, CLASS TYPE

A. PVC Pipe, Class Type: In accordance with ASTM D 2241.
1. Thermoplastic Pipe Materials Designation Code: PVC 1120, 1220 or 2120.
2. PVC Compound: Class 12454-B in accordance with ASTM D 1784.
3. Standard Dimension Ratio: SDR not greater than 17.

B. Fittings: Ductile iron with transition gasket sized to accommodate the outside pipe diameter.

2.04 SOURCE QUALITY CONTROL

A. PVC Piping, Schedule Type:
1. Mark pipe and fittings in accordance with ASTM D 1785.

B. PVC Piping, Class Type:
1. Test pipe to withstand, without failure, 600 pounds per square inch, gauge, hydrostatic pressure for a minimum of 5 seconds.
2. Test integral bell with the pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Where not otherwise specified, install piping in accordance with ASTM F 645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.
3. Locate unions where required for adequate access and assembly of the piping system.
4. Provide serrated nipples for transition from plastic pipe to rubber hose.

B. Installation of PVC Piping, Schedule Type:
1. Solvent weld joints in accordance with ASTM D 2855.
2. Install piping in accordance with manufacturer's published instructions.

C. Installation of PVC Piping, Class Type:
1. Install piping in accordance with the Appendix of AWWA C 900 complemented with manufacturer's published instructions.

3.02 FIELD QUALITY CONTROL

A. Leakage Test for PVC Piping, Class Type:
1. Polyvinyl-Chloride (PVC) Piping, Class Type: Subject to visible leaks test and to pressure test with maximum leakage allowance, as specified in Section 15956.

2. Pressure Test with Maximum Leakage Allowance: Perform test after backfilling.
   a. Pressure: 125 pounds per square inch, gauge.
   b. Maximum leakage allowance as follows, wherein the value for leakage is in gallons per 100 joints per hour:

NPS, Inches	**1-1/2**	**2**	**2-1/2**	**3**	**4**	**6**	**8**	**10**	**12**
Leakage	0.41	0.52	0.63	0.76	0.98	1.45	1.88	2.35	2.80

3. Test Procedure: Pull the mandrel through the line under test by one person, by hand, with reasonable effort, without the aid of mechanical equipment.
4. Failing Test: Where the mandrel test is not successful, remove and replace the section of piping with the obstruction, and test the piping again, including visible leaks test, pressure test with maximum leakage allowance, mandrel tests, and other specified tests:
   a. Correction of excessive deflection or obstructions by methods other than removal of the affected piping and replacement of the removed piping with new piping will not be accepted.

END OF SECTION

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SECTION 15956

PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Test requirements for piping systems.

1.02 REFERENCES

A. Uniform Plumbing Code (UPC).

B. Uniform Mechanical Code (UMC).

1.03 TESTING REQUIREMENTS

A. General Requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 15052; are specified in the specifications covering the various types of piping; and are specified herein.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the Uniform Plumbing Code, and UL requirements.
   4. When testing with water, the specified test pressure is considered to be the pressure at the highest point of the piping section under test. Lower test pressure as necessary to prevent testing the lowest point above a safe test pressure.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for Testing, Cleaning, and Disinfecting:
   1. Water for testing, cleaning, and disinfecting will be provided by the OWNER.

D. Pipes to be Tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful Tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test Completion: Drain and leave piping clean after successful testing.

G. Test Water Disposal: Dispose of testing water in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site.

1.04 SUBMITTALS

A. Schedule and Notification of Tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of Readiness to Test: Immediately before testing, notify ENGINEER in writing of readiness, not just intention, to test piping. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.05 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

C. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

D. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping schedule.

B. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment or piping specialties in test sections if test pressure exceeds the valve, equipment or piping specialty safe test pressure allowed by the item's manufacturer.

4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
6. When Test Results Indicate Failure of Selected Sections, Limit Tests to Piping:
   a. Between valves.
   b. Between a valve and the end of the piping.
   c. Less than 500 feet long.
7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing Procedures:
1. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where noted on the Piping Schedule
2. Before pressurizing for the tests, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
3. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure Test with Maximum Leakage Allowance:
1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
2. Pressure test piping after completion of visible leaks test.
3. For piping systems using joint designs other than flanged threaded or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
   a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
   b. Successful completion of the pressure test with maximum leakage allowance shall have been achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
   c. When leakage is allowed, calculate the allowable leakage by the following formula:

      $L = S \times D \times P^{1/2} \times 133{,}200^{-1}$ wherein the terms shall mean:

      L = Allowable leakage in gallons per hour.

      S = Length of the test section in feet.

      D = Nominal diameter of the piping in inches.

      P = Average observed test pressure in pounds per square inches, gauge, at the lowest point of the test section, corrected for elevation of the pressure gauge.

      x = The multiplication symbol.

END OF SECTION

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SECTION 15958

MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Testing of mechanical equipment and systems.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01756 - Testing, Training, and Facility Start-Up.
      b. Section 15956 - Piping Systems Testing.
      c. Section 16405 - Electric Motor

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. S1.4 Specification for Sound Level Meters.

B. Hydraulic Institute (HI).

1.03 SUBMITTALS

A. Schedule of factory tests and field tests as specified in Section 01756 and this Section.

B. Test instrumentation calibration data.

C. Start-up plan as specified in Section 01756.

D. Test plan specified in this Section.

E. Test result reports.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 QUALITY CONTROL TESTING AND REPORTING

A. Scheduling and notification:
   1. Witnessed source quality control tests: Schedule test date and notify ENGINEER at least 30 days prior to start of test.
   2. Field quality control tests: Schedule test date and notify ENGINEER at least 7 days prior to start of test.

B. Testing levels:
   1. Test equipment based on test levels specified in the equipment section of this Project.
   2. Requirements for Test Levels 1 to 4 are defined below.
   3. Test levels apply for both Source (Factory) Quality Control Tests and Field Quality Control Tests as specified in the equipment sections of this Project.
   4. If testing is not specified in the equipment section, provide Level 1 testing.

C. Witnessing: Source Quality Control Tests not witnessed unless specified otherwise in the equipment section; Field Quality Control Tests shall be witnessed.

D. Instrumentation: Provide necessary test instrumentation which has been calibrated within 1 year from date of test to recognized test standards traceable to the National Institute of Standards and Technology, Washington, D.C. or approved source. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for Field Quality Control Tests.

E. Temporary facilities and labor: Provide necessary fluids, utilities, temporary piping, temporary supports, temporary access platforms or access means and other temporary facilities and labor necessary to safely operate the equipment and accomplish the specified testing. With OWNER's permission, some utilities may be provided by fully tested permanently installed utilities that are part of the Work.

F. Test fluids:
   1. Factory tests: Use water or air as appropriate at ambient conditions unless specified otherwise in the equipment section.
   2. Field tests: Use specified process fluid at available conditions.

G. Pressure testing: Hydrostatically pressure test pressure containing parts in the factory at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher. Submit pressure test reports before shipping.

H. Test measurement and result accuracy:
   1. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
   2. Do not adjust results of tests for instrumentation accuracy. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

I. Field testing:
   1. Submit test plan as specified in Section 01756 and this Section. Indicate test start time and duration, equipment to be tested, other equipment involved or required; temporary facilities required, number and skill or trade of personnel involved; safety issues and planned safety contingencies; anticipated effect on OWNER's existing equipment and other information relevant to the test. Provide locations of all instruments to be used for testing. Provide calibration records for all instrumentation.
   2. Perform general start-up and testing procedures as specified in Section 01756.
   3. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.

J. Reports: Submit reports for source and field-testing. Submit Source Quality Control Test result reports before shipping equipment to the field. Report features:
   1. Report results in a bound document in generally accepted engineering format with title page, written summary of results compared to specified requirements, and appropriate curves or plots of significant variables in English units.
   2. Include appendix with a copy of raw, unmodified test data sheets indicating test value, date and time of reading, and initials of person taking the data.
   3. Include appendix with sample calculations for adjustments to raw test data and for calculated results.
   4. Include appendix with the make, model, and last calibration date of instrumentation used for test measurements.
   5. Include in body of report a drawing or sketch of the test system layout showing location and orientation of the test instruments relative to the tested equipment features.

3.02 EQUIPMENT TESTING, GENERAL

A. Tests for pumps, all levels of testing:
   1. Test in accordance with applicable HI Standards in addition to the requirements in this and other Sections.
   2. Test tolerances: In accordance with appropriate HI Standards, except the following modified tolerances apply:
      a. From 0 to plus 5 percent of head at the specified flows rated design point flow.
      b. From 0 to plus 5 percent of flow at the rated design point head.
      c. No negative tolerance for the efficiency at the specified flows rated design point.
      d. No positive tolerance for vibration limits. Vibration limits and test methods in HI Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

B. Tests for drivers: Test motors as specified in Section 16405. Test other drivers as specified in the driver equipment section.

3.03 REQUIREMENTS FOR VIBRATION TESTING

A. Definitions:
   1. Peak-to-peak displacement: The root mean squared average of the peak-to-peak displacement multiplied by the square root of 2.
   2. Peak velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
   3. Peak acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
   4. High frequency enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency.
      a. Manufacturers: One of the following or equal:
         1) Rockwell Automation, Entek Group, "Spike Energy" analysis.
         2) CSI, "PeakVue."
   5. Low speed equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
   6. High speed equipment: Equipment and equipment components operating at or above 600 revolutions per minute.

B. Vibration instrumentation requirements:
   1. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12 bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, RS232C data output port, circuitry for integration of acceleration data to velocity or double integration to displacement.
      a. Manufacturers: One of the following or equal:
         1) Entek-IRD, Division of Rockwell Automation, Enpac 1200 with applicable data analysis software or Entek Model 838 analyzer with built in printer.
         2) Computational Systems Inc., (CSI) Division of Emerson Electric, Model 2120A, Data Collector/analyzer with applicable analysis software.
   2. Analyzer settings:
      a. Units: English, inches/second, mils, and gravitational forces.
      b. Fast fourier transform lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 revolutions per minute; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
      c. Sample averages: 4 minimum
      d. Maximum frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
      e. Amplitude range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
      f. Fast fourier transform windowing: Hanning Window.
      g. High pass filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.

3. Accelerometers:
    a. For low speed equipment: Low frequency, shear mode accelerometer, 500 millivolts per gravitational force sensitivity, 10 gravitational force range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount.
        1) Manufacturers: One of the following or equal:
            a) Wilcoxon Research, Model 797L.
            b) PCB, Model 393C.
    b. For high speed equipment: General purpose accelerometer, 100 millivolts per gravitational force sensitivity, 50 gravitational force range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder.
        1) Manufacturers: One of the following or equal:
            a) Wilcoxon Research, Model 793.
            b) Entek-IRD Model 943.

C. Accelerometer mounting:
    1. Use magnetic mounting or stud mounting.
    2. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
    3. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.

D. Vibration testing results presentation:
    1. Provide equipment drawing with location and orientation of measurement points indicated.
    2. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.
    3. When Vibration Spectra Data required:
        a. Plot peak vibration velocity versus frequency in cycles per minute.
        b. Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label probable cause of vibration peaks whether in excess of specification limits or not.
        c. Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
        d. Plot motor spectra on a log amplitude scale versus frequency.
    4. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
    5. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.04 TESTING LEVELS

A. Level 1 Quality Control Tests:
    1. Level 1 General Equipment Performance Test:

a. For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
b. Operate at rated design load conditions.
c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

2. Level 1 Pump Performance Test:
   a. Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16405 or the applicable equipment section. Use actual driver for field tests.
   c. Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.
3. Level 1 Vibration Test:
   a. Test requirement:
      1) Measure filtered vibration spectra versus frequency in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component.
      2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
   b. Equipment operating condition: Test at specified maximum speed.
4. Level 1 Noise Test:
   a. Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.

B. Level 2 Quality Control Tests:
1. Level 2 General Performance Test:
   a. For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.
   b. Operate at rated design load conditions.
   c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
2. Level 2 Pump Performance Test:
   a. Test 2 hours minimum for flow and head at the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16405. Use actual driver for field tests.

c. Test for flow and head at 2 additional conditions; 1 at 25 percent below the rated flow and 1 at 10 percent above the rated flow.
d. Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.

3. Level 2 Vibration Test:
   a. Test requirement:
      1) Measure filtered vibration spectra versus frequency and measure vibration phase in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.
      2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
   b. Equipment operating condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.
   c. Natural frequency test of field installed equipment:
      1) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears and supports.
      2) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.
      3) Perform with equipment and attached piping full of intended service or process fluid.
4. Level 2 Noise Test:
   a. Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.

C. Level 3 Quality Control Tests:
1. Level 3 General Equipment Performance Tests:
   a. For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
   b. Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
   c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration or temperatures are observed.
   d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
   e. Bearing temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 3 Pump Performance Test:
    a. Test 4 hours minimum for flow and head at or near the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
    b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16405. Use actual driver for field tests.
    c. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes; for factory testing, test at other speeds may be omitted if test driver at reduced speeds is used for rated condition testing.
    d. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment section) and record observations on noise levels.
3. Level 3 Vibration Test:
    a. Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.
    b. Perform High Frequency Enveloping Analysis for gears and bearings.
        1) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.
        2) Report results in units of acceleration versus frequency in cycles per minute.
    c. Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).
    d. Plot vibration spectra on 3 different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.
4. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at 4 locations approximately 90 degrees apart in plan view; report results for each of 8 octave band mid-points beginning at 63 hertz.

D. Level 4 Quality Control Tests:
1. Level 4 General Equipment Performance Test:
    a. For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.
    b. Operate at rated design load conditions for1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
    c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration or temperatures are observed.

d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
e. Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 4 Pump Performance Test:
   a. Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.
   b. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration and noise data at each test condition.
   c. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment section) and record observations on noise levels.
   d. Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
   e. Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
      1) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
      2) Perform efficiency testing with test fluids at maximum rated speed.
      3) Perform priming time testing with test fluids at maximum rated speed.
3. Level 4 Vibration Test: Same as Level 3 vibration test.
4. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

3.05 SOURCE QUALITY CONTROL

A. Test equipment as specified for each type of test at the test levels specified in equipment sections. Prepare and submit test reports as specified.

B. Inspection and balancing:
   1. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.
   2. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.

C. Critical speed of rotating equipment: Satisfy the following:
   1. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment's maximum operating speed.
   2. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment's lowest operating speed.
   3. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.

3.06 FIELD QUALITY CONTROL

A. Test equipment as specified for each type of test at the test levels specified in equipment sections. Prepare and submit test reports as specified. Comply with latest version of applicable standards.

B. For variable speed equipment, conduct test to establish performance over the entire speed range and at the average operating condition. Establish performance curves for:
   1. The speed corresponding to the rated maximum capacity.
   2. The speed corresponding to the minimum capacity.
   3. The speed corresponding to the average operating conditions.

3.07 VIBRATION ACCEPTANCE CRITERIA

A. Testing of rotating mechanical equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.

B. Vibration displacement limits: Unless otherwise specified, equipment operating at speeds 600 revolutions per minute or less is not to exhibit unfiltered readings in excess of following:

Operating Speed (revolutions per minute)	**Unfiltered (Overall) Peak-to-Peak Amplitude (mils)**
	All Rotating Equipment
0 - 300	6.5
301 - 600	4.5
Note: For all equipment, axial shaft displacements not to exceed 50 percent of the maximum radial shaft displacements shown in the table relative to the casing.	

C. Vibration velocity limits: Unless otherwise specified, equipment operating at speeds greater than 600 revolutions per minute is not to exceed the following peak velocity limits:

Item	**Unfiltered Overall Limit (inches per second)**	**Any Filtered Peak Limit (inches per second)**
Non-Clog Solids Handling	0.35	0.25

Item	Unfiltered Overall Limit (inches per second)	Any Filtered Peak Limit (inches per second)
Centrifugal Pumps		
Horizontal and Vertical In-Line Centrifugal Pumps (other than Non-Clog type)	0.18 (Input BHP 25 or less)	0.14 (Input BHP 25 or less)
	0.22 (Input BHP more than 25 but less than 100)	0.18 (Input BHP more than 25 but less than 100)
	0.25 (Input BHP 100 or more)	0.20 (Input BHP 100 or more)
Vertical Turbine, Mixed Flow, and Propeller Pumps	0.31 (Input BHP 100 or less)	0.22
	0.35 (Input BHP 125 or more)	0.25
Vertical Turbine, Mixed Flow, and Propeller Short Set Pumps	0.28 (Input BHP 100 or less)	0.21
	0.33 (Input BHP 125 or more)	0.24
Motors	See Applicable Motor Specification	
Gear Reducers, Radial	Not to exceed AGMA 6000-A88 limits	
Other Reducers, Axial	0.10	0.10
Centrifugal Fans and Blowers	0.15	0.10
Other Equipment, Radial	0.16	0.10
Other Equipment, Axial	0.10	0.10

D. Equipment operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.

E. Additional criteria:
   1. No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude component without manufacturer's detailed verification of origin and ultimate effect of such excitation.
   2. The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.
   3. For motors, the following shall be cause for rejection:
      a. Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that are more than 40 percent of the peak at rotational frequency.
      b. Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.

c. Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around 2 times the rotor bar pass frequency.
d. Phasing problems evidenced by 1/3 line frequency side band spectral peaks around the 2 times electrical line frequency peak.

4. The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.

3.08 NOISE REQUIREMENTS AND CONTROL

A. Make measurements in relation to reference pressure of 0.0002 microbar.

B. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.

C. Set sound level meter to slow response.

D. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

3.09 FUNCTIONAL AND OPERATIONAL TESTING OF EQUIPMENT

A. Functional testing as specified in Section 01756 and this Section.

B. General checkout: Prior to operating equipment, inspect, test, and check supporting systems, including but not limited to power systems, control systems, piping systems, lubrication systems, and safety systems.
1. Test and calibrate instrumentation and electrical devices.
2. Test and prepare piping as specified in Sections 15956.
3. As a minimum for control systems associated with the equipment, perform the following:
   a. Individual Loop Tests: Test from field device to intermediate terminations to controller and back to controlled element.
   b. End-to-end test: Simulate input at field device and observe control system response at the final field control element.
4. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.

C. Operation of related existing equipment: OWNER will operate related existing equipment or facilities necessary to accomplish the testing.

D. Acceptable tests: Demonstrate the equipment performance meets the requirements of this Section and the equipment section; when the equipment fails to meet the specified requirements, perform additional more detailed testing to determine the cause, correct, repair, or replace the causative components and repeat the testing that revealed the deficiency.

E. Operational testing: As specified in Section 01756.

END OF SECTION

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.02 DESIGN REQUIREMENTS

A. All electronic boards as part of electrical equipment shall meet the atmospheric conditions of the space the equipment is installed in. All electronic boards which are not installed in a conditioned environment shall be fungus-resistant.

B. All electrical equipment shall be rated for the conditions the equipment is installed in.

1.03 STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Perform all work; furnish and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:
   1. Local Laws and Ordinances.
   2. State and Federal Laws.
   3. National Electrical Code (NEC).
   4. State Fire Marshal.
   5. Underwriters' Laboratories (UL).
   6. National Electrical Safety Code (NESC).
   7. American National Standards Institute (ANSI).
   8. National Electrical Manufacturer's Association (NEMA).
   9. National Electrical CONTRACTOR'S Association (NECA) Standard of Installation.
   10. Institute of Electrical and Electronics Engineers (IEEE).
   11. Insulated Cable Engineers Association (ICEA).
   12. Occupational Safety and Health Act (OSHA).
   13. National Electrical Testing Association (NETA).
   14. American Society for Testing and Materials (ASTM).
   15. Florida Building Code, including Broward County amendments.

B. Conflicts, if any, which may exist between the above items, will be resolved at the discretion of the ENGINEER.

C. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

D. Obtain all permits and pay all fees required by any governmental agency having jurisdiction over the work. Arrange all inspections required by these agencies. On completion of the work, furnish satisfactory evidence to the ENGINEER that the work is acceptable to the regulatory authorities having jurisdiction.

1.04 ELECTRICAL COORDINATION

A. Work Provided Under this Contract:
   1. Perform demolition of existing equipment as shown on drawings and as stated in specifications. Turn over the removed items to Owner if requested by them or dispose as needed.
   2. Provide and install new breaker and modify the existing MCC-HW1 and MCC-HW2 at the Headworks building as described in the drawings and specifications for a complete working system in place**.**
   3. Provide and install all conduits, seal-offs, disconnects, junction boxes, conduit supports and wire as described in the drawings complete in place. This includes all instrumentation cables between the instruments and the control panel, and electrical equipment complete in place.
   4. Furnish and install new electrical equipment racks, supports, junction boxes, etc. as described in the drawing and specifications for a complete working system in place.
   5. Provide and install new conduits and cables for instrumentation system complete in place.
   6. Provide and install new light poles and receptacle system as per drawings and specification for a complete working system in place.
   7. Provide all incidental equipment, labor and material obviously required but not specified in the drawings or specifications to complete the installation as a total working system.
   8. Terminate new input-output (I/O) signals as stated in drawings N-1 thru N-3 and E-8 at the existing Headworks PLC control panel and update as-built I/O drawings.
   9. Provide all miscellaneous electrical including terminations, fittings, wiring, conduit, junction boxes, etc. not specified but obviously necessary for a complete working system in place.

B. Temporary Power:
   1. Provide temporary power for all office trailers and for all construction areas. Coordinate with local power and telephone utility for temporary construction power and telephone service during construction.

1.05 SUBMITTALS

A. Quality Control Submittals:
   1. Voltage Field Test Results.
   2. Voltage Balance Report.
   3. Equipment Line Current Report.
   4. Factory test certification and reports for all major electrical equipment.
   5. Site test certification and reports as specified in other Division 16, ELECTRICAL sections.

B. The following information shall be provided for all electrical equipment:

1. A copy of each specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation.
2. Electrical equipment submittals shall be made by specification section. Submit one package per specification section and do not group multiple specification sections under one submittal package.
3. Provide complete conduit and equipment layouts: a scaled plan layout of the electrical room(s) showing spatial relationships of all equipment as well as the overall size of the room. Minimum scale shall be ¼"=1'-0".
4. Provide a conduit plan for major power, instrumentation and control conduits, both interior and exterior, showing routing, size and stub up locations for buried or in slab conduits.

1.06 ENVIRONMENTAL CONDITIONS

A. All chemical rooms and areas shall be designated as corrosive.

B. All indoor chemical and process equipment areas shall be considered wet locations.

C. Electrical equipment in rooms designated as Classified by NFPA 70 (national electrical code) as Division 1 or Division 2 shall meet all requirements set forth for that classification as described in NEC article 500.

1.07 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The Electrical Drawings were developed from past record drawings and information supplied by the OWNER. Verify all scaled dimensions prior to submitting bids.

B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and electrical system which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the CONTRACTOR's failure to fulfill this requirement.

C. Carry out any work involving the shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the OWNER. Do such work when directed by the ENGINEER.

D. After award of Contract, locate all existing underground utilities at each area of construction activity. Protect all existing underground utilities during construction. Pay for all required repairs without increase in Contract cost, should damage to underground utilities occur during construction.

1.08 RESPONSIBILITY

A. The CONTRACTOR shall be responsible for:
   1. Complete systems in accordance with the intent of these Contract Documents.
   2. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under Division 16, ELECTRICAL.
   3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

1.09 INTENT OF DRAWINGS

A. Electrical plan Drawings show only general location of equipment, devices, and raceway, unless specifically dimensioned. The CONTRACTOR shall be responsible for the proper routing of raceway, subject to the approval of the ENGINEER.

B. All electrical equipment sizes and characteristics have been based on manufacturer Square D. If the CONTRACTOR chooses to and is allowed to substitute, the CONTRACTOR shall be responsible for fitting all the equipment in the available space as shown on the Drawings.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

B. Equipment Finish:
   1. Provide manufacturers' standard finish and color, except where specific color is indicated.
   2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.02 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panel boards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.03 CHECKOUT AND STARTUP

A. Startup:
   1. Demonstrate satisfactory operation of all 480-volt electrical equipment. Participate with other trades in all startup activities.
   2. Assist the Instrumentation and Control (I&C) Contractor in verifying signal integrity of all control and instrumentation signals.

END OF SECTION

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SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American National Standards Institute (ANSI):
      a. C55,1, Standard for Shunt Power Capacitors.
      b. C62.11, Standard for Metal-Oxide Surge Arrestors for AC Circuits.
      c. Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
   2. American Society for Testing and Materials (ASTM):
      a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
      c. A570, Standard Specification for Steel, Sheet, and Strip, Carbon, Hot-Rolled, Structural Quality.
   3. Federal Specifications (FS):
      a. W-C-596, Connector, Receptacle, Electrical.
      b. W-S-896E, Switches, Toggle, Flush Mounted.
   4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
      c. CP I, Shunt Capacitors.
      d. ICS 2, Industrial Control Devices, Controllers, and Assemblies.
      e. KS 1, Enclosed Switches.
      f. LA I, Surge Arrestors.
      g. PB 1, Panelboards.
      h. ST 20, Dry-Type Transformers for General Applications.
      i. WD I, General Requirements for Wiring Devices.
   6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   7. Underwriters Laboratories, Inc. (UL):
      a. 67, Standard for Panelboards.
      b. 98, Standard for Enclosed and Dead-Front Switches.
      c. 198C, Standard for Safety High-Intermpting-Capacity Fuses, Current-Limiting Types.
      d. 198E, Standard for Class Q Fuses.
      e. 486E, Standard for Equipment Wiring Terminals.
      f. 489, Standard for Molded Case Circuit Breakers and Circuit Breaker Enclosures.
      g. 508, Standard for Industrial Control Equipment.
      h. 810, Standard for Capacitors.
      i. 943, Standard for Ground-Fault Circuit Interrupters.

j. 1059, Standard for Terminal Blocks.
k. 1561, Standard for Dry-Type General-Purpose and Power Transformers.

1.02 SUBMITTALS

A. Shop Drawings:
1. Device boxes for use in hazardous areas.
2. Junction and pull boxes used at, or below, grade.
3. Hardware.
4. Terminal junction boxes.
5. Panelboards and circuit breaker data.
6. Fuses.
7. Contactors.
8. Transformers.
9. All other miscellaneous material part of this project.
10. Wire pulling compound.

1.03 QUALITY ASSURANCE

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

1.04 SPARE PARTS

A. Furnish, tag, and box for shipment and storage the following spare parts:
1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

PART 2 PRODUCTS

2.01 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:
1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, cast ferrous metal, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs (Cast Mounting) Manufacturer:
a. Crouse-Hinds; Type FS or FD.
b. Appleton; Type FS or FD.

C. Cast Aluminum:
1. Material:
a. Box: Cast, copper-free aluminum.
b. Cover: Gasketed, weatherproof, cast copper-free aluminum with stainless steel screws.

2. Hubs: Threaded.
3. Lugs: Cast mounting.
4. Manufacturers:
    a. Crouse-Hinds; Type FS-SA or FD-SA.
    b. Appleton; Type FS or FD.

D. PVC-Coated Sheet Steel:
1. Type: One-piece.
2. Material: Zinc- or cadmium-plated.
3. Coating: All surfaces; 40-mil PVC.
4. Manufacturer: Appleton.

E. Nonmetallic:
1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.
3. Manufacturer: Carlon; Type FS or FD, with Type E98 or E96 covers.

2.02 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article OUTLET AND DEVICE BOXES.

B. Large Sheet Steel Box: NEMA 250, Type 1.
1. Box: Code-gauge, galvanized steel.
2. Cover: Full access, screw type.
3. Machine Screws: Corrosion-resistant.

C. Large Stainless Steel Box: NEMA 250, Type 4X.
1. Box: 14-gauge, ASTM A240, Type 316 stainless steel.
2. Cover: Hinged with screws.
3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
4. Manufacturers:
    a. Hoffman Engineering Co.
    b. Robroy Industries.

D. Large Nonmetallic Box:
1. NEMA 250, Type 4X.
2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat. Do not use nonmetallic box for direct sunlight application.
3. Cover: Hinged with screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Conduit hubs and mounting lugs.
6. Manufacturers:
    a. Crouse-Hinds; Type NJB.
    b. Carlon; Series N, C, or H.
    c. Robroy Industries.

2.03 WIRING DEVICES

A. Switches:
1. NEMA WD I and FS W-S-896E.

2. Specification grade, totally-enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.
5. Color:
    a. Office Areas: Ivory.
    b. Other Areas: Brown.
6. Switches with Pilot Light: 125-volt, neon light with red jewel, or lighted toggle when switch is ON.
7. Manufacturers:
    a. Bryant.
    b. Leviton.
    c. Hubbell.
    d. Pass and Seymour.
    e. Arrow Hart.

B. Receptacle, Single and Duplex:
1. NEMA WD 1 and FS W-C-596.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Color:
    a. Office Areas: Ivory.
    b. Other Areas: Brown.
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
7. Manufacturers:
    a. Bryant.
    b. Leviton.
    c. Hubbell.
    d. Pass and Seymour.
    e. Sierra.
    f. Arrow Hart.

2.04 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Plastic:
1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.
2. Color: To match associated wiring device.
3. Mounting Screw: Oval-head metal, color matched to plate.

C. Metal:
1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

D. Cast Metal:
   1. Material: Malleable ferrous metal, with gaskets.
   2. Screw: Oval-head stainless steel.

E. Engraved:
   1. Character Height: 3/16 inch.
   2. Filler: Black.

F. Weatherproof:
   1. For Receptacles: Gasketed, cast metal or stainless steel, with individual cap over each receptacle opening.
   2. Mounting Screw: Stainless steel.
      a. Cap Spring: Stainless steel.
      b. Manufacturers:
         1) General Electric.
         2) Bryant.
         3) Hubbell.
         4) Sierra.
         5) Pass and Seymour.
         6) Crouse-Hinds; Type WLRD or WLRS.
         7) Bell.
         8) Arrow Hart.
   3. For Switches: Gasketed, cast metal incorporating external operator for internal switch.
      a. Mounting Screw: Stainless steel.
      b. Manufacturers:
         1) Crouse-Hinds; DS-181 or DS-185.
         2) Appleton; FSK-LVTS or FSK-IVS.

G. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

2.05 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB I, NFPA 70, and UL 67, including panelboards installed in motor control equipment.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Rating: If not otherwise shown in plans. Applicable to a system with available short-circuit current of 25,000 amperes rms symmetrical at 208Y/120 or 120/240 volts and 65,000 amperes rms symmetrical at 480Y/277 volts.

E. Where ground fault interrupter circuit breakers are indicated or required by code: 5 mA trip, 10,000 amps interrupting capacity circuit breakers.

F. Cabinet: As shown on plans.

G. Bus Bar:
   1. Material: Copper, full sized throughout length.
   2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
   3. Neutral: Insulated, rated 150 percent of phase bus bars with at least one terminal screw for each branch circuit.
   4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
   5. Lugs and Connection Points:
      a. Suitable for either copper or aluminum conductors.
      b. Solderless main lugs for main, neutral, and ground bus bars.
      c. Subfeed or through-feed lugs as shown.
   6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

H. Circuit Breakers:
   1. NEMA AB 1 and UL 489.
   2. Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
   3. Noninterchangeable, in accordance with NFPA 70.
   4. Locking: Provisions for handle padlocking, unless otherwise shown.
   5. Type: Bolt-on circuit breakers in all panelboards.
   6. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
   7. Do not substitute single-pole circuit breakers with handle ties for multipole breakers.
   8. Do not use tandem or dual circuit breakers in normal single-pole spaces.
   9. Ground Fault Interrupter:
      a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).
      b. Sensor with same rating as circuit breaker and a push-to-test button.

I. Manufacturers:
   1. Square D;
   2. Eaton;
   3. Or approved equal.

2.06 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA AB I, UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: As shown or as required.

C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Multipole breakers to automatically open all poles when an overload occurs on one-pole.

G. Enclosure: NEMA 250, Type 12, Industrial Use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multipole circuit breakers are shown.

2.07 NONFUSED DISCONNECT SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: NEMA 250, Type 12, industrial use, 4X- outdoors, wet locations and corrosive areas, unless otherwise shown.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

2.08 FUSE, 0 TO 600 VOLTS

A. Current-limiting, with 200,000 ampere rms interrupting rating.

B. Provide to fit mountings specified with switches and features to reject Class H fuses.

C. Motor and Transformer Circuits, 0- to 600-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-1, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPS-RK.
      b. Littlefuse; Type LLS-RK.

D. Motor and Transformer Circuits, 0- to 250-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-1, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPN-RK.
      b. Littlefuse; Type LLN-RK.

E. Feeder and Service Circuits, 0- to 600-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-I, dual element, with time delay.
   3. Manufacturers:
      a. Bussmann; Type LPS-RK.

b. Littlefuse; Type LLS-RK.

F. Feeder and Service Circuits, O- to 250-Volt:
1. Amperage: 0 to 600.
2. UL 198E, Class RK-I, dual element, with time delay.
3. Manufacturers:
a. Bussmann; Type LPN-RK.
b. Littleluse; Type LLN-RK.

G. Feeder and Service Circuits, 0- to 600-Volt:
1. Amperage: 601 to 6,000.
2. UL 198C, Class L, double O-rings and silver links.
3. Manufacturers:
a. Bussmann; Type KRP-C.
b. Littlefuse; Type KLPC.

2.09 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. Contact Rating: NEMA ICS 2, Type A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Lights: LED Push-to-test.

D. Pushbutton Color:
1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbuttons and selector switches lockable in the OFF position where indicated.

F. Legend Plate:
1. Material: Aluminum.
2. Engraving: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, indicating specific function.
3. Letter Height: 7/64 inch.

G. Manufacturers:
1. Heavy-Duty Type:
a. General Electric.
b. Square DT.
c. Cutler-Hammer.

2.10 TERMINAL BLOCK (0 TO 600 VOLTS)

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of all control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between the compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:
   1. Capable of wire connections without special preparation other than stripping.
   2. Capable of jumper installation with no loss of terminal or rail space.
   3. Individual, rail mounted.

I. Marking system allowing use of preprinted or field-marked tags.

J. Manufacturers:
   1. Weidmuller.
   2. Ideal.
   3. Electrovert.

2.11 MAGNETIC CONTROL RELAY

A. NEMA ICS 2, Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control with field convertible contacts.

B. Time Delay Relay Attachment:
   1. Pneumatic type, timer adjustable from 0.2 to 60 seconds (minimum).
   2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

D. Manufacturers:
   1. Cutler-Hammer; Type M-600.
   2. General Electric; Type CR120B.

2.12 RESET TIMER

A. Drive: Synchronous motor, solenoid operated clutch.

B. Mounting: Semiflush, panel.

C. Contacts: 10-amp, 120-volt.

D. Manufacturers:
   1. Eagle Signal; Bulletin 125.
   2. Automatic Timing and Controls; Bulletin 305.

2.13 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0 to 99,999.9 hours, nonreset type.

C. Mounting: Semiflush, panel.

D. Manufacturers:
   1. General Electric; Type 240, 2-1/2-inch Big Look.
   2. Eagle Signal; Bulletin 705.

2.14 SUPPORT AND FRAMING CHANNELS

A. Material:
   1. Dry indoors - galvanized.
   2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

B. Finish:
   1. Dry indoors - galvanized..
   2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

C. Inserts: Continuous.

D. Beam Clamps: Gray cast iron.

E. Manufacturers:
   1. B-Line.
   2. Unistrut.

2.15 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: White, engraved to a black core.

D. Engraving:
   1. Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
   2. Panelboards: Panelboard designation, service voltage, and phases.

E. Letter Height:
   1. Pushbuttons/Selector Switches: 1/8 inch.
   2. Panelboards: 1/4 inch.

2.16 SURGE PROTECTION DEVICE (SPD)

A. This section describes the material and installation requirements for transient voltage surge suppression (TVSS) or Surge Protection devices (SPD) in switchboards, panelboards, and motor control centers for the protection of all AC electrical circuits.

B. SPD shall be listed and component recognized in accordance with UL 1449 and UL 1283.

C. SPD shall be installed and warranted by and shipped from the electrical distribution equipment manufacturer’s factory.

D. SPD shall provide surge current diversion paths for all modes of protection; L-L, L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

E. SPD shall be modular in design. Each module shall be fused with a surge rated fuse.

F. A UL approved disconnect switch shall be provided as a means of disconnect in the switchboard device only.

G. SPD shall meet or exceed the following criteria:
   1. Maximum surge current capability (single pulse rated) shall be:
      a. Service entrance switchboard 300kA
      b. Branch panelboards 150kA
      c. Motor control centers 80kA
   2. UL 1449 Listed and Recognized Component Suppression Voltage Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	400V	400V	400V
480Y/277	800V	800V	800V

H. SPD shall have a minimum EMI/RFI filtering of -44dB at 100kHz with an insertion ration of 50:1 using MIL STD. 220A methodology.

I. SPD shall be provided with 1 set of NO/NC dry contacts.

J. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period. Warranty will be the responsibility of the electrical distribution equipment manufacturer.

K. Approve manufactures are:
   1. Cutler Hammer CPS Series
   2. General Electric Tranquell Series
   3. Siemans TPS Series
   4. Square D Company XTE Series

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with NECA 5055.

3.02 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:
   1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.

a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.

2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:
1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by ENGINEER.
3. Light Switch: Install on lock side of doors.
4. Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.

D. Mounting Height:
1. General:
   a. Measured to centerline of box.
   b. Where specified heights do not suit building construction or finish, mount as directed by ENGINEER.
2. Light Switch: 48 inches above floor.
3. Thermostat: 54 inches above floor.
4. Telephone Outlet: 6 inches above counter tops or 15 inches above floor.
5. Wall Mounted Telephone Outlet: 52 inches above floor.
6. Convenience Receptacle:
   a. General Interior Areas: 15 inches above floor.
   b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of splashback, or 6 inches above countertops without splashback.
   c. Industrial Areas, Workshops: 48 inches above floor.
   d. Outdoor, All Areas: 24 inches above finished grade.
7. Special-Purpose Receptacle: 54 inches above floor or as shown.

E. Install plumb and level.

F. Flush Mounted:
1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.

I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

J. Provide plaster rings where necessary.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. Install stainless steel mounting hardware in industrial areas.

M. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

N. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

O. Box Type (Steel Raceway System):
   1. Exterior Locations:
      a. Exposed Raceways: Cast metal.
      b. Concealed Raceways: Cast metal.
      c. Concrete Encased Raceways: Cast metal.
      d. Class I, II, or III Hazardous Areas: Cast metal.
   2. Interior Dry Locations:
      a. Exposed Rigid Conduit: Cast metal.
      b. Exposed EMT: Sheet steel.
      c. Concealed Raceways: Sheet steel.
      d. Concrete Encased Raceways: Cast metal.
      e. Lighting Circuits, Ceiling: Sheet steel.
      f. Class I, II, or III Hazardous Areas: Cast metal.
   3. Interior Wet Locations:
      a. Exposed Raceways: Cast metal.
      b. Concealed Raceways: Cast metal.
      c. Concrete Encased Raceways: Cast metal.
      d. Lighting Circuits, Ceiling: Sheet steel.
      e. Class I, II, or III Hazardous Areas: Cast metal.
   4. Cast-In-Place Concrete Slabs: Sheet steel.

P. Box Type (Rigid Aluminum Raceway System): Cast aluminum.

Q. Box Type (Nonmetallic Raceway System):
   1. Corrosive Locations: Nonmetallic.
   2. Exposed Raceways: Nonmetallic.
   3. Concealed Raceways: Nonmetallic.
   4. Concrete Encased Raceways: Nonmetallic.

R. Box Type, Corrosive Locations (PVC-Coated Rigid Galvanized Steel Raceway System): PVC coated cast metal..

3.03 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Installed boxes shall be accessible.

F. Do not install on finished surfaces.

G. Install plumb and level.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.

J. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. At or Below Grade:
   1. Install boxes for below grade conduits flush with finished grade in locations outside of paved areas, roadways, or walkways.
   2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
   3. Obtain ENGINEER's written acceptance prior to installation in paved areas, roadways, or walkways.
   4. Use boxes and covers suitable to support anticipated weights.

M. Flush Mounted:
   1. Install with concealed conduit.
   2. Holes in surrounding surface shall be no larger than required to receive box.
   3. Make edges of boxes flush with final surface.

N. Mounting Hardware:
   1. Noncorrosive Interior Areas: Galvanized.
   2. All Other Areas: Stainless steel.

O. Location/Type:
   1. Finished, Indoor, Dry: NEMA 250, Type 1.
   2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
   3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
   4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.
   5. Unfinished, Indoor and Outdoor, Hazardous: NEMA 250, Type 7 and Type 9, where indicated.
   6. Underground Conduit: Concrete Encased.
   7. Corrosive Locations: Nonmetallic.

3.04 WIRING DEVICES

A. Switches:
   1. Mounting Height: See Paragraph OUTLET AND DEVICE BOXES.

2. Install with switch operation in vertical position.
3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:
1. Install with grounding slot down except where horizontal mounting is shown, in which case install with neutral slot up.
2. Ground receptacles to boxes with grounding wire only.
3. Weatherproof Receptacles:
   a. Install in cast metal box.
   b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for "downstream" conventional receptacles.
5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

C. Multioutlet Surface Raceway System:
1. Install in accordance with manufacturer's instructions.
2. Wire alternate outlets to each circuit where two-circuit, three-wire supply is shown.

3.05 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to the box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Engrave with designated titles.

F. Types (Unless Otherwise Shown):
1. Office: Stainless Steel.
2. Exterior: Weatherproof.
3. Interior:
   a. Flush Mounted Boxes: Stainless Steel.
   b. Surface Mounted, Cast Metal Boxes: Cast metal.
   c. Surface Mounted, Sheet Steel Boxes: Stainless Steel.
   d. Surface Mounted, Nonmetallic Boxes: Plastic.

3.06 PUSHBU'ITON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Heavy-Duty, oil-tight Type: Locations (Unless Otherwise Shown): Nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Heavy-Duty, Watertight, and Corrosion-Resistant Type:

1. Locations (Unless Otherwise Shown): Nonhazardous, outdoor, or normally wet areas.
2. Mounting: NEMA 250, Type 4X enclosure.

3.07 TERMINAL JUNCTION BOX

A. Install in accordance with Paragraph JUNCTION AND PULL BOXES.

B. Label each block and terminal with permanently attached, nondestructible tag.

C. Do not install on finished outdoor surfaces.

D. Location:
1. Finished, Indoor, Dry: NEMA 250, Type 1.
2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.08 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

3.09 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moistureproof, flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and three-phase units, 15 to 112 kVA.

3.10 SUPPORT AND FRAMING CHANNEL

A. Furnish zinc-rich primer; paint cut ends prior to installation, where applicable.

B. Install where required for mounting and supporting electrical equipment and raceway systems.

3.11 MOTOR SURGE PROTECTION

A. Ground in accordance with NFPA 70.

B. Low Voltage: Ground terminals to equipment bus.

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Association of State Highway and Transportation Officials (AASHTO): Division I, Standard Specifications for Highway Bridges, Fourteenth Edition.
   2. American National Standards Institute (ANSI):
      a. C80.1, Rigid Steel Conduit-Zinc Coated.
      b. C80.3, Electrical Metallic Tubing-Zinc Coated.
      c. CS0.5, Rigid Aluminum Conduit.
      d. C80.6, Intermediate Metal Conduit (IMC)-Zinc Coated.
   3. American Society for Testing and Materials (ASTM):
      a. A123 El, Standard Specification for Zinc-Coated (Galvanized) Coatings on Iron and Steel Products.
      b. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
   5. National Electrical Manufacturers Association (NEMA):
      a. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
      b. TC 2, Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
      c. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
      d. TC 6, PVC and ABS Plastic Utilities Duct for Underground Installation.
      e. VE 1, Metallic Cable Tray Systems.
   6. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
   7. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Safety Flexible Metal Conduit.
      b. 6, Standard for Safety Rigid Metal Conduit.
      c. 360, Standard for Safety Liquid-Tight Flexible Steel Conduit.
      d. 514B, Standard for Safety Fittings for Conduit and Outlet Boxes.
      e. 514C, Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
      f. 651, Standard for Safety Schedule 40 and 80 PVC Conduit.
      g. 651A, Standard for Safety Type EB and Rigid PVC Conduit and HDPF Conduit.
      h. 797, Standard for Safety Electrical Metallic Tubing.
      i. 870, Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings.
      j. 1242, Standard for Safety Intermediate Metal Conduit.
      k. 1660, Standard for Safety Liquid-Tight Flexible Nonmetallic Conduit.

1.02 SUBMITTALS

A. Shop Drawings:
   1. Manufacturer's Literature for applicable conduit type:
      a. Rigid galvanized steel conduit.
      b. Electric metallic tubing.
      c. Rigid aluminum conduit.
      d. PVC Schedule 40 conduit.
      e. PVC-coated rigid galvanized steel conduit.
      f. Flexible metal, liquid-tight conduit.
      g. Flexible, nonmetallic, liquid-tight conduit.
      h. Conduit fittings.
      i. Wireways.
   2. Precast Manholes and Handholes:
      a. Dimensional drawings and descriptive literature.
      b. Traffic loading calculations.
      c. Accessory information.
   3. Cable Tray Systems:
      a. Dimensional drawings, calculations, and descriptive information.
      b. NEMA load/span designation and how it was selected.
      c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.
      d. Location and magnitude of maximum simple beam deflection of tray for loading specified.
      e. Layout drawings and list of accessories being provided.
   4. Conduit Layout:
      a. Plan and section type, showing arrangement and location of conduit and duct bank required for:
         1) Low and medium voltage feeder and branch circuits.
         2) Instrumentation and control systems.
         3) Communications systems.
         4) Empty conduit for future use.
      b. Reproducible mylar; scale not greater than 1 inch equals 20 feet.
         1) Equipment and machinery proposed for bending metal conduit.
         2) Method for bending PVC conduit less than 30 degrees.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):
   1. Meet requirements of ANSI C80.1 and UL6.
   2. Material: Hot-dip galvanized, with chromated protective layer.

B. Electric Metallic Tubing (EMT):
   1. Meet requirements of ANSI C80.3 and UL 797.

2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.

C. Rigid Aluminum Conduit:
1. Meet requirements of ANSI C80.5 and UL 6.
2. Material: Type 6063, copper-free aluminum alloy.

D. PVC Schedule 40 Conduit:
1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

E. PVC-Coated Rigid Galvanized Steel Conduit:
1. Meet requirements of NEMA RN 1.
2. Material:
a. Conduit: Meet requirements of ANSI C80.1 and UL 6
b. PVC Coating: 40 mils nominal thickness, bonded to metal.

F. Flexible Metal, Liquid-Tight Conduit:
1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

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

2.02 FITTINGS

A. Rigid Galvanized Steel and Intermediate Metal Conduit:
1. General:
a. Meet requirements of UL 514B.
b. Type: Threaded, galvanized. Set screw fittings not permitted.
2. Bushing:
a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
b. Manufacturers:
1) Thomas & Betts; Type BIM.
2) O.Z./Gedney; Type HB.
3. Grounding Bushing:
a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
b. Manufacturers:
1) Appleton; Series GIB.
2) O.Z. Gedney; Type HBLG.
4. Conduit Hub:
a. Material: Malleable iron with insulated throat.
b. Manufacturers:
1) O.Z. Gedney; Series CH.

2) T & B; Series 370.

5. Conduit Bodies:
   a. Material: Malleable iron, sized as required by NFPA 70.
   b. Manufacturers (For Normal Conditions):
      1) Appleton; Form 35 threaded Unilets.
      2) Crouse-Hinds; Form 7 or 8 threaded condulets.
      3) Killark; Series O Electrolets.
   c. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting Manufacturers:
   a. Appleton; Type EYF, EYM, or ESU.
   b. Crouse-Hinds; Type EYS or EZS.
   c. Killark; Type EY or EYS.
8. Drain Seal Manufacturers:
   a. Appleton; Type SF.
   b. Crouse-Hinds; Type EYD or EZD.
9. Drain/Breather Fitting Manufacturers:
   a. Appleton; Type ECDB.
   b. Crouse-Hinds; ECD.
10. Expansion Fitting Manufacturers:
    a. Deflection/Expansion Movement:
       1) Appleton; Type DF.
       2) Crouse-Hinds; Type XD.
    b. Expansion Movement Only:
       1) Appleton; Type XJ.
       2) Crouse-Hinds; Type XJ.
11. Cable Sealing Fittings:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. For Conductors With OD of 1/2 Inch or Less: Neoprene bushing at connector entry.
    c. Manufacturers:
       1) Crouse-Hinds; CGBS.
       2) Appleton; CG-S.

B. Electric Metallic Tubing:
   1. Meet requirements of UL 514B.
   2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
   3. Compression Ring: Stainless steel.
   4. Coupling Manufacturers:
      a. Appleton; Type 95T.
      b. Crouse-Hinds; Type CPR.
   5. Connector Manufacturers:
      a. Appleton; Type 86T.
      b. Crouse-Hinds; Type CPR.

C. Rigid Aluminum Conduit:
   1. General:
      a. Meet requirements of UL 514B.

b. Type: Threaded, copper-free. Set screw fittings not permitted.

2. Insulated Bushing:
   a. Material: Cast aluminum, with integral insulated throat, rated for 150 degrees C.
   b. Manufacturer: O.Z. Gedney; Type AB.
3. Grounding Bushing:
   a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.
   b. Manufacturer: O.Z. Gedney; Type ABLG.
4. Conduit Hub:
   a. Material: Cast aluminum, with insulated throat.
   b. Manufacturers:
      1) O.Z. Gedney; Type CHA.
      2) T & B; Series 370AL.
5. Conduit Bodies:
   a. Manufacturers (For Normal Conditions):
      1) Appleton; Form 85 threaded Unilets.
      2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
      3) Killark; Series O Electrolets.
   b. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting Manufacturers:
   a. Appleton; Type EYF-AL or EYM-AL.
   b. Crouse-Hinds; Type EYS-SA or EZS-SA.
   c. Killark; Type EY or EYS.
8. Drain Seal Manufacturers:
   a. Appleton; Type EYDM-A.
   b. Crouse-Hinds; Type EYD-SA or EZD-SA.
9. Drain/Breather Fitting Manufacturers:
   a. Appleton; Type ECDB.
   b. Crouse-Hinds; ECD.
10. Expansion Fitting Manufacturers:
    a. Deflection/Expansion Movement: Steel City; Type DF-A.
    b. Expansion Movement Only: Steel City; Type AF-A.
11. Cable Sealing Fittings: To form watertight nonslip cord or cable connection to conduit.
    a. Bushing: Neoprene at connector entry.
    b. Manufacturer: Appleton CG-S.

D. PVC Conduit and Tubing:
   1. Meet requirements of NEMA TC-3.
   2. Type: PVC, slip-on.

E. PVC-Coated Rigid Galvanized Steel Conduit:
   1. Meet requirements of UL 514B.
   2. Type: Rigid galvanized steel, PVC coated by conduit manufacturer.
   3. Overlapping pressure sealing sleeves.
   4. Conduit Hangers, Attachments, and Accessories: PVC-coated.

F. Flexible Metal, Liquid-Tight Conduit:
   1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
   2. Insulated throat and sealing O-rings.
   3. Long design type extending outside of box or other device at least 2 inches.
   4. Manufacturer: T & B; Series 5300.

G. Flexible, Nonmetallic, Liquid-Tight Conduit: Meet requirements of UL 514B.
   1. Type: One-piece fitting body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
   2. Manufacturers:
      a. Carlon; Type LT.
      b. Kellems; Polytuff.
      c. T & B; LT Series.

H. Watertight Entrance Seal Device:
   1. New Construction:
      a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
      b. Manufacturer: O.Z./Gedney; Type FSK or WSK, as required.
   2. Gored-Hole Application:
      a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
      b. Manufacturer: O.Z./Gedney; Series CSM.

I. Hazardous Locations: Approved for use in the atmosphere involved.
   1. Manufacturer: Crouse-Hinds; Type ECGJH.

J. Corrosive Locations:
   1. Material: 40-mil PVC-coated rigid steel.
   2. Manufacturers:
      a. Robroy Industries.
      b. Carlon.
      c. Crouse-Hinds.

2.03 WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, with removable, hinged cover.

C. Rating: Outdoor raintight if outdoor, and indoor if indoor.

D. Finish: Gray, baked enamel.

E. Manufacturers:
   1. Square D.
   2. B-Line Systems, Inc.

2.04 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO Division 1, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6- or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage:
   1. Slope floors toward drain points, leaving no pockets or other non-draining areas.
   2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

E. Raceway Entrances:
   1. Provide on all four sides.
   2. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.
   3. At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:
   1. Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
   2. Location:
      a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
      b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:
   1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
   2. Wall Attachment:
      a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
      b. Insert Spacing: Maximum 3-foot on center entire inside perimeter of manhole.
      c. Arrange so that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:
   1. Material: Machined cast iron.
   2. Cover Type: Indented, solid top design, with two drop handles each.
   3. Cover Loading: AASHTO Division I, H-20.
   4. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
      a. Above 600 Volts: ELECTRIC HV.
      b. 600 Volts and Below: ELECTRIC LV.
      c. TELEPHONE.

I. Handhole Frames and Covers:
   1. Material: Steel, hot-dipped galvanized.
   2. Cover Type: Solid, bolt-on, of checkered design.
   3. Cover Loading: H-20.

4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
    a. 600 Volts and Below: ELECTRIC LV.
    b. TELEPHONE.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:
1. U.S. Precast.
2. Brooks Products, Inc.
3. Penn-Cast Products, Inc.
4. Concrete Conduit Co.
5. Associated Concrete Products, Inc.
6. Utility Vault Co.
7. Pipe,Inc.

2.05 ACCESSORIES

A. Duct Bank Spacers:
1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturer: Underground Device, Inc.; Type WUNPEECE.

B. Identification Devices:
1. Raceway Tags:
    a. Material: Permanent, nylon.
    b. Shape: Round.
    c. Raceway Designation: Pressure stamped, embossed, or engraved.
    d. Tags relying on adhesives or taped-on markers not permitted.
2. Warning Tape:
    a. Material: Polyethylene, 4-mil gauge.
    b. Color: Red.
    c. Width: Minimum 6-inch.
    d. Designation: Warning on tape that electric circuit is located below tape.
    e. Manufacturers:
        1) Blackburn, Type RT.
        2) Griffolyn Co.
3. Buried Raceway Marker:
    a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
    b. Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES. in letters 1/4-inch high.
    c. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

C. Raceway Coating:
1. Material: Bitumastic or plastic tape coating.
2. Manufacturers:
    a. Koppers bitumastic; No. 505.
    b. Scotchwrap; No. 51, plastic tape.

D. Wraparound Duct Band:
   1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
   2. Manufacturer: Raychem; Type TWDB.

PART 3 EXECUTION

3.01 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors. Reference Section 16120, CONDUCTORS, concerning conduit sizing for aluminum conductors.

B. All installed Work shall comply with NECA 5055.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Aluminum Conduit: Do not install in direct contact with concrete. Use unistrut or back and strap (clamp back strap) for installation on concrete wall or surface.

G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

M. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

N. Install watertight fittings in outdoor, underground, or wet locations.

O. Paint threads, before assembly of fittings, of galvanized conduit or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

P. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

Q. Do not install raceways in concrete equipment pads, foundations, or beams.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

T. Use long radius elbow for conduit with fiber optic cable, indicated or not on the drawings.

3.02 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum cover 1-1/2 inches.

B. Provide support during placement of concrete to ensure raceways remain in position.

C. Floor Slabs:
   1. Outside diameter of conduit not to exceed one-third of the slab thickness.
   2. Separate conduit by minimum six times conduit outside diameter, except at crossings.

3.03 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed:
   1. Rigid Aluminum.

C. Interior, Exposed:
   1. Rigid Aluminum.
   2. Electric metallic tubing for ceiling portion of lighting circuits in a conditioned environment.

D. Interior, Concealed (Not Embedded in Concrete):
   1. Rigid Aluminum.
   2. PVC Schedule 40.

E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: PVC Schedule 40.

F. Concrete Slab on Top: PVC Schedule 40.

G. Under Slabs-On-Grade: PVC Schedule 40.

H. Corrosive Areas: PVC Schedule 40.

I. Lightning Protection: PVC Schedule 40.

J. Class 1 Division 2 Area: Rigid Aluminum.

3.04 CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:
   1. Conduit Size 4 Inches or Less: Flexible metal, liquid-tight conduit.
   2. Conduit Size Over 4 Inches: Nonflexible.
   3. Corrosive Areas: Flexible, nonmetallic, liquid or PVC-coated metallic, liquid-tight.
   4. Length: 18-inch minimum, 60-inch maximum, of sufficient length to allow movement or adjustment of equipment.

B. Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Transition From Underground or Concrete Embedded to Exposed: PVC Coated Rigid galvanized steel conduit.

E. Under Equipment Mounting Pads: Rigid galvanized steel conduit.

F. Exterior Light Pole Foundations: Rigid galvanized steel conduit.

3.05 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit in contact with concrete floor slabs to a point 2 inches above concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:
   1. General: Seal raceway at the first box or outlet with minimum 2 inches thick expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
   2. Concrete Roof or Membrane Waterproofed Wall or Floor:
      a. Provide a watertight seal.
      b. Without Concrete Encasement: Install watertight entrance seal device on each side.
      c. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
      d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.

e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

3. Heating, Ventilating, and Air Conditioning Equipment:
   a. Penetrate equipment in area established by manufacturer.
   b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
   c. Seal penetration with silicone type sealant.
4. Corrosive-Sensitive Areas:
   a. Seal all conduit passing through chlorine and ammonia room walls.
   b. Seal all conduit entering equipment panel boards and field panels containing electronic equipment.
   c. Seal penetration with silicone type sealant.
5. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.
6. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
   a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
   b. Fill space between raceway and sleeve with an expandable plastic compound on each side.
7. Manholes and Handholes:
   a. Metallic Raceways: Provide insulated grounding bushings.
   b. Nonmetallic Raceways: Provide bell ends flush with wall.
   c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.06 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 40 percent extra space for future conduit.

C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
   1. Wood: Wood screws.
   2. Hollow Masonry Units: Toggle bolts.
   3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
   4. Steelwork: Machine screws.

D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.07 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:
   1. Bends 30-Degree and Larger: Provide factory-made elbows.
   2. 90-Degree Bends: Provide rigid steel elbows.
   3. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.08 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.09 PVC CONDUIT

A. Solvent Welding:
   1. Provide manufacturer recommended solvent; apply to all joints.
   2. Install such that joint is watertight.

B. Adapters:
   1. PVC to Metallic Fittings: PVC terminal type.
   2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belied-End Conduit: Bevel the unbelled end of the joint prior to joining.

3.10 PVC-COATED RIGID STEEL CONDUIT

A. Install in accordance with manufacturer's instructions.

B. Provide PVC boot to cover all exposed threading.

3.11 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

3.12 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Sheet Metal Boxes, Cabinets, and Enclosures:
   1. Rigid Galvanized Conduit:
      a. Provide one lock nut each on inside and outside of enclosure.
      b. Install grounding bushing.
      c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
      d. Install insulated bushing on ends of conduit where grounding is not required.
      e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   2. Electric Metallic Tubing: Provide gland compression, insulated connectors.
   3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
   4. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
   5. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
   6. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.

C. Motor Control Center, Switchboard, Switchgear, and Free-Standing Enclosures: Terminate conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.13 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:
   1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
   2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Installation with Other Piping Systems:
   1. Crossings: Maintain minimum 12-inch vertical separation.
   2. Parallel Runs: Maintain minimum 12-inch separation.
   3. Installation over valves or couplings not permitted.

I. Metallic Raceway Coating: At couplings and joints and along entire length, apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

J. Concrete Encasement: As specified in Section 03300, CAST-IN-PLACE CONCRETE.
   1. Concrete Color: Gray, dust top of concrete ductbank with powdered red concrete dye before concrete sets and trowel dry onto top of ductbank.

K. Backfill:
   1. As specified in Section 01045, CUTTING AND PATCHING
   2. Do not backfill until inspected by ENGINEER.

3.14 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade back to original state.

B. Do not install until final raceway grading has been determined.

C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

D. Grounding: As specified in Section 16450, GROUNDING.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be i-inch minimum height.

3.15 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Paragraph IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.16 IDENTIFICATION DEVICES

A. Raceway Tags:
   1. Identify origin and destination.
   2. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.
   3. Provide nylon strap for attachment.

B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

C. Buried Raceway Markers:
   1. Install at grade to indicate direction of underground raceways.
   2. Install at all bends and at intervals not exceeding 100 feet in straight runs.
   3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.17 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up damage to coating on PVC-coated conduit with patching compound approved by manufacturer.

END OF SECTION

SECTION 16120

CONDUCTORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American National Standards Institute (ANSI): 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   2. American Society for Testing and Materials (ASTM):
      a. A167, Standard Specification for Stainless and Heat Resisting Chromium-Nickel-P1ated Steel Plate, Sheet, and Strip.
      b. B3, Standard Specification for Soft or Annealed Copper Wire.
      c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
      d. B263, Standard Test Method for Determination of Cross- Sectional Area of Stranded Conductors.
   3. Association of Edison Illuminating Companies (AEIC):
      a. CS 5, Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 35 kV.
      b. CS 6, Ethylene- Propylene-Rubber-Insulated Shielded Power Cables Rated 5 Through 69 kV.
   4. Insulated Cable Engineer's Association, Inc. (ICEA): T-29-250, Procedure for Conducting Vertical Cable Tray Flame Test With a Theoretical Heat Input of 210,000 Btu/hour.
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 48, Standard Test Procedures and Requirements or High-Voltage Alternating Current Cable Terminations.
      b. 404, Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V through 46,000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V through 500,000V.
   6. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.
   7. National Electrical Manufacturers' Association (NEMA):
      a. CC 1, Electric Power Connectors for Substations.
      b. WC 3, Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      c. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      d. WC 7, Crosslinked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      e. WC 8, Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      f. WC 55, Instrumentation Cables and Thermocouple Wire.
   8. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   9. Underwriters Laboratories, Inc. (UL):
      a. 13, Standard for Safety Power-Limited Circuit Cables.

b. 44, Standard for Safety Rubber-Insulated Wires and Cables.
c. 62, Standard for Safety Flexible Cord and Fixture Wire.
d. 486A, Standard for Safety Wire Connector and Soldering Lugs for Use with Copper Conductors.
e. 486B, Standard for Safety Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.
f. 510, Standard for Safety Insulating Tape.
g. 854, Standard for Safety Service-Entrance Cables.
h. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces.
i. 1072, Standard for Safety Medium-Voltage Power Cables.
j. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
k. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Shop Drawings:
1. Wire and cable descriptive product information.
2. Wire and cable accessories descriptive product information.
3. Cable fault detection system descriptive product information.
4. Manufactured wiring systems descriptive product information.
5. Manufactured wire systems rating information.
6. Manufactured wire systems dimensional drawings.
7. Manufactured wire systems special fittings.
8. Busway descriptive product information.
9. Busway rating information.
10. Busway dimensional drawings.
11. Busway special fitting information.
12. Busway-equipment interface information for equipment to be connected to busways.

B. Quality Control Submittals:
1. Certified Factory Test Report for conductors 600 volts and below.
2. Certified Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:
1. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Stranded copper.

2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Stranded copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW insulation.

D. Direct Burial and Aerial Conductors and Cables:
1. Type USE/RHH/RHW insulation, UL t(54 listed, Type RHW-2/USE-2.
2. Conform to physical and minimum thickness requirements of NEMA WC 3.

E. Flexible Cords and Cables:
1. Type SOW-A50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 8.

F. Cable Tray Conductors and Cables: Type TC.

2.02 600-VOLT RATED CABLE

A. General:
1. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Wire and Connectors:
1. Cable shall be rated for 600 volts and shall meet the requirements below:
2. Conductors shall be stranded
3. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.
4. Type of wire shall be XHHW or THHN, rated 75 degrees C suitable for wet locations except where required otherwise by the drawings.
5. No wire smaller than No. 12 gauge shall be used unless specifically indicated.
6. Conductor metal shall be copper.
7. All conductors shall be megger tested after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance.

C. Type l-Multiconductor Control Cable:
1. Conductors:
a. No. 14 AWG, seven-strand copper.
b. Insulation: 15-mil PVC with 4-mil nylon.
c. UL 1581 listed as Type THHN/THWN rated VW-l.
d. Conductor group bound with spiral wrap of barrier tape.
e. Color Code: In accordance with NEMA WC 5, Method 1, Sequence K-2.
2. Cable: Passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (inches)	Jacket Thickness (mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	00.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. Rome Cable.

D. Type 2-Multiconductor Power Cable:
1. Conductors:
   a. Class B stranded, coated copper.
   b. Insulation: Chemically crosslinked ethylene-propylene with Hypalon jacket.
   c. UL 1581 listed as Type EPR, rated VW-1.
   d. Color Code: Conductors, size No. 8 AWG and smaller, colored conductors, NEMA WC5 Method 1, color 5 per Article POWER CONDUCTOR COLOR CODING. Conductors, size No. 6 AWG and larger, NEMA WC5, Method 4.
2. Cable pass the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. of Conductors	Max.Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2 3 4	0.42 0.45 0.49	45 45 45
10	10	2 3 4	0.54 0.58 0.63	60 60 60
8	10	3 4	0.66 0.72	60
6	8	3 4	0.74 0.81	60
4	6	3 4	0.88 0.97	60 80
2	6	3 4	1.01 1.11	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.46	80
4/0	4	3 4	1.56 1.78	80

4. Manufacturers:
    a. Okonite Co.
    b. Pome Cable.

E. Type B-No. 16 AWG, Twisted, Shielded Pair (TSP), Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
    1. Outer Jacket: 45-mil nominal thickness.
    2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
    3. Dimension: 0.31-inch nominal OD.
    4. Conductors:
        a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8
        b. 20 AWG, seven-strand tinned copper drain wire.
        c. Insulation: 15-mil nominal PVC.
        d. Jacket: 4-mil nominal nylon.
        e. Color Code: Pair conductors black and red.
    5. Manufacturers:
        a. Okonite Co.
        b. Alpha Wire Corp.
    6. The following test shall be performed on instrumentation and control system cables. All tests shall be end-to-end test of installed cables with the ends supported in free air, not adjacent to any ground object. All test data shall be recorded on forms acceptable to the Engineer. Complete records of all tests shall be made and delivered to the Engineer.
        a. Continuity tests shall be performed by measuring wire/shield loop resistances of signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall carry by more than $\pm$2 ohms from the calculated average loop resistance valve.
        b. Insulation resistance tests shall be performed by using a 500 volt megohmeter to measure the insulation resistance between each channel wire and channel shield, between individual channel shields in a multi-channel cable, between each individual channel and the overall cable shield in multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 10 megohms shall be unacceptable.

F. Type B1-No. 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
    1. Outer Jacket: 45-mil nominal.
    2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
    3. Dimension: 0.32-inch nominal OD.
    4. Conductors:
        a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
        b. 20 AWG, seven-strand, tinned copper drain wire.
        c. Insulation: 15-mil nominal PVC.
        d. Jacket: 4-mil nylon.
        e. Color Code: Triad conductors black, red, and white.

5. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.

G. Type B2-No. 18 AWG, Multi-Twisted, Shielded Pairs with a Common, Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 55 requirements.
1. Conductors:
    a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8
    b. Tinned copper drain wires.
    c. Pair drain wire size AWG 20, group drain wire size AWG 18.
    d. Insulation: 15-mil PVC.
    e. Jacket: 4-mil nylon.
    f. Color Code: Pair conductors black and red with red conductor numerically printed for group identification.
    g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
3. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.50	45
8	0.68	60
12	0.82	60
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

4. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.

H. Type B3-No. 18 AWG, Multi-twisted Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 55.
1. Conductors:
    a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
    b. Tinned copper drain wire size 18 AWG
    c. Insulation: 15-mil nominal PVC.
    d. Jacket: 4-mil nylon.
    e. Color Code: Pair conductors black and red, with red conductor numerically printed for group identification.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
3. Cable Sizes:

Number Of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.46	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.06	80
36	1.21	80
50	1.42	80

4. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.

I. Ethernet Cat. 6e UTP Cable (Copper):
1. Section applies to all Ethernet Cable (Copper) except for Fiber Optic cable.
2. Conductor Physical Characteristics: 4 twisted pairs (8 conductors), 23 AWG solid bare Copper with Polyolefin Insulation. Overall Nominal Diameter: 0.235 inch. Operating Temperature Range: -20'C to +75'C. Model Number – 7881A, Belden Inc.
3. NEC/UL specification CMR, UL444, UL verified category 6.
4. Manufacturer:
   a. Belden Inc.

2.03 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.04 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:
1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arcs and Fireproofing:
   a. 30-mil, elastomer
   b. Manufacturers and Products:
      1) Scotch; Brand 77, with Scotch Brand 69 glass cloth tape binder.
      2) Plytnount; Plyarc 30, with Plymount Plyglas glass cloth tape binder.

B. Identification Devices:
1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:
   1. Nylon, Self-Insulated Crimp Connectors:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) Burndy; Insulink.
         3) ILSCO.
   2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) Burndy; Insulink.
         3) ILSCO.

D. Cable Lugs:
   1. In accordance with NEMA CC I.
   2. Rated 600 volts of same material as conductor metal.
   3. Insulated, Locking-Fork, Compression Lugs:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) ILSCO; ILSCONS.
   4. Un-insulated Crimp Connectors and Terminators:
      a. Manufacturers and Products:
         1) Square D; Versitide.
         2) Thomas & Betts; Color-Keyed.
         3) ILSCO.
   5. Un-insulated, Bolted, Two-Way Connectors and Terminators:
      a. Manufacturers and Products:
         1) Thomas & Betts; Locktite.
         2) Burndy; Quiklug.
         3) ILSCO.

E. Cable Ties: Nylon, adjustable, self-locking, and reusable.
   1. Manufacturers and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyofin.
   1. Manufacturers and Product: Thomas & Betts; SHRINK-KON.

2.05 PULLING COMPOUND

A. Nontoxic, non-corrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:
   1. Ideal Co.; Yellow 77.
   2. Polywater, Inc.
   3. Cable Grip Co.

2.06 WARNING TAPE

A. As specified in Section 16110, RACEWAYS.

2.07 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and Below: Test in accordance with UL 44 and 854 Standards.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation to be in accordance with NECA 5055.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

F. Bundling: Where single conductors and cables in manholes, hand holes, vaults, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

I. Cable Tray Installation:
   1. Install wire and cable parallel and straight in tray.
   2. Bundle, in groups, all wire and cable of same voltage having a common routing and destination; use cable ties, at maximum intervals of 8 feet.
   3. Clamp cable bundles prior to making end termination connections.
   4. Separate cables of different voltage rating in same cable tray with barriers.
   5. Fasten wires, cables, and bundles to tray with nylon cable straps at the following maximum intervals:
      a. Horizontal Runs: 20 feet.
      b. Vertical Runs: 5 feet.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:
   1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
   2. No. 8 AWG and Smaller: Provide colored conductors.
   3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation. Coordinate with AHJ and local codes and adjust the color accordingly.		

   4. Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, hand holes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:
   1. Assign circuit name based on device or equipment at load end of circuit.
   2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:
   1. Conductors No. 3 AWG and Smaller: Identify with sleeves.
   2. Cables, and Conductors No. 2 AWG and Larger:
      a. Identify with marker plates.
      b. Attach marker plates with nylon tie cord.
   3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by ENGINEER.

C. Connections and Terminations:
   1. Install wire nuts only on solid conductors.
   2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.
   3. Install un-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
   4. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
   5. Install un-insulated bolted, two-way connectors for motor circuit conductors No. 12 and larger.
   6. Tape insulates all un-insulated connections.
   7. Place no more than one conductor in any single-barrel pressure connection.
   8. Install crimp connectors with tools approved by connector manufacturer.
   9. Install terminals and connectors acceptable for type of material used.
   10. Compression Lugs
      a. Attach with a tool specifically designed for purpose.
      b. Tool shall provide complete controlled crimp and shall not release until crimp is complete.
      c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:
   1. Indoors: Use general purpose, flame retardant tape.
   2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

F. Cap spare conductors and conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:
   1. Remove surplus wire, bridle and secure.
   2. Where conductors pass through openings or over edges in sheet metal, remove bums, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:
   1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
   2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
   3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.

4. Where connections of cables installed under this section are to be made under PROCESS INSTRUMENTATION AND CONTROL SYSTEMS, leave pigtails of adequate length for bundled connections.
5. Cable Protection:
    a. Under Infinite Access Floors: May be installed without bundling.
    b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2-inch in diameter.
    c. Maintain integrity of shielding of instrumentation cables.
    d. Ensure grounds do not occur because of damage to jacket over the shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.05 FIELD QUALTTY CONTROL - LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:
1. Inspect Each Individual Exposed Power Cable No. 6 and Larger For:
    a. Physical damage.
    b. Proper connections in accordance with single-line diagram.
    c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
    d. Color coding conformance with specifications.
    e. Proper circuit identification.
2. Mechanical Connections For:
    a. Proper lug type for conductor material.
    b. Proper lug installation.
    c. Bolt torque level in accordance with NETA ATS, Table 10. 1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
    a. Proper shield grounding.
    b. Proper terminations.
    c. Proper circuit identification.
4. Control Cables For:
    a. Proper termination.
    b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:
1. Insulation Resistance Tests:
    a. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
    b. Evaluate ohmic values by comparison with conductors of same length and type.
    c. Investigate values less than 50 megohms.
    d. Utilize 1,000V dc megohmmeter for 600V insulated conductors.
2. Continuity test by ohmmeter method to ensure proper cable connections.

END OF SECTION

SECTION 16405

ELECTRIC MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Anti-Friction Bearing Manufacturers' Association (AFBMA):
      a. 9, Load Ratings and Fatigue Life for Ball Bearings.
      b. 11, Load Rating and Fatigue Life for Roller Bearings.
   2. American National Standards Institute (ANSI): C50.41, Polyphase Induction Motors for Power Generating Stations.
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
      a. 85, Test Procedure for Airborne Sound Measurements on Rotating Machines.
      b. 112, Standard Test Procedures for Polyphase Induction Motors and Generators.
      c. 114, Standard Test Procedures for Single-Phase Induction Motors.
      d. 620, Guide for Construction and Interpretation of Thermal Limit Curves for Squirrel-Cage Motors Over 500 Horsepower.
      e. 841, Recommended Practice for Chemical Industry Severe-Duty Squirrel-Cage Induction Motors, 600V and Below.
   4. National Electrical Manufacturers Association (NEMA):
      a. MG 1, Motors and Generators.
      b. MG 13, Frame Assignments for Alternating Current Integral Horsepower Induction Motors.
      c. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   5. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
   6. Underwriters Laboratories (UL):
      a. 547, Thermal Protectors for Electric Motors.
      b. 674, Electric Motors and Generators Used in Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. CISD-TEFC: Chemical industry, severe-duty enclosure.

B. DIP: Dust-ignition-proof enclosure.

C. EXP: Explosion-proof enclosure.

D. ODP: Open drip-proof enclosure.

E. TEFC: Totally enclosed, fan cooled enclosure.

F. TENV: Totally enclosed, non-ventilated enclosure.

G. WPI: Open weather protected enclosure, Type I.

H. WPII: Open weather protected enclosure, Type II.

I. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Descriptive information.
   2. Nameplate data in accordance with NEMA MG 1.
   3. Additional Rating Information:
      a. Service factor.
      b. Locked rotor current.
      c. No load current.
      d. Safe stall time for motors 200 horsepower and larger.
      e. Multispeed load classification (e.g., variable torque).
      f. Adjustable frequency drive motor load classification (e.g., variable torque) and minimum allowable motor speed for that load classification.
   4. Enclosure type and mounting (e.g. horizontal, vertical).
   5. Dimensions and total weight.
   6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
   7. Bearing type.
   8. Bearing lubrication.
   9. Bearing life.
   10. Space heater voltage and watts.
   11. Description and rating of motor thermal protection.
   12. Motor sound power level in accordance with NEMA MG 1.
   13. Maximum brake horsepower required by the equipment driven by the motor.
   14. Description and rating of submersible motor moisture-sensing system.

B. Quality Control Submittals:
   1. Factory test reports, certified.
   2. Manufacturer's Certificate of Proper Installation, 100 horsepower and larger.
   3. Operation and Maintenance Manual.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. General Electric.

B. Reliance.

C. Magnetek.

D. Siemens.

E. U.S.Motors.

F. Westinghouse.

G. Toshiba.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, use a single supplier to provide a drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. Frame assignments in accordance with NEMA MG 13.

E. Provide motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

F. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

G. Lifting lugs on all motors weighing 100 pounds or more.

H. Operating Conditions:
   1. Maximum ambient temperature not greater than 50 degrees C.
   2. Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.
   3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specifications.

B. Constant Speed Applications: Brake horsepower of the driven equipment at any head capacity point on the pump curve not to exceed motor nameplate horsepower rating, excluding any service factor.

C. Adjustable Frequency, Adjustable Speed Applications: Driven equipment brake horsepower at any head capacity point on the pump curve not to exceed motor nameplate horsepower rating, excluding any service factor.

2.04 SERVICE FACTOR

A. 1.15 minimum at rated ambient temperature, unless otherwise indicated.

2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60-Hz.

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specifications:

Size	Voltage	Phases
1/2 hp and smaller	115	1
3/4 hp through 400 hp	460	3
450 hp and larger	4,000	3

C. Suitable for full voltage starting.

D. One hundred horsepower and larger also suitable for reduced voltage starting with 65 or 80 percent voltage tap settings on reduced inrush motor starters.

E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 horsepower, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:
   1. Efficiency:
      a. Tested in accordance with NEMA MG 1, paragraph 12.54.1. Tested efficiency shall meet or exceed listed in NEMA MG 1 Table 12-10.
      b. Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.
   2. Power Factor: Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code F or lower if motor horsepower not covered by NEMA MG 1 tables.

B. Safe stall time 15 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

B. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.

C. Three-Phase and Integral Horsepower Motors, Unless Otherwise Indicated in Motor-Driven Equipment Specifications: Class F with Class B rise at nameplate horsepower and designated operating conditions, except EXP and DIP motors which must be Class B with Class B rise. Insulation shall be chemical and humidity resistant.

2.09 ENCLOSURES

A. All enclosures to conform to NEMA MG 1.

B. Unless otherwise noted, all motors shall be TEFC and shall be furnished with a drain hole with porous drain/weather plug.

C. Explosion-Proof (EXP):
   1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class 1, Division 1, Group C and D hazardous locations.
   2. Drain holes with drain and breather fittings.
   3. Integral thermostat opening on excessive motor temperature in accordance with UL 547 and NFPA 70.
   4. Thermostat leads to terminate in a terminal box separate from main terminal box.

D. Dust-Ignition-Proof (DIP):
   1. TEFC listed to met UL 674 and NFPA 70 requirements for Class II, Division 1, Group E, F, G.
   2. Integral thermostat opening on excessive motor temperature in accordance with UL 547 and NFPA 70.
   3. Thermostat leads to terminate in a terminal box separate from main terminal box.

E. Submersible: In accordance with Paragraph SPECIAL MOTORS.

F. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Paragraph SPECIAL MOTORS.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for all motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1-11.06 and 20.62 and NFPA 70, Article 430:

Voltage	Horsepower	Percentage
Below 600	15 thru 125	500
Below 600	150 thru 300	275
Below 600	350 thru 600	225
Above 600	All Sizes	200

E. Terminal for connection of equipment grounding wire in each terminal box.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:
   1. 3/4 horsepower and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
   2. 1 Through 400 horsepower: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
   3. Above 400 horsepower: Regreasable antifriction bearings in labyrinth sealed end bells with removable grease relief plugs.
   4. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in AFBMA 9 and 11.

B. Vertical Motors:
   1. Thrust Bearings:
      a. Antifriction bearing.
      b. Manufacturer's standard lubrication 100 horsepower and smaller.
      c. Oil lubricated 125 horsepower and larger.
      d. Minimum 100,000 hours L-10 bearing life.
   2. Guide Bearings:
      a. Manufacturer's standard bearing type.
      b. Manufacturer's standard lubrication 100 horsepower and smaller.
      c. Oil lubricated 125 horsepower and larger.
      d. Minimum 100,000 hours L-1O bearing life.

C. Regreasable Antifriction Bearings:
   1. Readily accessible, grease injection fittings.
   2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:
   1. Oil reservoirs with sight level gauge.
   2. Oil fill and drain openings with opening plugs.
   3. Provisions for necessary oil circulation and cooling.

2.12 NOISE

A. Measured in accordance with IEEE 85 and NEMA MG 1 and be less than levels in 12.53.3 at no load.

B. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1-12.06 and 1-12.07.

2.14 EQUIPMENT FINISH

A. External Finish: Prime and finish coat manufacturer's standard. Field painting in accordance with Section 09960.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen over Air Openings: Stainless steel on motors with ODP, WPI, and WPII enclosures meeting requirements for Guarded Machine in NEMA MG 1.

B. Winding Thermal Protection:
   1. Thermostats:
      a. Motors for constant speed and adjustable speed application 50 and larger.
      b. Bi-metal disk or rod type thermostats embedded in stater windings (normally closed contact).
      c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature. (Manual reset will be provided at motor controller.)
   2. Motor Space Heaters: All motors 50 horsepower and larger except if otherwise noted, shall be furnished with 120V ac space heaters. The rating of the space heaters shall be determined in accordance with the motor manufacturer's standard for particular frame size and type. Coordinate the power requirements of the space heater with the manufacturer of motor starters or adjustable frequency drive for sizing of the control transformer. Space heater wire leads shall be brought out in the conduit box on the motor and clearly identified.

2.16 SPECIAL MOTORS

A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.

B. Chemical Industry, Severe-Duty (CISD-TEFC):
   1. In accordance with IEEE 841.
   2. TEFC in accordance with NEMA MG 1.
   3. Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.
   4. Motor Frame, End Shields, Terminal Box(es), and Fan Cover: Cast iron.
   5. Ventilating Fan: Corrosion-resistant, non-sparking, external.
   6. Drain and Breather Fittings: Stainless steel.
   7. Nameplate: Stainless steel.
   8. Gaskets between terminal box halves and terminal box and motor frame.
   9. Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.
   10. Double shielded bearings.
   11. 125,000 hours minimum L-10 bearing life for direct-connected loads.
   12. External Finish: Double-coated epoxy enamel.
   13. Coated rotor and stator air gap surfaces.
   14. Insulation System, Windings, and Connections:
      a. Class F insulation, Class B rise or better at 1.0 service factor.
      b. Multiple dips and bakes of nonhygroscopic polyester varnish.
   15. Service Factor:
      a. At 40 Degrees C Ambient: 1.15.
      b. At 65 Degrees C Ambient: 1.00.

16. Safe Stall Time Without Injurious Heating: 20 seconds minimum.
17. Motor shall be equal to U.S. Motors Severe Duty Premium Efficient Motors. Provide motors with insulated bearing to prevent ground current damage.

C. Severe-Duty Explosion-Proof: Meet requirements for EXP enclosures and CISD-TEFC motors.

D. Severe-Duty, Dust-Ignition-Proof: Meet requirements for DIP enclosures and CISD-TEFC motors.

E. Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in the motor-driven equipment specifications.

F. Submersible Pump Motors:
1. Manufacturers:
   a. Myers.
   b. Flygt.
2. At 100 Percent Load:

Horsepower	Guaranteed Minimum Efficiency	Guaranteed Minimum Power Factor
5 thru 10	80	82
10.1 thru 50	85	82
50. 1 thru 100	87	82
Over 100	89	82

3. Insulation System: Manufacturer's standard Class B or Class F.
4. Motor capable of running dry continuously.
5. Enclosure.
   a. Hermetically sealed, watertight, for continuous submergence up to 65-foot depth.
   b. Listed to meet UL 674 and NFPA 70 requirements for Class 1, Division 1, Group D hazardous atmosphere.
   c. Seals: Tandem mechanical.
6. Bearing and Lubrication:
   a. Permanently sealed and lubricated, replaceable antifriction guide and thrust bearings.
   b. Minimum 15,000 hours L-10 bearing life.
7. Inrush kVA/horsepower no greater than NEMA MG 1 and NFPA 70, Code F.
8. Winding Thermal Protection:
   a. Thermal sensor and switch assemblies, one each phase embedded in stator windings and wired in series.
   b. Switches normally closed, open upon excessive winding temperature, and automatically reclose when temperature has cooled to safe operating level.
   c. Switch contacts rated at 5 amps, 120 volts ac.
9. Motor Seal Failure Moisture Detection:
   a. Probes or sensors to detect moisture beyond seals.

b. Probe or sensor monitoring module for mounting in motor controller, suitable for operation from 120-volt ac supply.
c. Monitoring module with control power transformer, probe test switch and test light, and two independent 120-volt ac contacts, one opening and one closing when the flux of moisture is detected.

10. Bearing Overtemperature Protection for Motors Larger than 100 Horsepower:
    a. Sensor on lower bearing housing monitoring bearing temperature.
    b. Any monitoring relay necessary to provide 120-volt ac contact opening on bearing overtemperature.
11. Winding thermal protection, moisture detection, and bearing overtemperature specified above may be monitored by a single device providing two independent 120-volt ac contacts, one closing and one opening on malfunction.
12. Connecting Cables:
    a. One cable containing power, control, and grounding conductors.
    b. Each cable suitable for hard service, submersible duty with watertight seal where cable enters motor.
    c. Length: 30 feet minimum, coordinate proper length
    d. UL 1 listed and sized in accordance with NFPA 70.

G. Inclined Motors:
1. Motors suitable for operation only in horizontal position not acceptable.
2. Bearings designed for thrust imposed by driven equipment and by motor rotor when motor is in inclined position.
3. Lubrication system designed to provide adequate bearing lubrication when motor is in inclined position.

2.17 FACTORY TESTING

A. Tests:
1. In accordance with IEEE 112 for polyphase motors and IEEE 114 for single-phase motors.
2. Routine (production) tests on all motors in accordance with NEMA MG 1, plus no load power at rated voltage and polyphase, rated voltage measurement of locked rotor current. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency at 50, 75, and 100 percent of rated horsepower:
    a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, paragraphs 12.54 and 12.57.
    b. For motors 500 horsepower and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
4. Power factor:
    a. Speed.
    b. Current at rated horsepower.
    c. kW input at rated horsepower.
    d. On motors of 100 horsepower and smaller, furnish a certified copy of a motor efficiency test report on an identical motor.

B. Test Report Forms:
1. Routine Tests: IEEE 112, Form A-1.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts. Provide anchor bolts meeting manufacturer's recommendations and of sufficient size and number for the specified seismic conditions.

3.02 FIELD QUALITY CONTROL

A. General: Inspection and testing limited to motors rated 5 horsepower and larger.

B. Visual and Mechanical Inspection:
   1. Proper electrical and grounding connections.
   2. Shaft alignment.
   3. Blockage of ventilating air passageways.
   4. Operate Motor and Check For:
      a. Excessive mechanical and electrical noise.
      b. Overheating.
      c. Correct rotation.
      d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
      e. Excessive vibration.
   5. Check operation of space heaters.

C. Electrical Tests:
   1. Insulation Resistance Tests:
      a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
         1) Motors above 200 horsepower for l0-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
         2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
      b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
   2. Calculate polarization index ratios for motors above 200 horsepower. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
   3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
   4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.
   5. Overpotential Tests:
      a. Applied dc voltage in accordance with IEEE 95.
      b. Limited to 4,000-volt motors rated 1,000 horsepower and greater.
      c. Test results evaluated on pass/fail basis.

3.03 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative at site for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 75 horsepower.

B. Manufacturer's Certificate of Proper Installation.

3.04 SUPPLEMENTS

A. Table supplements, following "END OF SECTION," are a part of this Specification.

END OF SECTION

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
1	1800	80.0	81.5			Mfr.'s Std.	Mfr.'s Std.		
	1200	78.5	79.3			Mfr.'s Std.	Mfr.'s Std.		
1.5	3600	79.3	81.5			Mfr.'s Std.	Mfr.'s Std.		
	1800	79.3	82.0			Mfr.'s Std.	Mfr.'s Std.		
	1200	82.5	84.0		82.0	Mfr.'s Std.	Mfr.'s Std.		Mfr.'s Std.
2	3600	82.0	84.0			Mfr.'s Std.	Mfr.'s Std.		
	1800	81.5	83.7			Mfr.'s Std.	Mfr.'s Std.		
	1200	85.5	85.5	83.7	83.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	82.9	82.5	82.9	81.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
3	3600	82.0	84.0	82.0	82.0	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	84.8	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	87.5	88.1	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	84.1	82.9	84.1	82.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
5	3600	84.8	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	86.5	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	87.5	88.1	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	86.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
7.5	3600	86.5	88.1	84.8	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	88.5	88.5	88.4	87.5	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	86.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
10	3600	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	89.5	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
15	3600	88.5	89.8	88.4	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	91.0	91.0	90.9	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	90.2	90.2	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
20	3600	91.0	90.6	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	91.7	91.7	91.7	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.0	90.6	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
25	3600	91.7	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.7	91.0	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
30	3600	91.7	91.4	89.5	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.7	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	91.7	91.7	90.9	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
40	3600	91.7	91.7	90.2	89.3	86.6	86.1	87.0	89.0
	1800	93.6	93.0	92.8	91.7	78.2	78.2	83.0	84.5
	1200	92.4	92.4	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.0	90.9	90.2	70.0	70.5	70.0	70.5
50	3600	92.0	92.0	90.2	89.3	85.1	86.7	89.0	89.0
	1800	93.6	93.0	92.8	91.7	79.5	79.4	82.5	82.5
	1200	92.4	92.4	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.7	90.9	90.9	78.5	72.9	78.5	80.0
60	3600	92.7	93.0	91.7	90.9	85.8	88.3	87.5	89.0
	1800	93.6	94.1	93.5	92.8	80.5	79.9	80.5	80.5
	1200	93.0	93.0	92.8	91.7	81.5	81.5	81.5	81.5
	900	92.4	91.7	91.7	90.9	79.5	73.2	79.5	79.5
70	3600	93.6	93.6	91.7	91.7	87.1	88.5	88.5	88.5
	1800	94.5	94.5	93.5	93.5	81.0	81.5	81.0	81.5
	1200	93.6	93.5	93.5	92.8	82.0	82.0	82.0	82.0
	900	92.8	92.4	92.8	91.7	80.5	74.5	80.5	81.0
100	3600	93.6	93.3	91.7	90.7	87.0	88.2	87.0	88.5
	1800	95.1	94.5	94.0	93.5	81.0	81.0	81.0	81.0
	1200	93.6	93.6	92.8	92.8	82.1	81.7	85.5	85.5
	900	93.5	92.4	92.8	91.7	77.0	77.3	77.0	80.0
125	3600	93.6	93.7	91.7	91.7	86.4	89.1	87.0	90.5
	1800	94.5	94.7	93.5	92.8	85.4	85.5	87.5	86.0
	1200	93.6	94.1	93.5	92.8	82.7	82.3	85.5	85.5

TABLE 1									
MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
	900	93.5	93.0	92.8	92.4	78.5	78.5	78.5	78.5
150	3600	93.6	93.7	92.4	91.7	86.5	90.0	86.5	90.5
	1800	95.0	95.2	94.5	94.0	82.5	85.0	84.5	85.0
	1200	94.5	94.5	93.5	94.0	81.5	81.5	81.5	81.5
	900	93.5	93.0	92.8	92.4	78.0	78.5	78.0	78.5
200	3600	94.3	94.3	92.4	93.0	87.8	89.4	91.0	91.0
	1800	95.0	95.2	94.0	94.0	85.2	86.5	87.0	87.0
	1200	94.5	94.5	93.5	93.5	79.0	82.5	79.0	82.5
250	3600	94.3	94.7	91.7	92.4	85.0	86.5	85.0	96.5
	1800	85.4	95.4	94.5	94.5	79.0	79.0	79.0	79.0
	1200	95.0	94.5	94.5	93.5	82.0	82.0	82.0	82.0
300	3600	93.7	94.3			89.8	89.9		
	1800	95.4	95.2	94.5	94.0	80.0	80.0	800	80.0
	1200	93.7	93.7			84.5	90.1		
350	3600	94.3	94.7			89.4	85.9		
	1800	94.7	94.7			85.9	85.9		
400	3600	94.3				88.4			
	1800	9437				86.8			
450	3600	94.7				89.1			
500	3600	94.7				88.3			

SECTION 16450

GROUNDING

PART 1 GENERAL

1.01 SCOPE

A. Provide and install grounding system as shown on drawings and as specifies herein complete in place.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American National Standards Institute (ANSI): C2, National Electrical Safety Code (NESC).
   2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

B. Submittals
   1. 1. Shop Drawings:
      a. a.Product Data:
         1) Exothermic weld connectors.
         2) Mechanical connectors.
         3) Compression connectors.

C. UL Compliance
   1. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PART 2 PRODUCTS

2.01 GROUND ROD

A. Material: Copper clad.

B. Diameter: Minimum 5/8 inch.

C. Length: 20 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 16120, CONDUCTORS.

2.03 CONNECTORS

A. Exothermic Weld Type:
   1. Outdoor Weld: Suitable for exposure to elements or direct burial.
   2. Indoor Weld: Use low-smoke, low-emission process.
   3. Manufacturers:

a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
b. Thermoweld.

B. Compression Type:
1. Compress deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels pre-filled with oxide inhibiting and anti-seizing compound and sealed.
5. Manufacturers:
a. Burndy Corp.
b. Thomas and Betts Co.
c. Ilso Corp.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.
1. Manufacturers:
a. Burndy Corp.
b. Thomas and Betts Co.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers:
1. Christy Co.; No. G5.
2. Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 EXECUTION

3.01 GENERAL

A. Grounding shall comply with NFPA 70 and ANSI C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

F. Shielded Control Cables:
1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum I inch at termination to field instrument and apply heat shrink tube.
3. Do not ground control cable shield at more than one point.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to non-current carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to non-current carrying grounding bus.

C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

3.05 GROUNDING WELLS

A. Install inside buildings, asphalt, and paved areas.

B. Install riser ring and cover flush with surface.

C. Place 9 inches crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:
   1. Above grade Connections: Use exothermic weld, mechanical, or compression-type connectors.
   2. Below grade Connections: Install exothermic weld type connectors.
   3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
   4. Notify Engineer before backfilling ground connections.

B. Exothermic Weld Type:
   1. Wire brush or file contact point to bare metal surface.
   2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
   3. Avoid using badly worn molds.
   4. Mold to be completely filled with metal when making welds.
   5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:
   1. Install in accordance with connector manufacturer's recommendations.
   2. Install connectors of proper size for grounding conductors and ground rods specified.
   3. Install using connector manufacturer's compression tool having proper sized dies and proof of calibration within the last 12 months.

D. Mechanical Type:
   1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
   2. Install in accordance with connector manufacturer's recommendations.
   3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each.

B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all non-current carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of substation transformers to substation grounding grid and system grounding network.

C. Bond neutrals of pad-mounted transformers to four locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

3.11 INSTRUMENT GROUND - SURGE SUPPRESSION

A. Connect all instrument surge protection with #6 insulated copper groundwire (in conduit where above grade) to closest plant ground system

3.12 BONDING

A. Bond to Main Conductor System:

B. All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.

C. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.

D. Provide air terminals as required.

E. Bond steel columns or major framing members to grounding system per National Electrical Code.

F. Bond each main down conductor to grounding system.

G. All conduits terminations in panels shall be grounded using appropriate ground bushing and conductor to nearest ground point.

3.13 GROUNDING SYSTEM

A. Grounding Conductor:

B. Completely encircle building structure.

C. Bury minimum 30 inches below finished grade.

D. Minimum 2 feet distance from foundation walls.

E. Interconnect ground rods by direct-buried copper cables.

F. Connections:
   1. Install ground cables continuous between connections.
   2. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and non-accessible connections.
   3. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
   4. Use bolded offset parapet bases or through-roof concealed base assemblies for air terminal connections.
   5. Provide interconnections with electrical and telephone systems and all underground water and metal pipes.
   6. Provide electric service arrestor ground wire to building water main.

3.14 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection:
   1. Equipment and circuit grounds in motor control centers, panelboards, switchboards, and switchgear assemblies for proper connection and tightness.
   2. Ground bus connections in motor control centers, panelboards, switchboards, and switchgear assemblies for proper termination and tightness,
   3. Effective transformer core and equipment grounding.
   4. Accessible connections to grounding electrodes for proper fit and tightness.
   5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:
   1. Fall-Of-Potential Test:
      a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
      b. Main ground electrode system resistance to ground to be no greater than 5 ohms.
   2. Two-Point Direct Method Test:
      a. In accordance with IEEE 81, Section 8.2. 1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
      b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

END OF SECTION

SECTION 16480

LOW VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American National Standard Institute (ANSI):
      a. C2, National Electrical Safety Code (NESC).
      b. C57.12.28, Switchgear and Transformers - Pad-Mounted Equipment-Enclosure Integrity.
      c. Z55, Gray Finishes for Industrial Apparatus and Equipment.
   2. National Electrical Manufacturers Association (NEMA):
      a. AB 1 Molded Case Circuit Breakers.
      b. ICS 1, General Standards for Industrial Control and Systems.
      c. ICS 2, Standards for Industrial Control Devices, Controllers, and Assemblies.
      d. ICS 2.3, Instructions for Handling, Installation, Operation, and Maintenance of Motor Control Centers
      e. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
      f. 250-1997, Enclosures for Electrical Equipment (1,000 volts maximum).
   3. National Fire Protection Association (NFPA): 70-90, National Electrical Code. (NEC) Latest Edition.
   4. Underwriters Laboratories, Inc. (UL):
      a. 98, Standard for Safety Enclosed and Dead-Front Switches, Eleventh Edition.
      b. 489, Standard for Safety Molded Case Circuit Breakers and Circuit Breaker Enclosures, Seventh Edition.
      c. 845, Standard for Safety Motor Control Centers, Third Edition.
      d. 508A Industrial Control Equipment.
   5. Uniform Building Code (UBC): Section 2312, Earthquake Requirements.
   6. InterNational Electrical Testing Association (NETA) Acceptance Testing Specifications, latest edition.
   7. Institute of Electrical and Electronics Engineers (IEEE):
      a. 112, latest revision, Standard Test Procedure for Polyphase Induction Motors and Generators
      b. 43, latest edition, Recommended Practice for Testing Insulation Resistance of Rotating Machinery

1.02 SUBMITTALS

A. Shop Drawings:
   1. Itemized bill of material.
   2. Descriptive information.
   3. Dimensional drawings.
   4. Conduit entrance locations/provisions.
   5. Bus data including horizontal and vertical bus capacities, voltage rating and interrupting capacity. Include materials of construction

6. Protective Devices: Copies of time-current characteristics.
7. Anchoring instructions and details.
8. Typed tabulation:
    a. Motor name; tag (equipment) numbers as shown on Drawings.
    b. Motor horsepower.
    c. Nameplate full load current.
    d. Measured load current and voltage.
    e. Heater catalog number.
    f. Protective device trip settings.
9. Attach above typed, tabulated data to a copy of starter manufacturer's overload heater selection tables for the starters provided.
10. Control Diagrams:
    a. NEMA ICS 2, Section 322.08 Type I.
    b. Wiring Type B.
    c. In addition to standard NEMA control diagrams, provide the following:
        1) Remote control devices.
        2) Remote indication and/or pilot lights.
        3) Interconnections and interlocking circuits between starter and remote equipment.
        4) Remote sensors.
        5) Tag numbers associated with all control devices and equipment.
        6) Clearly identify items provided by others.
11. One-line diagrams.
12. Schematic (elementary) diagrams. Custom schematics shall be furnished.Diagrams shall include all remote devices. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the CONTRACTOR stamped "REJECTED-RESUBMIT."
13. Outline diagrams.
14. Interconnection diagrams.
15. Enclosure NEMA rating and color.
16. Ground bus size and material of construction.
17. Main incoming line entry provision (top or bottom).
18. Control unit nameplate schedule.
19. All circuit breaker types, frames and settings.
20. All starter NEMA sizes, auxiliary contact provisions, coil voltage Relays, timers, pilot devices, control transformer VA and fuse sizes.
21. Short circuit rating of the complete assembly.
22. Replacement parts lists and operation and maintenance procedures.
23. Plan and elevation dimensional views of each MCC section.

B. Quality Control Submittals:
    1. Manufacturer's installation instructions.
    2. Operation and Maintenance Manual.
    3. Factory test reports, certified.

1.03 UL COMPLIANCE

A. Products manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL Listing Mark. Where shown or required motor control centers shall be suitable for service entrance.

1.04 PACKING AND SHIPPING

A. Shipping Splits: Established by CONTRACTOR to facilitate ingress of equipment to final installation location within the building.

1.05 RESPONSIBILITIES

A. The information provided on the drawings is for guidance only and does not limit the equipment size. When motors furnished differ from the expected rating indicated the CONTRACTOR shall make the necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate the motors actually installed.

1.06 INSPECTION COORDINATION

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cutler-Hammer.

B. Square D.

C. General Electric

D. Or approved equal.

2.02 MOTOR CONTROL

A. General:
   1. Provide each motor with a suitable controller and devices that will function as specified for the respective motors and meeting NEMA ICS 2, (class A), the NEC, and UL.
   2. Like Items of Equipment: Same manufacturer as low voltage switchboard and panelboards for standardization. Devices of the same type shall be products of the same manufacturer. This requirement applies to all control devices, and insofar as practical, to equipment manufactured on a production basis. It also applies without exception to equipment custom fabricated for this project.
   3. Make adjustments as necessary to wiring, conduit; disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.
   4. Overload Protection:
      a. Each motor shall have a direct current sensing solid-state overload protection in all ungrounded phases. This protection shall have current overload relays sensitive to motor current, and mounted within the motor controller. Reset of the protection shall be manually activated with

externally operated reset button. All overload protection devices shall be the inverse time limit type and match the motor characteristic.

5. Control Transformer:
   a. Two winding, 120-volt secondary, primary voltage to suit.
   b. Two current-limiting fuses for primary circuit.
   c. One fuse in secondary circuit.
   d. Mount within starter unit.
6. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C capacity.
7. Lifting lugs on all equipment and devices weighing over 100 pounds.
8. Anchor Bolts: Galvanized, sized by equipment manufacturer.
9. Operating Conditions:
   a. Ambient Temperature: Maximum 40 degrees C.
   b. Equipment to be fully rated without any derating for operating conditions listed above.
10. Enclosures: In accordance with NEMA 250 and ANSI C57.12.28.
11. Equipment Finish:
   a. Electro-coating process applied over a rust-inhibiting phosphated base coating.
   b. Exterior Color: Manufacturer's standard.
12. All manual starters and combination motor starters shall be lockable in the off position.

B. Manually Operated Starter, Fractional Horsepower:
1. Rating: 16 amperes continuous at 277 volts maximum.
2. Single-phase, non-reversing, full voltage with overload protection.
3. Toggle operated, keyed where shown.
4. Enclosure: NEMA 250, Type 4, unless shown otherwise.
5. Neon Light: Red.
6. Handle guard/lock-off attachment.

C. Manually Operated Starter, Integral Horsepower:
1. Rating: Horsepower rated to maximum of 10 horsepower at 600 volts with overload protection.
2. Single or three-phase, non-reversing, full voltage.
3. Control: Toggle or pushbutton.
4. Enclosure: NEMA 250, Type 4, unless shown otherwise.
5. Red pilot light in series with an auxiliary contact.
6. Locking in OFF position.
7. Two spare auxiliary, field-convertible contacts.

D. Combination Full-Voltage, Magnetic Starter:
1. Rating: Horsepower rated at 600 volts, UL labeled for 100,000 amperes with overload protection.
2. Three-phase, non-reversing, full voltage.
3. Control: As shown.
4. Disconnect Type: Motor circuit protector.
5. Enclosure: As shown.
6. Pilot Lights: As shown.
7. Pad-lockable operating handles.

2.03 MOTOR CONTROL CENTERS

A. General:
   1. In accordance with NEMA ICS 2 and UL 845.
   2. The motor control centers shall be 600-volt class suitable for operation on a three-phase, 60-Hz system. The system operating voltage and number of wires shall be as indicated, on project drawings.
   3. MCC designated as service entrance rated shall include provision for termination of an incoming neutral conductor in conformance to NEC requirements.
   4. Short Circuit Rating: Amperes rms symmetrical as shown on Drawings for entire motor control center as a complete assembly.
   5. All controllers, main and branch circuit breakers, wire connections, and other devices to be front mounted and accessible unless otherwise noted.
   6. NEMA ICS 2, Section 322.08.
      a. Class: IIS.
      b. Type: B. Diagrams and wiring.
      c. Provide blank spaces on interconnection diagrams to add control conductor code designations during installation of equipment.
   7. Size and Arrangement
      a. Motor control centers shall be of mechanical groupings of control center units, assembled into a lineup of control center sections. Each control section shall be nominally 90-inches tall by minimum 20-inches deep.
      b. MCC's shall be designed to not exceed the space requirements as indicated on the Contract Drawings, including spaces, spares, and future compartments. MCC's shall be subject to rejection for exceeding the lengths indicated where allotted space is critical.
      c. Equipment within the MCC may be rearranged at the discretion of the manufacturer, providing the MCC provides the spares, space, and future provisions indicated.
      d. All switches and circuit breakers used as switches shall be located so that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, will not be more than 6-feet 7-in.

B. Enclosure:
   1. Type: NEMA 250, Type 1, gasketed.
   2. Construction:
      a. Sheet steel reinforced with channel or angle irons.
      b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
      c. Removable top cover plates and bottom cover plates.
      d. Removable plates on end panels for future bus extension.
      e. Structural members shall be fabricated of not less than 12 gauge steel and side and top panels and doors shall be not less than 14 gauge steel.
   3. Section Mounting: Removable formed-steel channel sills and lifting angles.
   4. Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.
   5. Vertical Wiring Compartment: Full height, isolated from unit starters with separate door.
   6. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.

7. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.
8. Door Interlocking: Interlock starter and feeder doors mechanically so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access at any time.
9. External disconnect handles, pad-lockable in OFF position.
10. Cable Entrance: Main leads enter as shown on the Drawings. Control and feeder circuits enter from top and bottom.
11. Spaces designated as "SPACE" or "BLANK" shall include blank hinged doors and vertical bus bars.
12. Control units inside compartments shall be clearly identified with tags or stencil markings.
13. Each control unit including spares, spaces and blanks, lights, and devices shall be identified by an engraved nameplate. Identification shall include circuit number as indicated.
14. Each motor control center shall be fitted with the manufacturer's nameplate which shall include the NEMA Standard electric rating and other pertinent data, including manufacturer, sales order number, date of manufacture, and place of manufacture.
15. Where "L" or "U" shaped MCC layouts are indicated, corner compartments shall have similar current and short circuit ratings as functional compartments.
16. Fans, heat exchangers, transformers, capacitors, junction boxes, or other devices may not be mounted on the outside of the motor control center enclosure.
17. Finish for motor control center shall be light grey, ANSI 61. The panels shall be given 2 coats of primer inside and out and 2 coats of enamel finish. External colors other than ANSI 61 will not be acceptable.
18. Each section shall be dead-front and dead-back construction. Rear access shall not be necessary for inspection and maintenance. The structure arrangement shall be for front only mounting of units.
19. Power cables to the motor control center shall be either top or bottom feed as indicated on the project drawings. Provide all necessary lugs, clamps, and supports to terminate incoming power cables.

C. Bus:
1. Horizontal Power Bus:
    a. Three-phase tin-plated, copper, entire width of control center, rated as indicated.
    b. Silver-plated at joints.
    c. Construct to allow future extension of additional sections.
    d. Pressure type solderless lugs for each incoming line cable.
    e. Isolated from top horizontal wireway.
    f. Provide Belleville washers on bus connection bolts.
2. Vertical Power Bus:
    a. Three-phase tin-plated, copper, full height of section, rated as required by the load but not less than 300 amperes, minimum.
    b. Silver-plated at joints.
    c. Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.
    d. Insulated and isolated barrier complete with shutters.
    e. Provide Belleville washers on bus connection bolts.
3. Neutral Bus: None.

4. Ground Bus:
    a. Copper, tin-plated, 33 percent minimum of phase bus ampacity, entire width of control center.
    b. Provide Belleville washers on bus connection bolts.
5. Bus Bracing: 65,000 amperes rms symmetrical.

D. Motor Controller Unit:
1. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.
2. Each motor starter unit shall consist of a combination magnetic contactor and short circuit protective device. Short circuit protective device shall be an instantaneous, magnetic only circuit breaker or thermal magnetic circuit breaker as defined in the project one line diagrams. All circuit breakers provided as part of a motor starter unit shall be capable of being padlocked in the open position. Reset of thermal overload elements shall be possible with unit door closed. Three phase overload trip units shall be furnished to suit the full load current of the equipment installed. Overload relays shall be solid state type capable of detecting phase loss and ground faults and shall meet NEMA class 20 tripping characteristics.
3. Magnetic starters shall have auxiliary contacts as required by electrical motor control diagrams, including N-O and N-C contacts as indicated, plus one each spare N-O and N-C contact. As a minimum, provide one normally open and one normally closed auxiliary contact.
4. Each starter unit shall have its own control power transformer. It shall have a 115-volt grounded secondary. One secondary fuse and 2 primary fuses shall be provided. Control power transformers shall be sized to accommodate the control devices indicated. Minimum transformer size is 50 VA. Local control devices shall be mounted independently of the cover door. All starters shall have a local "running" lamp and a "off" light to indicate the presence of control power when the motor is not running. Indicating lights shall be push-to-test type. Starters shall be provided with elapsed time meters, hand/off/auto selector switches, and other devices as indicated. All cubicle control wires shall be terminated at a pull apart disconnecting terminal block at the cubicle.
5. The motor control center manufacturer shall be responsible for identifying each control wire within each motor starter unit with wrap-around permanent plastic markers. Each control wire shall be identified at both ends. Markers shall be produced from a device specifically made to produce tags, such as manufactured by Brady Corporation or Thomas & Betts. Hand lettered markers are not acceptable.
6. Motor starters shall be designed to NEMA ratings. Starters designed to IEC ratings or with dual IEC/NEMA ratings will not be acceptable, either as part of any MCC, as remote starters, or as part of any equipment package.
7. Construction:
    a. Draw out combination type with stab connections for starters NEMA ICS, Size 4 and smaller. The fixed-type unit assembly shall be constructed so that it can be easily removed from its panel after disconnecting the wires to the terminal block and withdrawing from the primary bus. Removal of a unit assembly shall be possible without rear access and without disturbing any other unit in the motor control center.

b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 5 and larger.
c. Readily interchangeable with starters of similar size.
d. Pull-apart unit control wiring terminal boards on all units.

E. Starters:
1. NEMA ICS 2, Section 322.08 standard rating, except none smaller than NEMA ICS, Size 1.
2. Rating: Horsepower rated at 600 volt, UL labeled for 65,000 amperes with overload protection.
3. Three-phase, non-reversing, unless otherwise shown.
4. Disconnect Type: Motor circuit protector.
5. Combination Full Voltage, Magnetic Starter:
   a. Control: As shown.
   b. Pilot Lights: Red-ON and Green-OFF.
6. Combination Reduced Voltage Auto-Transformer Starters:
   a. Reduced voltage auto-transformer starters shall consist of a molded-case motor circuit protector in combination with a closed transition type auto-transformer starter with 50 percent, 65 percent, and 80 percent taps, and shall be set on the 65 percent tap.
   b. The starter shall have three phase solid state overload relays capable of sensing phase loss and ground fault with manual reset.
   c. The auto-transformer shall include a thermal switch wired to protect itself from overheating.
   d. Timing of the starting period shall be controlled by an adjustable accelerating relay. Requirements set forth in paragraph 2.03 for enclosures and devices apply herein.
7. Solid State Reduced Voltage Starters:
   a. Solid state reduced voltage starters shall meet the requirements of UL 508 and shall consist of an incoming power circuit breaker, a power section; logic board, isolation contactor, and paralleling full load bypass contactor.
   b. Soft Starters shall conform to the following:
      1) The SCR-based power section shall consist of 6 back-to-back SCRs, two SCRs per phase, and shall be rated for a minimum peak inverse voltage rating of 2.5 times line voltage, 1200 PIV for 480 volts. Units using triacs or SCR/diode combinations shall not be acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt characteristics of the electrical system.
      2) Starters shall include the following logic and control functions:
         a) Adjustable maximum starting current from 200 percent to 500 percent
         b) Ramp time adjustment from 1 to 40 seconds
         c) Adjustable linear voltage deceleration
         d) Kick start
         e) Phase loss protection
         f) Adjustable Undervoltage/ overvoltage protection
         g) Current unbalance protection
         h) Instantaneous overcurrent detection.
         i) Phase rotation protection (prevents starting)
         j) Shorted SCR detection.

k) Selectable Class 10, 20, 30 electronic overload protection. Heat sink over temperature protection shall be provided.
l) Dry contacts for remote indication of RUN and TRIP status
m) Battery “back up” of set starter parameters.
n) Event recorder.
o) Elapsed time meter.
p) LCD status display.

3) The paralleling bypass contactor shall energize when the motor reaches full speed. The contactor shall be fully rated for across-the-line starting duty. The effect of the bypass contactor during normal operation is the elimination of heat buildup resulting from the voltage drop across the SCR’s. The bypass contactor may also be used as a means of starting the motor should problems be encountered with the soft starter. A door mounted selector switch shall be furnished such that the starting means can be selected as being either via the soft starter or via the bypass contactor as across-the-line.
4) An isolation contactor shall be supplied. The isolation contactor shall remove three phase power from the input side of the solid state controller when the bypass contactor is selected for across-the-line starting
5) The starter shall be housed in an appropriate NEMA rated enclosure as directed by project drawings. Heaters and cooling fans shall be provided if required to maintain the equipment within the manufacturer’s environmental guidelines.
6) The enclosure shall be of two-door compartment type construction. The left hand compartment shall contain the starter power section and any equipment rated at line voltage. The right hand compartment shall include only that equipment rated at 120 VAC or less including the starter’s CPU PC card and LCD display. The enclosure shall include a partition dividing the two compartments. Each compartment shall be designed to provide a barrier between the equipment at line voltage and the equipment at 120 VAC or less
7) The starter shall be provided with a control power transformer sized to accommodate all controls indicated on the Contract Drawings. An input power circuit breaker shall be provided. Lug termination of the incoming power conductors shall not be permitted. The starter and circuit breaker shall be rated for 65 KAIC RMS at 480V.
8) The starter shall have door mounted indication of run, phase rotation, phase loss, undervoltage, current unbalance, and current trip.
9) Door mounted LCD / keyboard display assembly designed to:
a) Set or examine operating parameters.
b) Provide starter status information.
c) Provide real-time information about line current, voltage, and frequency.
d) Provide a means to start and stop the starter

c. Pad-lockable operating handle when de-energized.
d. Unit door interlocked to prevent opening when disconnect is in closed position.
e. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.

f. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

8. Two Speed Starters:
   a. Two Speed Starters shall be of the two-winding type unless otherwise indicated.
   b. Requirements set forth in paragraph 2.03 for enclosures and devices apply herein.
9. Disconnecting Device:
   a. In each starter, control circuit disconnect to de-energize circuits in unit which are not de-energized by starter power disconnect device.
   b. Pad-lockable in OPEN position.
10. Circuit Breaker:
   a. Meeting the requirements of NEMA AB1 and UL 489.
   b. Molded case with manufacturer's recommended trip setting for maximum motor protection.
   c. Magnetic trip only.
   d. Tripping indicated by operating-handle position.
   e. Interrupting capacity required for connection to system with short circuit capacity indicated.
11. Fused Switch:
   a. Heavy-duty, motor rated load-break, quick-make, quick-break type meeting the requirements of UL 98 and NEMA KS 1.
   b. Current-limiting fuses, with rejection clips.
12. Load Detector Relay:
   a. Manual reset with adjustable differential.
   b. Manufacturer:
      1) Cutler-Hammer; Type D60LA.
      2) Allen-Bradley; Bulletin 2100.
13. Motor Overload Protection:
   a. Direct current sensing solid-state overload protection in all ungrounded phases.
   b. Manual-reset overload relays.
14. Motor Thermal Protector Interface: Manual-reset interposing relay for connection to motor-mounted thermal protector system.
15. Ground Fault Protection: Where indicated and as specified in paragraph Feeder Units and Main Protective Device, except provide instantaneous operation device.
16. Capacitor Connection: Terminals to allow easy connection of power factor correction capacitors on source side of starter overload relays on starters where capacitor connection is shown.

F. Control Unit:
1. Disconnecting Device: Capable of de-energizing external source control circuits in unit.
2. Control Devices: As indicated and as specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.
3. Control Wiring:
   a. Minimum wire size 14 AWG copper.
   b. Permanent sleeve type markers with wire numbers applied to each end of wires.
   c. Terminate wires using insulated locking fork or ring type crimp terminals.
   d. Terminate current transformer leads on shorting type terminal blocks.

G. Incoming Line Terminal:
   1. Construction: As specified in Paragraph Motor Controller Unit.
   2. Incoming Service Feeder: Cable entering section as shown.
   3. Maximum short-circuit rating of 65,000 amperes.
   4. Mechanical type CU-/AL lugs for 75 degrees C cable.

H. Feeder Unit and Main Protective Device:
   1. Construction: As specified in Paragraph Motor Controller Unit.
   2. Incoming Service Feeder: Cable entering section as shown.
   3. Molded Case Circuit Breaker:
      a. In accordance with NEMA AB 1 and UL 489.
      b. Main and feeder protective device.
      c. UL labeled as suitable for service entrance.
      d. Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.
      e. Indicate tripping by operating-handle position.
      f. Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.
      g. Circuit breakers having a frame size of 150 amperes or less shall be molded-case type with thermal magnetic non-interchangeable, trip-free, sealed trip units.
      h. Circuit breakers with a frame size of 225 amperes to 1,200 amperes shall be molded case with interchangeable thermal and adjustable magnetic trip or RMS sensing electronic trip elements.
      i. The interrupting capacity of all main, and feeder branch circuit breakers shall be a minimum of 65,000 RMS symmetrical amperes. Service disconnects rated 1000A or more shall provide ground fault protection of equipment.
   4. Ground Fault Protection:
      a. Suitable for 480-volt, three-phase, three-wire, solidly grounded wye system.
      b. Ground sensors to encircle all phase conductors and neutral conductor where used and connected to ground relays with adjustable pickup settings and time-current characteristics indicated.
      c. Circuit breaker shunt trip and relay operating from fused 120-volt ac control source within control center.
      d. Manufacturers:
         1) Ground Fault System ITE; Ground Shield.
         2) General Electric; Ground Break.
   5. Phase Monitoring Relay:
      a. Three-phase monitoring relay to protect against low voltage, voltage unbalance, and phase reversal.
      b. Manufacturer: Furnas; Class 47.

I. Instruments:
   1. Provide solid state type metering where indicated. Include CT's and PT's of ratios as indicated.
      a. Solid state “metering” shall include but not be limited to the following functions:
         1) Metering: Device shall monitor Voltage (VLL/VLN), Current (Amps per phase), Real Power (W), Reactive Power (VAR) and Apparent

Power (VA). Device shall have data gathering ability for analysis. The device(s) shall conform to the requirements of UL 508.

2) Alarms: Device shall utilize assignable output relays to trigger alarms for specific applications. Alarm messages shall be displayed on the front panel of the device. Alarm outputs via dry contacts shall alarm Over/Under Current, Over/Under Voltage, Current Unbalance/Neutral Current, Phase Sequence, Over/Under Frequency, Power Factor and Switch Inputs.

3) Communications: Device shall be able to communicate with current and future process control systems using standard protocols such as Devicenet, Ethernet, Modbus, Profibus, or as called for on project drawings. Front and rear panel communications ports shall be available for information access. Display of monitored values shall be available both locally and remotely.

J. Pushbuttons, selector switches, and pilot lights shall be the heavy-duty, oil-tight type, sized to 30 mm. Miniature style devices are not acceptable. All devices shall conform to the requirements of UL 508.
   1. Lens colors for “run”, “stop”, “on”, “off”, “open”, and “closed” shall be coordinated with the District’s requirements.
   2. Pilot lights shall be LED, push-to-test type.
   3. Provide hazardous location type pilot devices in classified locations per the NEC.

K. Elapsed Time Meters: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

L. Time Delay Relays: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

M. Relays shall be 3 PDT with 10 amp contacts, plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips.

N. Reset Timers: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

O. Nameplates:
   1. Laminated plastic; white, engraved to black core.
   2. Provide for each motor control center and each unit.
   3. Engrave with inscription shown on single-line diagram.
   4. Provide blank nameplates on spaces for future units.
   5. Attach with stainless steel pan head screws on face of control center.

P. Factory Testing: NEMA ICS 1, Section 109.

2.04 SPARE PARTS

A. The CONTRACTOR shall furnish the following for each MCC as a minimum:
   1. One unit control transformer or power supply of each size furnished in magnetic starters or solid state reduced voltage starter installed in MCC.

B. Spare parts shall be identified by MCC number, type, size, and manufacturer

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with NEMA ICS 2.3, Submittal Drawings, and Manufacturer's Instructions and Recommendations.

B. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Install equipment plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

E. Grout mounting channels into floor or mounting pads.

F. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.

G. Motor control centers shall be installed on 3-1/2-inch concrete pads. After leveling and shimming, the CONTRACTOR shall anchor motor control centers to concrete pads, and shall grout so that no space exists between the pad and support beams.

H. The CONTRACTOR shall:
   1. Torque all bus bar bolts to manufacturer's recommendations. Tighten all sheet metal and structure assembly bolts.
   2. Adjust all Motor Circuit Protector (MCP) devices to the instantaneous trip setting position recommended for the actual horsepower and full load amps of the motor. Verify that overload devices are proper for equipment installed; make necessary changes in overload devices as required for motors having power factor correcting capacitors.
   3. After equipment is installed, touch up scratches and verify that nameplate, and other identification is accurate.
   4. Provide high voltage switchboard matting in front of the MCC. The mat shall be 1/4-inch thick and 36-inches wide.

3.02 TESTING

A. Factory Test: All motor control centers, micro processor based soft starters and their components shall be given manufacturer's standard electrical and mechanical production tests and inspections. The tests shall include electrical continuity check, dielectric tests for each circuit, and inspection for proper functioning of all components including controls, protective devices, metering, and alarm devices.

B. Field Test MCC:
   1. Visual and mechanical inspection after installation
      a. Inspect for physical damage, proper anchorage, and grounding
      b. Verify that the ratings of the solid state overload relays match the motor full-load current nameplate data.
      c. Check tightness of bolted connections.

C. Electrical Tests
   1. Insulation tests
      a. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute. Test voltage and minimum acceptable resistance shall be in accordance with manufacturer's recommendations.
      b. Measure insulation resistance of each starter section phase to phase and phase to ground with the starter contacts closed and the protective device open. Test voltage and minimum acceptable resistance shall be in accordance with the manufacturer's recommendations.
      c. Measure insulation resistance of each control circuit with respect to ground
   2. Verify proper operation of control logic in all modes of control.

3.03 CIRCUIT BREAKERS

A. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.

B. Adjust to approximately Il times motor rated current.

C. Determine motor rated current from motor nameplate following installation.

3.04 OVERLOAD RELAY

A. Adjust overload relays after the actual nameplate full-load current rating of motor has been determined.

3.05 MOTOR DATA

A. Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
   1. Motor served by tag number and equipment name.
   2. Nameplate horsepower.
   3. Motor code letter.
   4. Full load amperes.
   5. Service factor.
   6. Installed overload relay heater catalog number.

3.06 MANUFACTURERS' SERVICES

A. Furnish manufacturer's representative in accordance for the following services at jobsite or classroom as designated by OWNER, for minimum person-days listed below, travel time excluded:
   1. One (1) person-day for installation assistance, and inspection of installation.
   2. One (1) person-day for functional and performance testing.
   3. One (1) person-day for plant startup.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install lighting fixtures, and accessories for all lighting systems, complete and operable, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Electrical General Provisions.

1.03 REFERENCES

1. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section:
2. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL):
5. 595, Standard for Safety Marine-Type Electric Lighting Fixtures.
6. 844, Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
7. 924, Standard for Safety Emergency Lighting and Power Equipment.
8. ANSI C82.1-1977 Specifications for Fluorescent Lamp Ballasts
9. ANSI C84.4-1978 Specifications for High Intensity Discharge Lamp Ballast (Multiple Supply Type)
10. Standards of the Certified Ballast Manufacturers Association

1.04 SUBMITTALS

A. The Contractor shall submit the following in accordance with the requirements of the Section entitled "Submittals."

1. Shop drawings and catalog data:
    a. Interior Luminaires:
        1) Catalog data sheets and pictures.
        2) Luminaire finish and metal gauge.
        3) Lens material, pattern, and thickness.
        4) Candle power distribution curves in two or more planes.
        5) Candle power chart 0 to 90 degrees.
        6) Lumen output chart.
        7) Average maximum brightness data in foot-lamberts.
        8) Coefficients of utilization for zonal cavity calculations.
        9) Mounting or suspension details.
        10) Heat exchange and air handling data.

b. Exterior Luminaires:
    1) Catalog data sheets and pictures.
    2) Luminaire finish and metal gauge.
    3) Lens material, pattern, and thickness.
    4) IES lighting classification and isolux diagram.
    5) Fastening details to wall or pole.
    6) Ballast type, location, and method of fastening.
    7) For light poles, submit wind loading, complete dimensions, and finish.
c. Lamps:
    1) Voltages.
    2) Colors.
    3) Approximate life (in hours).
    4) Approximate initial lumens.
    5) Lumen maintenance curve.
    6) Lamp type and base.
    7) Copy of lamp order, including individual quantities, for Project.
d. Ballasts:
    1) Type.
    2) Wiring diagram.
    3) Nominal watts and input watts.
    4) Input voltage and power factor.
    5) Starting current, line current, and re-strike current values.
    6) Sound rating.
    7) Temperature rating.
    8) Efficiency ratings.
    9) Low temperature characteristics.
    10) Emergency ballasts rating and capacity data.
e. Photo-Time Control:
    1) Wiring diagram.
    2) Contact ratings.
f. Photocells:
    1) Voltage, and power consumption.
    2) Capacity.
    3) Contacts and time delay.
    4) Operating levels.
    5) Enclosure type and dimensions.
    6) Temperature range.

2. Complete literature for each fixture substitution. Photoelectric data shall include coefficients of utilization, average brightness, candle power distribution curves, and lumen output chart. Substitutions for specified fixtures shall be based upon quality of construction, light distribution, appearance, and maintenance. Other makes of fixtures than those specified will be approved by the Engineer provided they are judged equal in all respects to the type specified
3. For exterior pole mounted applications, submit calculations signed and sealed by a professional structural engineer registered in the State of Florida, certifying that the outdoor pole and fixture installation, including pole, fixture, base and installation method will meet the appropriate wind loading criteria given by the Florida Building Code for the wind zone in which the assembly will be installed.

1.05 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.06 QUALITY ASSURANCE

A. Exterior lighting system operation shall be demonstrated during the hours of darkness to indicate that fixtures are properly focused, photo-cell operation is correct, and that fixture switching functions as intended. Similar requirements shall apply to interior lighting. Through demonstration, the Contractor shall also verify that panel schedules properly indicate the lighting outlets connected to each circuit.

B. Lighting demonstration shall occur within 2 weeks prior to project acceptance.

C. Lighting fixtures shall be stored in their original cartons from the manufacturers until the time of installation. Fixtures poles shall be stored on blocks above grade until the time of installation.

1.07 CLEANUP

A. Fixture lenses, diffusers and reflects shall be cleaned just prior to the time specified for the system demonstrations.

B. Contractor shall re-lamp all lighting fixtures with new lamps 30 days prior to acceptance.

C. Fixture trim, including poles and support brackets, where finish has been damaged, shall be refinished.

PART 2 PRODUCTS

2.01 FIXTURES - GENERAL

A. All fixtures shall be pre-wired with leads for connection to building circuits.

B. All fluorescent and HID fixtures shall be provided with internal fuses, whether indicated on the lighting fixture schedule or not.

2.02 EXTERIOR FIXTURES

A. Exterior fixtures and pole assemblies, in combination with their method of installation, shall be capable of meeting the wind loading criteria for the wind zone of installation as defined in the Florida Building Code. The wind loading requirement shall apply to the entire assembly including foundation (or base) and earthen materials used to secure the foundation or base. The calculation required under section 1.04.A.3 shall include this analysis.

B. Exterior fixtures shall have corrosion-resistant hardware and hinged doors or lens retainer. Fixtures specified to be furnished with integral photo-electrical control shall be of the fixture manufacturer's standard design.

2.03 INTERIOR FIXTURES

A. Interior fluorescent fixtures without diffusers shall be furnished with end plates. Where diffusers are required, they shall be of high molecular strength acrylic. Minimum thickness of the acrylic shall be 0.125 inches for all diffusers, except that those on 4 foot square fixtures

2.04 LUMINAIRES

A. Specific requirements relative to execution of Work of this section are located in the Luminaire Schedule on Drawings.

B. Feed-through type or separate junction box.

C. Ballasts: Two-lamp when possible.

D. Tandem wired for three-lamp, fluorescent fixtures.

E. Wire Leads: Minimum 18 AWG.

F. Component Access: Accessible and replaceable without removing luminaire from ceiling.

G. Soffit Installations:
   1. UL Labeled: SUITABLE FOR DAMP LOCATIONS.
   2. Ballast: Removable, pre-wired.

H. Exterior Installations:
   1. UL Labeled: SUITABLE FOR WET LOCATIONS.
   2. Ballast: Removable, pre-wired.
   3. When factory-installed photocells are provided, entire assembly shall have UL label.

I. Emergency Lighting:
   1. Power Pack: Self-contained, 120-volt transformer, inverter/charger, sealed nickel cadmium battery, and indicator switch in accordance with UL 924.
   2. Lighted push-to-test indicator.
   3. Capable of providing full illumination for 1-1/2 hours in emergency mode.
   4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
   5. Capable of protecting against excess charging and discharging.

J. Lamps
   1. Fluorescent:
      a. Type Efficiency: Energy.
      b. Color: Cool white.
   2. High Intensity Discharge:
      a. Type: Metal Halide.
      b. Color: Color corrected.
   3. Manufacturers:
      a. General Electric.
      b. Sylvania.
      c. North American Phillips.

K. Ballasts
   1. General:
   2. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
   3. Certified by electrical testing laboratories to conform to Certified Ballast Manufacturer's specifications.
   4. Fluorescent:
      a. Type: High power factor, energy efficient, rapid-start and instant-start type ballast, compatible with lamps specified.
      b. Sound Rating: Minimum A, maximum allowable noise level of 30 decibels measured 2 feet from installed fixture.
      c. Class: P.
      d. Automatic resetting, thermo-protector to prevent case temperature from exceeding 110 degrees C in the event of a short circuit.
   5. High Pressure Sodium:
      a. High power factor, normal ambient, 180 degrees C insulation class, with capacitor and igniter.
      b. Type:
         1) Autotransformer for 50-watt lamps.
      c. Constant wattage autotransformer for lamps 70 watts and above.
      d. Manufacturers:
         1) Magnetek Jefferson.
         2) Advance Transformer.
         3) Universal.
   6. Metal Halide:
      a. The Metal Halide Electronic Ballast shall not have more than +/- 0.5% variation in output power with a +/- 10% variation in input line voltage and shall not have more than +/- 3% variation in output power within all ranges of accepted ANSI lamp voltages.
      b. Electronic Ballast shall have a 'square wave' output whose frequency does not exceed 200 Hz and be equipped with a safety shutdown feature to prevent excessive pulsing of failed lamps.
      c. Electronic Ballast shall comply with FCC Part 18C, Class A. Furthermore, the manufacturer must show documentation showing that the ballast meets or exceeds the non-consumer limits for EMI & RFI.
      d. Electronic Ballast shall:
         1) Have a Total Harmonic Distortion (THD) of less than 10%.
         2) Have a Lamp Crest Factor of less than 1.3.
         3) Have a Power Factor of 95% or greater.
         4) Be sound rated "A."
         5) Be thermally protected to shut off when Temperatures reach unacceptable levels.
      e. The Electronic Ballast shall be UL Listed and shall carry a Five (5) Year Warranty.
      f. For down light fixtures, the Metal Halide Electronic Ballast shall be marked "Suitable for recessed use."
      g. The specified lamps shall be approved or warranted by the lamp manufacturer for use on the designated Metal Halide Electronic Ballast.
      h. The minimum rating of the Power Supply Electrolytic Capacitor(s) shall be 5000 hours at 105 degrees Celsius.

L. Lighting Control
   1. Photocell:
      a. Automatic ON/OFF switching photo control.
      b. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
      c. Setting: ON at dusk and OFF at dawn.
      d. Time delay feature to prevent false switching.
      e. Field adjustable to control operating levels.
      f. Manufacturers:
         1) Tork.
         2) Paragon.

M. Poles
   1. Rating (with Luminaire): Shall meet Florida Building Code and ASCE 7-98 requirements for wind zone of installation.
   2. Material: Extruded aluminum or concrete.

PART 3 EXECUTION

3.01 LIGHTING FIXTURES

A. Lighting fixtures shall be furnished complete with lamps at each outlet in accordance with the Fixture Schedule.

B. Lighting fixtures shall be installed plumb and square with building and wall intersections. Pendant-mounted fixtures, which are mounted from sloping ceilings, shall be suspended by ball hangers. Fixtures installed in machinery rooms shall be located after machines have been installed. In all cases, fixture locations shall be coordinated with work of other trades to prevent obstruction of light from the fixtures. Fixtures shall be installed in accordance with the architectural reflected ceiling drawings. Unless otherwise indicated, fixtures shall be centered on ceiling tiles. All fixtures and outlets shall be rigidly supported from the building structure or rigid conduit.

C. Recessed fixtures shall be installed light-tight to the ceiling and shall be provided with auxiliary safety supports attached directly to the building structure. Said safety supports shall consist of #10 AWG soft drawn galvanized wires.

3.02 LUMINAIRES

A. General:
   1. Install in accordance with manufacturer's recommendations.
   2. Provide proper hangers, pendants, and canopies as necessary for complete installation.
   3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount.
   4. Install plumb and level.
   5. Mounting heights shown for wall mounted or pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
   6. Install each luminaire outlet box with galvanized stud.

B. Pendant Mounted:
   1. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
   2. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
   3. Provide twin-stem hangers on single luminaires.

C. Pole Mounted:
   1. Provide precast concrete base or pre-cast concrete pole as described in the drawings.
   2. Provide branch circuit in-line fuses in pole base handhole.

D. Swinging Type:
   1. Provide, at each support, safety cable capable of supporting four times the vertical load from the structure to the luminaire.

E. Finished Areas:
   1. Install symmetrically with tile pattern.
   2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
   3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.
   4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
   5. Junction Boxes:
      a. Flush and Recessed Luminaires: Locate minimum 1 foot from luminaire.
      b. In concealed locations, install junction boxes to be accessible by removing luminaire.
      c. Wiring and Conduit:
      d. Provide wiring of temperature rating required by luminaire.
      e. Provide flexible steel conduit.
      f. Provide plaster frames when required by ceiling construction.
   6. Independent Supports:
      a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
      b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
      c. Fasten chain or wire to each end of luminaire.

F. Unfinished Areas: Locate luminaires to avoid either conflict with other building systems or blockage of luminaire light output.
   1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.
   2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

G. Lamps
   1. Provide in each fixture, the number and type for which the fixture is designed, unless otherwise noted.

H. Ballasts
   1. Install in accordance with manufacturer's recommendations.
   2. Utilize all ballast mounting holes to fasten securely within luminaire.
   3. Replace noisy or defective ballasts.

I. Lighting Control
   1. Outdoor Luminaires: Photocells with time clocks will switch lights ON at dusk and OFF at a set time.

J. Cleaning Following Construction
   1. Remove all labels and other markings, except UL listing mark.
   2. Wipe luminaires inside and out to remove construction dust.
   3. Clean luminaire plastic lenses with anti-static cleaners only.
   4. Touch up all painted surfaces of luminaires and poles with matching paint ordered from manufacturer.
   5. Replace all defective lamps at time of Substantial Completion.

3.03 COORDINATION

A. The Contractor shall coordinate lighting fixture locations with all other disciplines. In case light fixtures are covered by pipe or other equipment, fixtures shall be moved with no cost to the Owner to provide for lighting level on the floor as indicated.

END OF SECTION

SECTION 16950

ELECTRICAL TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Acceptance testing of electrical system, wiring, equipment, and grounding.

1.02 REFERENCES

A. National Electrical Testing Association (NETA):
   1. ATS-2009: Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.

B. ANSI: Test Procedures for Electrical Equipment.

C. ASTM: American Society for Testing and Materials.

D. ANSI/IEEE: Recommended Practices for Testing: Machinery, Ground Impedance, Cables and Terminations.

1.03 SUBMITTALS

A. Pre-Test Submittals:
   1. Testing service qualifications.
   2. Test personnel qualifications (resumes).
   3. Equipment testing schedule.
   4. Test data forms, custom edited for difference types of electrical equipment.

B. Post-Test Submittals: Summary Test Report consists of the following:
   1. Summary of testing for the project.
   2. Description of the equipment tested.
   3. Description of the test and test procedures.
   4. Test results for each apparatus and motorized equipment.
   5. Conclusions and recommendations.
   6. Completed test forms, including witness's signatures.
   7. List of test equipment and calibration documents.
   8. Date and time.
   9. A copy of this specification section with each paragraph check marked indicating compliance or marked with explicit deviations.

C. Submit Equipment Testing Schedule no later than 7 days prior to scheduled date of testing.

D. Project Record Documents: Note or indicate wiring deviations from Contract Documents on Project Record Documents.

1.04 QUALITY ASSURANCE

A. Prequalified Testing Services:
   1. Provide the services of certified electricians to perform testing of conductor insulation.
   2. Provide adequate test instruments for testing of conductor's insulation.
   3. Submit certification data and experience of personnel for required testing.

B. Testing service or testing personnel may be accepted or rejected based upon, but not limited to, the testing equipment intended to be used, the qualifications of the firm, and personnel.

C. Test Equipment Traceability:
   1. Testing firm shall have a calibration program to maintain test instrumentation and equipment within rated accuracy, including stickers with calibration dates record.
   2. Equipment and instruments used to evaluate electrical performance shall be calibrated to a standard traceable to the National Institute of Standards and Technology.
   3. Test equipment operating instructions and procedures shall be with the test equipment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 SAFETY AND PRECAUTIONS

A. Testing firm shall perform tests following a safe practice in accordance with OSHA and accident prevention procedures by National Safety Council and applicable codes.

B. Tests shall be performed with apparatus de-energized, except as necessary for equipment performance and functional test.

3.02 EXAMINATION

A. Verify that electrical work is free from improper grounds, short circuits, and overloads.

B. Verify correctness of wiring first by visual comparison of the conductor connections with connection diagrams.

C. Make individual circuit continuity checks by using electrical circuit testers.

D. Verify correctness of wiring by actual electrical operation of electrical and mechanical devices in both manual and automatic modes of operation.

3.03 VERIFICATION OF EQUIPMENT RATINGS

A. Prior to perform acceptance testing, the testing personnel shall inspect and verify adequate short circuit rating of electrical equipment.

3.04 ACCEPTANCE TESTING

A. General Requirements:
   1. Perform testing and allow OWNER and ENGINEER to witness testing.
   2. Perform tests to assure that electrical equipment will operate within industry and manufacturer's published tolerances, and will perform safely. Record test result data, to be used as a baseline for future tests.
   3. Test motorized equipment to verify conformance with the Contract Documents and for acceptance.
   4. Equipment for which acceptable test data has not been submitted, or has been submitted but rejected, shall be deemed as not meeting Contract requirements.

B. Equipment and Materials Inspection and Test Procedures. Complete test reports for each individual piece of equipment and systems:
   1. Panelboard Assemblies (Low Voltage):
      a. Visual and Mechanical Inspection:
         1) Compare equipment nameplate and data with drawings and specifications.
         2) Inspect physical, electrical, and mechanical condition.
         3) Confirm correct application of manufacturer’s recommended lubricants.
         4) Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.
         5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
         6) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
            a) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
            b) Make key exchange with devices operated in off-normal positions.
         7) Clean panelboard.
      b. Electrical Tests:
         1) Perform ground-resistance tests.
         2) Perform resistance tests through ball bus joints with a low-resistance ohmmeter.
         3)
   2. Metering :
      a. Visual and Mechanical Inspection
         1) Compare equipment nameplate and data with drawings and specifications.
         2) Inspect physical and mechanical condition.
         3) Verify tightness of electrical connections.
   3. Motor Starters: Low Voltage:
      a. Visual and Mechanical Inspection:

1) Compare equipment nameplate and data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

b. Electrical Tests:
1) Insulation Tests:
a) Measure insulation-resistance of each combination starter, phase-to-phase and phase-to-ground, with the starter contacts closed and the protective device open.
b) Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

c. Test Values:
1) Bolt-torque levels shall be in accordance with data specified by manufacturer.
2) Insulation-resistance values.
3) Overload trip times shall be in accordance with manufacturer's published data.

4. Circuit Breakers: Low-Voltage Molded Case - 100 Amp or Larger Only:
a. Visual and Mechanical Inspection:
1) Compare equipment nameplate and data with drawings and specifications.
2) Inspect circuit breaker for correct mounting.
3) Operate circuit breaker to insure smooth operation.
4) Inspect case for cracks or other defects.
5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

b. Electrical Tests:
1) Perform an insulation-resistance test at 1,000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
2) Perform adjustments for the final settings in accordance with the coordination study.
3) Perform long-time delay time-current characteristics tests by passing 300 percent through each pole separately unless series testing is required to defeat ground fault functions.
4) Determine short-time pickup and delay by primary current injection.
5) Determine ground-fault pickup and time delay by primary current injection.
6) Determine instantaneous pickup current by primary injection using run-up or pulse method.
7) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

c. Test Values:
1) Bolt-torque levels shall be in accordance with data specified by manufacturer.

2) Compare microhm or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than 25 percent. Investigate any value exceeding manufacturer's recommendations.
3) Insulation resistance shall not be less than 100 megohms.
4) Trip characteristics of breakers shall fall within manufacturer's published time-current tolerance bands, including adjustment factors.

5. Rotating Machinery: AC Motors:
   a. Visual and Mechanical Inspection:
      1) Compare equipment nameplate and data with Drawings and Specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect for correct anchorage, mounting, grounding, connection, and lubrication.
      4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
      5) When applicable, perform special tests such as air gap spacing and pedestal alignment.
      6) Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.
   b. Electrical Tests: Induction Motors:
      1) Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.
         a) Motors larger than 200 horsepower: Test duration shall be for ten minutes. Calculate polarization index.
         b) Motors 200 horsepower and less: Test duration shall be for one minute. Calculate the dielectric-absorption ratio.
      2) Test motor starter in accordance with Section 7.16 of these specifications.
      3) Verify that resistance temperature detector (RTD) circuits conform to drawings. Verify that metering or relaying devices using the RTD's have the correct rating.
      4) Verify that the motor space heater is functional.
      5) Perform a rotation test to insure correct shaft direction.
      6) Measure running current and evaluate relative to load conditions and nameplate full-load amperes.
6. Low-Voltage Surge Protection Devices (TVSS):
   a. Visual and Mechanical Inspection:
      1) Compare equipment nameplate and data with drawings and specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect for correct mounting and adequate clearances.
      4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
      5) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
7. Dry Type Transformers:
   a. Air-Cooled, 600 Volt and Below (50 kVA Single-Phase, 50 kVA Three-Phase and Smaller):
      1) Compare equipment nameplate and data with the Drawings and Specifications.

2) Inspect physical and mechanical condition.
3) Verify that resilient mounts are free and that any shipping brackets have been removed.
4) Perform insulation-resistance test. Calculate polarization index. Measurements shall be made from winding-to-winding and each winding-to-ground. Test voltages and minimum resistance.
5) Verify that winding turns-ratio measurements and polarities are in accordance with nameplate.
6) Verify that as-left tap connections are as specified.

8. Grounding Systems:
   a. Visual and Mechanical Inspection
      1) Verify ground system is in compliance with drawings and specifications.
   b. Electrical Tests:
      1) Perform fall-of-potential test or alternative in accordance with IEEE Standard 81-1991 on the main grounding electrode or system.
      2) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
   c. Test Values:
      1) The resistance between the main grounding electrode and ground should be no greater than five ohms for commercial or industrial systems and one ohm or less for generating grounds unless otherwise specified.
      2) Investigate point-to-point resistance values which exceed 0.5 ohm.
9. Low-Voltage Cables: 600 Volt:
   a. Visual and Mechanical Inspection:
      1) Compare cable data with drawings and specifications.
      2) Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
      3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
      4) Inspect compression-applied connectors for correct cable match and indentation.
      5) Verify cable color coding with applicable engineer's specifications and National Electrical Code standards.
   b. Electrical Tests:
   c. Perform an insulation resistance test on all cables.
10. Lighting System Controllers:
    a. Perform lighting system controller function tests upon completion of equipments, to prove correct interaction of switches, controllers, and photocells.

3.05 SUMMARY TEST REPORT

A. Upon completion of testing of all electrical equipment, submit summary test report.

END OF SECTION

MANATEE COUNTY
SOUTHWEST WATER RECLAMATION FACILITY
CLARIFIER 3 AND 4 REHABILITATION
MANATEE COUNTY PROJECT # 6078981

Technical Specifications

Prepared For:

MANATEE COUNTY

PUBLIC WORKS DEPARTMENT

March 2013

Prepared By:

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MANATEE COUNTY
SOUTHWEST WATER RECLAMATION FACILITY
CLARIFIER 3 AND 4 REHABILITATION
MANATEE COUNTY PROJECT # 6078981
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DIVISION 1 – GENERAL REQUIREMENTS

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SECTION 01005

GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE AND INTENT

A. Description
   1. The work to be done consists of the furnishing of all labor, materials and equipment, and the performance of all work included in this Contract.

B. Work Included
   1. The Contractor shall furnish all labor, superintendence, materials, plant, power, light, heat, fuel, water, tools, appliances, equipment, supplies, shop drawings, working drawings and other means of construction necessary or proper for performing and completing the work. He shall obtain and pay for all required permits necessary for the work, other than those permits such as FDEP permits. He shall perform and complete the work in the manner best calculated to promote rapid construction consistent with safety of life and property and to the satisfaction of the Engineer, and in strict accordance with the Contract Documents. The Contractor shall clean up the work and maintain it during and after construction, until accepted, and shall do all work and pay all costs incidental thereto. He shall repair or restore all structures and property that may be damaged or disturbed during performance of the work.
   2. The cost of incidental work described in these General Requirements, for which there are no specific Contract Items, shall be considered as part of the general cost of doing the work and shall be included in the prices for the various Contract Items. No additional payment will be made therefore.
   3. The Contractor shall provide and maintain such modern plant, tools, and equipment as may be necessary, in the opinion of the Engineer, to perform in a satisfactory and acceptable manner all the work required by this Contract. Only equipment of established reputation and proven efficiency shall be used. The Contractor shall be solely responsible for the adequacy of his workmanship, materials and equipment, prior approval of the Engineer notwithstanding.

C. Public Utility Installations and Structures
   1. Public utility installations and structures shall be understood to include all poles, tracks, pipes, wires, conduits, house service connections, vaults, manholes and all other appurtenances and facilities pertaining thereto whether owned or controlled by the Owner, other governmental bodies or privately owned by individuals, firms or corporations, used to serve the public with transportation, traffic control, gas, electricity, telephone, sewage, drainage, water or other public or private property which may be affected by the work shall be deemed included hereunder.
   2. The Contractor shall protect all public utility installations and structures from damage during the work. Access across any buried public utility installation or structure shall be made only in such locations and by means approved by the Engineer. The Contractor shall so arrange his operations as to avoid any damage to these facilities. All required protective devices and construction shall be provided by the Contractor at his expense. All existing public utilities

damaged by the Contractor which are shown on the Plans or have been located in the field by the utility shall be repaired by the Contractor, at his expense, as approved by the Engineer. No separate payment shall be made for such protection or repairs to public utility installations or structures.

3. Public utility installations or structures owned or controlled by the Owner or other governmental body, which are required by this contract to be removed, relocated, replaced or rebuilt by the Contractor not identified in any separate bid item shall be considered as a part of the general cost of doing the work and shall be included in the prices bid for the various contract items. No separate payment shall be made therefore.
4. Where public utility installations or structures owned or controlled by the Owner or other governmental body are encountered during the course of the work, and are not indicated on the Plans or in the Specifications, and when, in the opinion of the Engineer, removal, relocation, replacement or rebuilding is necessary to complete the work under this Contract, such work shall be accomplished by the utility having jurisdiction, or such work may be ordered, in writing by the Engineer, for the contractor to accomplish. If such work is accomplished by the utility having jurisdiction, it will be carried out expeditiously and the Contractor shall give full cooperation to permit the utility to complete the removal, relocation, replacement or rebuilding as required. If such work is accomplished by the Contractor, it will be in accordance with the General and Supplemental General Conditions.
5. The Contractor shall give written notice to Owner and other governmental utility departments and other owners of public utilities of the location of his proposed construction operations, at least forty-eight hours in advance of breaking ground in any area or on any unit of the work. This can be accomplished by making the appropriate contact with the Sunshine State One-Call of Florida, Inc. Call Center ("Call Sunshine") and per all requirements provided for in the Florida Underground Facilities Damage Prevention and Safety Act (Florida Statutes, Title XXXIII, Chapter 556).
6. The maintenance, repair, removal, relocation or rebuilding of public utility installations and structures, when accomplished by the Contractor as herein provided, shall be done by methods approved by the Engineer.

1.02 PLANS AND SPECIFICATIONS

A. Plans
   1. When obtaining data and information from the Plans, figures shall be used in preference to scaled dimensions, and large scale drawings in preference to small scale drawings.

B. Copies Furnished to Contractor
   1. The Contractor shall furnish each of the subcontractors, manufacturers, and material men such copies of the Contract Documents as may be required for their work. Additional copies of the Plans and Specifications, when requested, may be furnished to the Contractor at cost of reproduction.

C. Supplementary Drawings
   1. When, in the opinion of the Engineer, it becomes necessary to explain more fully the work to be done or to illustrate the work further or to show any changes which may be required, drawings known as Supplementary Drawings, with specifications pertaining thereto, will be prepared by the Engineer and five paper prints thereof will be given to the Contractor.

D. Contractor to Check Plans and Data
   1. The Contractor shall verify all dimensions, quantities and details shown on the Plans, Supplementary Drawings, Schedules, Specifications or other data received from the Engineer, and shall notify him of all errors, omissions, conflicts, and discrepancies found therein. Failure to discover or correct errors, conflicts or discrepancies shall not relieve the Contractor of full responsibility for unsatisfactory work, faulty construction or improper operation resulting there from nor from rectifying such conditions at his own expense. He will not be allowed to take advantage of any errors or omissions, as full instructions will be furnished by the Engineer, should such errors or omissions be discovered. All schedules are given for the convenience of the Engineer and the Contractor and are not guaranteed to be complete. The Contractor shall assume all responsibility for the making of estimates of the size, kind, and quality of materials and equipment included in work to be done under the Contract.

E. Specifications
   1. The Technical Specifications consist of three parts: General, Products and Execution. The General Section contains General Requirements which govern the work. Products and Execution modify and supplement these by detailed requirements for the work and shall always govern whenever there appears to be a conflict.

F. Intent
   1. All work called for in the Specifications applicable to this Contract, but not shown on the Plans in their present form, or vice versa, shall be of like effect as if shown or mentioned in both. Work not specified in either the Plans or in the Specifications, but involved in carrying out their intent or in the complete and proper execution of the work, is required and shall be performed by the Contractor as though it were specifically delineated or described.
   2. The apparent silence of the Specifications as to any detail, or the apparent omission from them of a detailed description concerning any work to be done and materials to be furnished, shall be regarded as meaning that only the best general practice is to prevail and that only material and workmanship of the best quality is to be used, and interpretation of these Specifications shall be made upon that basis.
   3. The inclusion of the Related Requirements (or work specified elsewhere) in the General part of the specifications is only for the convenience of the Contractor, and shall not be interpreted as a complete list of related Specification Sections.

1.03 MATERIALS AND EQUIPMENT

A. Manufacturer
   1. The names of proposed manufacturers, material men, suppliers and dealers who are to furnish materials, fixtures, equipment, appliances or other fittings shall be submitted to the Engineer for approval. Such approval must be obtained before shop drawings will be checked. No manufacturer will be approved for any materials to be furnished under this Contract unless he shall be of good reputation and have a plant of ample capacity. He shall, upon the request of the Engineer, be required to submit evidence that he has manufactured a similar product to the one specified and that it has been previously used for a like purpose for a sufficient length of time to demonstrate its satisfactory performance.

2. All transactions with the manufacturers or subcontractors shall be through the Contractor, unless the Contractor shall request, in writing to the Engineer, that the manufacturer or subcontractor deal directly with the Engineer. Any such transactions shall not in any way release the Contractor from his full responsibility under this Contract.
3. Any two or more pieces or material or equipment of the same kind, type or classification, and being used for identical types of services, shall be made by the same manufacturer.

B. Delivery
1. The Contractor shall deliver materials in ample quantities to insure the most speedy and uninterrupted progress of the work so as to complete the work within the allotted time. The Contractor shall also coordinate deliveries in order to avoid delay in, or impediment of, the progress of the work of any related Contractor.

C. Tools and Accessories
1. The Contractor shall, unless otherwise stated in the Contract Documents, furnish with each type, kind or size of equipment, one complete set of suitably marked high grade special tools and appliances which may be needed to adjust, operate, maintain or repair the equipment. Such tools and appliances shall be furnished in approved painted steel cases, properly labeled and equipped with good grade cylinder locks and duplicate keys.
2. Spare parts shall be furnished as specified.
3. Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, weight and principal rating data.

D. Installation of Equipment.
1. The Contractor shall have on hand sufficient proper equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character.
2. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Plans, unless directed otherwise by the Engineer during installation. All equipment shall be correctly aligned, leveled and adjusted for satisfactory operation and shall be installed so that proper and necessary connections can be made readily between the various units.
3. The Contractor shall furnish, install and protect all necessary anchor and attachment bolts and all other appurtenances needed for the installation of the devices included in the equipment specified. Anchor bolts shall be as approved by the Engineer and made of ample size and strength for the purpose intended. Substantial templates and working drawings for installation shall be furnished.
4. The Contractor shall, at his own expense, furnish all materials and labor for, and shall properly bed in non-shrink grout, each piece of equipment on its supporting base that rests on masonry foundations.
5. Grout shall completely fill the space between the equipment base and the foundation. All metal surfaces coming in contact with concrete or grout shall receive a coat of coal tar epoxy equal to Koppers 300M.

E. Service of Manufacturer's Engineer

1. The Contract prices for equipment shall include the cost of furnishing (as required by equipment specifications sections) a competent and experienced engineer or superintendent who shall represent the manufacturer and shall assist the Contractor, when required, to install, adjust, test and place in operation the equipment in conformity with the Contract Documents. After the equipment is placed in permanent operation by the Owner, such engineer or superintendent shall make all adjustments and tests required by the Engineer to prove that such equipment is in proper and satisfactory operating condition, and shall instruct such personnel as may be designated by the Owner in the proper operation and maintenance of such equipment.

1.04 INSPECTION AND TESTING

A. General
   1. Inspection and testing of materials will be performed by the Owner unless otherwise specified.
   2. For tests specified to be made by the Contractor, the testing personnel shall make the necessary inspections and tests and the reports thereof shall be in such form as will facilitate checking to determine compliance with the Contract Documents. Three (3) copies of the reports shall be submitted and authoritative certification thereof must be furnished to the Engineer as a prerequisite for the acceptance of any material or equipment.
   3. If, in the making of any test of any material or equipment, it is ascertained by the Engineer that the material or equipment does not comply with the Contract, the Contractor will be notified thereof and he will be directed to refrain from delivering said material or equipment, or to remove it promptly from the site or from the work and replace it with acceptable material, without cost to the Owner.
   4. Tests of electrical and mechanical equipment and appliances shall be conducted in accordance with recognized test codes of the ANSI, ASME, or the IEEE, except as may otherwise be stated herein.
   5. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

B. Costs
   1. All inspection and testing of materials furnished under this Contract will be performed by the Owner or duly authorized inspection engineers or inspections bureaus without cost to the Contractor, unless otherwise expressly specified.
   2. The cost of shop and field tests of equipment and of certain other tests specifically called for in the Contract Documents shall be borne by the Contractor and such costs shall be deemed to be included in the Contract price.
   3. Materials and equipment submitted by the Contractor as the equivalent to those specifically named in the Contract may be tested by the Owner for compliance. The Contractor shall reimburse the Owner for the expenditures incurred in making such tests on materials and equipment which are rejected for non-compliance.

C. Inspections of Materials
   1. The Contractor shall give notice in writing to the Engineer, at least two weeks in advance of his intention to commence the manufacture or preparation of

materials especially manufactured or prepared for use in or as part of the permanent construction. Such notice shall contain a request for inspection, the date of commencement and the expected date of completion of the manufacture of preparation of materials. Upon receipt of such notice, the Engineer will arrange to have a representative present at such times during the manufacture as may be necessary to inspect the materials or he will notify the Contractor that the inspection will be made at a point other than the point of manufacture, or he will notify the Contractor that inspection will be waived. The Contractor must comply with these provisions before shipping any material. Such inspection shall not release the Contractor from the responsibility for furnishing materials meeting the requirements of the Contract Documents.

D. Certificate of Manufacture
   1. When inspection is waived or when the Engineer so requires, the Contractor shall furnish to him authoritative evidence in the form of Certificates of Manufacture that the materials to be used in the work have been manufactured and tested in conformity with the Contract Documents. These certificates shall be notarized and shall include copies of the results of physical tests and chemical analyses, where necessary, that have been made directly on the product or on similar products of the manufacturer.

E. Shop Tests of Operating Equipment
   1. Each piece of equipment for which pressure, duty, capacity, rating, efficiency, performance, function or special requirements are specified shall be tested in the shop of the maker in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents. No such equipment shall be shipped to the work until the Engineer notifies the Contractor, in writing, that the results of such tests are acceptable.
   2. Five copies of the manufacturer's actual test data and interpreted results thereof, accompanied by a certificate of authenticity sworn to by a responsible official of the manufacturing company, shall be forwarded to the Engineer for approval.
   3. The cost of shop tests and of furnishing manufacturer's preliminary and shop test data of operating equipment shall be borne by the Contractor.

F. Preliminary Field Tests
   1. As soon as conditions permit, the Contractor shall furnish all labor, materials, and instruments and shall make preliminary field tests of equipment. If the preliminary field tests disclose any equipment furnished under this Contract which does not comply with the requirements of the Contract Documents, the Contractor shall, prior to the acceptance tests, make all changes, adjustments and replacements required. The furnishing Contractor shall assist in the preliminary field tests as applicable.

G. Final Field Tests
   1. Upon completion of the work and prior to final payment, all equipment and piping installed under this Contract shall be subjected to acceptance tests as specified or required to prove compliance with the Contract Documents.

   2. The Contractor shall furnish labor, fuel, energy, water and all other materials, equipment and instruments necessary for all acceptance tests, at no additional cost to the Owner. The Supplier shall assist in the final field tests as applicable.

H. Failure of Tests
   1. Any defects in the materials and equipment or their failure to meet the tests, guarantees or requirements of the Contract Documents shall be promptly corrected by the Contractor. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the Contract shall be final and conclusive. If the Contractor fails to make these corrections or if the improved materials and equipment, when tested, shall again fail to meet the guarantees of specified requirements, the Owner, notwithstanding its partial payment for work, and materials and equipment, may reject the materials and equipment and may order the Contractor to remove them from the site at his own expense.
   2. In case the Owner rejects any materials and equipment, then the Contractor shall replace the rejected materials and equipment within a reasonable time. If he fails to do so, the Owner may, after the expiration of a period of thirty (30) calendar days after giving him notice in writing, proceed to replace such rejected materials and equipment, and the cost thereof shall be deducted from any compensation due or which may become due the Contractor under his Contract.

I. Final Inspection
   1. During such final inspections, the work shall be clean and free from water. In no case will the final pay application be prepared until the Contractor has complied with all requirements set forth and the Engineer has made his final inspection of the entire work and is satisfied that the entire work is properly and satisfactorily constructed in accordance with the requirements of the Contract Document.

1.05 TEMPORARY STRUCTURES

A. Temporary Fences
   1. If, during the course of the work, it is necessary to remove or disturb any fence or part thereof, the Contractor shall, at his own expense, if so ordered by the Engineer, provide a suitable temporary fence which shall be maintained until the permanent fence is replaced. The Engineer shall be solely responsible for the determination of the necessity for providing a temporary fence and the type of temporary fence to be used.

1.06 TEMPORARY SERVICES

A. First Aid
   1. The Contractor shall keep upon the site, at each location where work is in progress, a completely equipped first aid kit and shall provide ready access thereto at all times when people are employed on the work.

1.07 LINES AND GRADES

A. Grade
   1. All work under this Contract shall be constructed in accordance with the lines and grades shown on the Plans, or as given by the Owner/Engineer. The full responsibility for keeping alignment and grade shall rest upon the Contractor.

B. Safeguarding Marks

1. The Contractor shall safeguard all points, stakes, grade marks, monuments and bench marks made or established on the work, bear the cost of reestablishing them if disturbed, and bear the entire expense of rectifying work improperly installed due to not maintaining or protecting or to removing without authorization such established points, stakes and marks.
2. The Contractor shall safeguard all existing and known property corners, monuments and marks adjacent to but not related to the work and, if required, shall bear the cost of reestablishing them if disturbed or destroyed.

C. Datum Plane
1. All elevations indicated or specified refer to the Mean Sea Level Datum of the NGVD 1929 Datum and/or NAVD 1988.

1.08 ADJACENT STRUCTURES AND LANDSCAPING

A. Responsibility
1. The Contractor shall also be entirely responsible and liable for all damage or injury as a result of his operations to all other adjacent public and private property, structures of any kind and appurtenances thereto met with during the progress of the work. The cost of protection, replacement in their original locations and conditions or payment of damages for injuries to such adjacent public and private property and structures affected by the work, whether or not shown on the Plans, and the removal, relocation and reconstruction of such items called for on the Plans or specified shall be included in the various Contract Items and no separate payments will be made therefore. Where such public and private property, structures of any kind and appurtenances thereto are not shown on the Plans and when, in the opinion of the Engineer, additional work is deemed necessary to avoid interference with the work, payment therefore will be made as provided for in the General Conditions.
2. Contractor is expressly advised that the protection of buildings, structures, tunnels, tanks, pipelines, etc. and related work adjacent and in the vicinity of his operations, wherever they may be, is solely his responsibility. Conditional inspection of buildings or structures in the immediate vicinity of the project which may reasonably be expected to be affected by the Work shall be performed by and be the responsibility of the Contractor.
3. Contractor shall, before starting operations, make an examination of the interior and exterior of the adjacent structures, buildings, facilities, etc., and record by notes, measurements, photographs, etc., conditions which might be aggravated by open excavation and construction. Repairs or replacement of all conditions disturbed by the construction shall be made to the satisfaction of the Owner and to the satisfaction of the Engineer. This does not preclude conforming to the requirements of the insurance underwriters. Copies of surveys, photographs, reports, etc., shall be given to the Engineer.
4. Prior to the beginning of any excavations, the Contractor shall advise the Engineer of all buildings or structures on which he intends to perform work or which performance of the project work will affect.

B. Protection of Trees
1. All trees and shrubs shall be adequately protected by the Contractor with boxes and otherwise and in accordance with ordinances governing the protection of trees. No excavated materials shall be placed so as to injure such trees or shrubs. Trees or shrubs destroyed by negligence of the Contractor or

his employees shall be replaced by him with new stock of similar size and age, at the proper season and at the sole expense of the Contractor.

2. Beneath trees or other surface structures, where possible, pipelines may be built in short tunnels, backfilled with excavated materials, except as otherwise specified, or the trees or structures carefully supported and protected from damage.
3. The Owner may order the Contractor, for the convenience of the Owner, to remove trees along the line or trench excavation. If so ordered, the Owner will obtain any permits required for removal of trees. Such tree removal ordered shall be paid for under the appropriate Contract Items.

C. Lawn Areas

1. Lawn areas shall be left in as good condition as before the starting of the work. Where sod is to be removed, it shall be carefully removed, and later replaced, or the area where sod has been removed shall be restored with new sod in the manner described in the Workmanship and Materials Paragraph in Section 02485, Seeding & Sodding.

D. Restoration of Fences

1. Any fence, or part thereof, that is damaged or removed during the course of the work shall be replaced or repaired by the Contractor and shall be left in as good a condition as before the starting of the work. The manner in which the fence is repaired or replaced and the materials used in such work shall be subject to the approval of the Engineer. The cost of all labor, materials, equipment, and work for the replacement or repair of any fence shall be deemed included in the appropriate Contract Item or items, or if no specific Item is provided therefore, as part of the overhead cost of the work, and no additional payment will be made therefore.

1.09 PROTECTION OF WORK AND PUBLIC

A. Barriers and Lights

1. During the prosecution of the work, the Contractor shall put up and maintain at all times such barriers and lights as will effectually prevent accidents. The Contractor shall provide suitable barricades, red lights, "danger" or "caution" or "street closed" signs and watchmen at all places where the work causes obstructions to the normal traffic or constitutes in any way a hazard to the public, in accordance with state and local requirements.

B. Smoke Prevention

1. A strict compliance with ordinances regulating the production and emission of smoke will be required. No open fires will be permitted.

C. Noise

1. The Contractor shall eliminate noise to as great an extent as practicable at all times. Air compressing plants shall be equipped with silencers and the exhaust of all engines or other power equipment shall be provided with mufflers. In the vicinity of hospitals and schools, special care shall be used to avoid noise or other nuisances. The Contractor shall strictly observe all local regulations and ordinances covering noise control.
2. Except in the event of an emergency, no work shall be done between the hours of 7:00 P.M. and 7:00 A.M., or on weekends. If the proper and efficient prosecution of the work requires operations during the night or weekends, the

written permission of the Owner shall be obtained before starting such items of the work.

D. Access to Public Services
   1. Neither the materials excavated nor the materials or plant used in the construction of the work shall be so placed as to prevent free access to all fire hydrants, valves or manholes.

E. Dust prevention
   1. The Contractor shall prevent dust nuisance from his operations or from traffic by keeping the roads and/or construction areas sprinkled with water at all times.

1.10 CUTTING AND PATCHING

A. The Contractor shall do all cutting, fitting or patching of his portion of the work that may be required to make the several parts thereof join and coordinate in a manner satisfactory to the Engineer and in accordance with the Plans and Specifications. The work must be done by competent workmen skilled in the trade required by the restoration.

1.11 CLEANING

A. During Construction
   1. During construction of the work, the Contractor shall, at all times, keep the site of the work and adjacent premises as free from material, debris and rubbish as is practicable and shall remove the same from any portion of the site if, in the opinion of the Engineer, such material, debris, or rubbish constitutes a nuisance or is objectionable.
   2. The Contractor shall remove from the site all of his surplus materials and temporary structures when no further need therefore develops.

B. Final Cleaning
   1. At the conclusion of the work, all equipment, tools, temporary structures and materials belonging to the Contractor shall be promptly taken away, and he shall remove and promptly dispose of all water, dirt, rubbish or any other foreign substances.
   2. The Contractor shall thoroughly clean all equipment and materials installed by him and shall deliver such materials and equipment undamaged in a bright, clean, polished and new operating condition.

1.12 MISCELLANEOUS

A. Protection Against Siltation and Bank Erosion
   1. The Contractor shall arrange his operations to minimize siltation and bank erosion on construction sites and on existing or proposed water courses and drainage ditches.
   2. The Contractor, at his own expense, shall remove any siltation deposits and correct any erosion problems as directed by the Engineer which results from his construction operations.

B. Protection of Wetland Areas

1. The Contractor shall properly dispose of all surplus material, including soil, in accordance with Local, State and Federal regulations. Under no circumstances shall surplus material be disposed of in wetland areas as defined by the Florida Department of Environmental Protection or Southwest Florida Water Management District.

C. Existing Facilities
   1. The work shall be so conducted to maintain existing facilities in operation insofar as is possible. Requirements and schedules of operations for maintaining existing facilities in service during construction shall be as described in the Special Provisions.

D. Use of Chemicals
   1. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, must show approval of either EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with instructions.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS/REQUIREMENTS INCLUDED

A. The work included in this contract consists of the following:
   1. Demolition of the clarifier mechanisms (including effluent launders), RAS pump nos. 4-6 and VFD's, scum ejectors, area lighting, and electrical and I&C conduits.
   2. New clarifier mechanisms with scum troughs and weirs, RAS pump nos. 4-6 with VFD's, scum pumping systems, sluice gates for isolation, and associated scum piping connections.
   3. New clarifier control panel, new electrical distribution equipment, new electrical and I&C wiring and conduits from source to new clarifiers, scum pumps, and RAS pumps. New area lighting for clarifiers and new lighting for RAS pump station.

B. The Contractor shall furnish all shop drawings, working drawings, labor, materials, equipment, tools, services and incidentals necessary to complete all work required by these Specifications and as shown on the Contract Drawings.

C. The Contractor shall perform the work complete, in place and ready for continuous service and shall include any repairs, replacements, and/or restoration required as a result of damages caused prior to acceptance by the Owner.

D. The Contractor shall furnish and install all materials, equipment and labor which is reasonably and properly inferable and necessary for the proper completion of the work, whether specifically indicated in the Contract Documents or not.

1.02 CONTRACTS

A. Construct all the Work under a single contract.

1.03 WORK SEQUENCE

A. Clarifier Shutdown:
   1. Only one clarifier can be out of service for rehabilitation at a time.
   2. Contractor shall complete all work on one clarifier before beginning construction on the second clarifier. All work on the first clarifier, including replacement of the perimeter walkway, startup and testing, shall be completed prior to beginning work on the second clarifier.
   3. Coordinate with plant staff on sequence of clarifier shutdown requirements.
   4. Contractor shall provide a detailed sequence of construction and get approval from Owner and Engineer.

B. All work done under this Contract shall be done with a minimum of inconvenience to the users of the system or facility. The Contractor shall coordinate his work with private property owners such that existing utility services are maintained to all users to the maximum extent possible.

C. The Contractor shall, if necessary and feasible, construct the work in stages to accommodate the Owner's use of the premises during the construction period; coordinate the construction schedule and operations with the Owner's Representative.

D. The Contractor shall, where feasible, construct the Work in stages to provide for public convenience and not close off public use of any facility until completion of construction to provide alternative usage.

1.04 CONSTRUCTION AREAS

A. The Contractor shall: Limit his use of the construction areas for work and for storage, to allow for:
   1. Work by other Contractors.
   2. Owner's Use.
   3. Public Use.

B. Coordinate use of work site under direction of Engineer or Owner's Representative.

C. Assume full responsibility for the protection and safekeeping of products under this Contract, stored on the site.

D. Move any stored products under the Contractor's control, which interfere with operations of the Owner or separate contractor.

E. Obtain and pay for the use of additional storage of work areas needed for Contractor operations.

1.05 OWNER OCCUPANCY

A. It is assumed that portions of the Work will be completed prior to completion of the entire Work. Upon completion of construction of each individual facility, including testing, if the Owner, at its sole discretion, desires to accept the individual facility, the Contractor will be issued a dated certificate of completion and acceptance for each individual facility. The Owner will assume ownership and begin operation of the individual facility on that date and the three-year guaranty period shall commence on that date. The Owner has the option of not accepting the entire work as a whole until it is completed, tested and approved by the Engineer and Owner.

1.06 PARTIAL OWNER OCCUPANCY

A. The Contractor shall schedule his operations for completion of portions of the Work, as designated, for the Owner's occupancy prior to substantial completion of the entire work.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01015

CONTROL OF WORK

PART 1 GENERAL

1.01 WORK PROGRESS

A. The Contractor shall furnish personnel and equipment which will be efficient, appropriate and adequately sized to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the time stipulated in the Contract. If at any time such personnel appears to the Engineer to be inefficient, inappropriate, or insufficient for securing the quality of work required for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character, or increase the personnel and equipment and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

1.02 PRIVATE LAND

A. The Contractor shall not enter or occupy private land outside of easements, except by permission of the affected property owner.

1.03 WORK LOCATIONS

A. Work shall be located substantially as indicated on the drawings, but the Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons.

1.04 OPEN EXCAVATIONS

A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access to private property during construction shall be removed when no longer required. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of open trench, prohibiting stacking excavated material in the street and requiring that the trench shall not remain open overnight.

B. The Contractor shall take precautions to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles which could be dangerous to the public shall be barricaded and well lighted at all times when construction is not in progress.

1.05 DISTRIBUTION SYSTEMS AND SERVICES

A. The Contractor shall avoid interruptions to water, telephone, cable TV, sewer, gas, or other related utility services. He shall notify the Engineer and the appropriate agency well in advance of any requirement for dewatering, isolating, or relocating a section of a utility, so that necessary arrangements may be made.

B. If it appears that utility service will be interrupted for an extended period, the Engineer may order the Contractor to provide temporary service lines at the Contractor's expense. Inconvenience of the users shall be kept to the minimum, consistent with existing conditions. The safety and integrity of the systems are of prime importance in scheduling work.

1.06 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

A. The Contractor shall assume full responsibility for the protection of all buildings, structures and utilities, public or private, including poles, signs, services to building utilities, gas pipes, water pipes, hydrants, sewers, drains and electric and telephone cables and other similar facilities, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operation shall be repaired by the Contractor at his expense.

B. The Contractor shall bear full responsibility for obtaining locations of all underground structures and utilities (including existing water services, drain lines and sewers). Services to buildings shall be maintained and all costs or charges resulting from damage thereto shall be paid by the Contractor.

C. Protection and temporary removal and replacement of existing utilities and structures as described in this Section shall be a part of the work under the Contract and all costs in connection therewith shall be included in the unit prices established in the Bid.

D. If, in the opinion of the Engineer, permanent relocation of a utility owned by the Owner is required, he may direct the Contractor, in writing, to perform the work. Work so ordered will be paid for at the Contract unit prices, if applicable, or as extra work as classified in the General Conditions. If relocation of a privately owned utility is required, the Owner will notify the utility to perform the work as expeditiously as possible. The Contractor shall fully cooperate with the Owner and utility and shall have no claim for delay due to such relocation. The Contractor shall notify public utility companies in writing at least 48 hours (excluding Saturdays, Sundays and legal holidays) before excavating near their utilities.

1.07 TEST PITS

A. Test pits for the purpose of locating underground pipeline or structures in advance of the construction shall be excavated and backfilled by the Contractor immediately after the utility location and the surface shall be restored in a manner equal or better than the original condition. No separate payment will be made.

1.08 CARE AND PROTECTION OF PROPERTY

A. The Contractor shall be responsible for the preservation of all public and private property and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition equal or better to that existing before the damage was done, or he shall make good the damage in another manner acceptable to the Engineer.

B. All sidewalks which are disturbed by the Contractor's operations shall be restored to their original or better condition by the use of similar or comparable materials. All curbing shall be restored in a condition equal to the original construction and in accordance with the best modern practice.

C. Along the location of this work, all fences, walks, bushes, trees, shrubbery and other physical features shall be protected and restored in a thoroughly workmanlike manner unless otherwise shown on the drawings. Fences and other features removed by the Contractor shall be replaced in the location indicated by the Engineer as soon as conditions permit. All grass areas beyond the limits of construction which have been damaged by the Contractor shall be regraded and sodded to equal or exceed original conditions.

D. Trees close to the work which drawings do not specify to be removed, shall be boxed or otherwise protected against injury. The Contractor shall trim all branches that are liable to damage because of his operations, but in no case shall any tree be cut or removed without prior notification to the Engineer. All injuries to bark, trunk, limbs and roots of trees shall be repaired by dressing, cutting and painting according to approved methods, using only approved tools and materials.

E. The protection, removal and replacement of existing physical features along the line of work shall be a part of the work under the Contract and all costs in connection therewith shall be included in the unit and/or lump sum prices established under the items in the Bid.

1.09 MAINTENANCE OF TRAFFIC

A. Open pits, trenches, unpaved streets, debris, or other obstructions due to construction that will prevent the normal flow of traffic during an extended construction stoppage, for any reason, shall be minimized. In the event an extended construction stoppage is found to be necessary, Contractor shall, at his own expense, provide normal traffic flow during extended construction stoppage. Extended stoppage will be defined by the Engineer.

B. All excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, he shall repair the road surface, provide temporary roadways, erect wheel guards or fences, or take other safety measures which are satisfactory to the Engineer and Owner.

C. Detours around construction areas will be subject to the approval of the Owner and the Engineer. Where detours are permitted, the contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic

is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured, will be strictly controlled by the Owner.

1.10 WATER FOR CONSTRUCTION PURPOSES

A. In locations where public water supply is available, the Contractor may purchase water for all construction purposes.

B. The Contractor shall be responsible for paying for all water tap fees incurred for the purpose of obtaining a potable water service or temporary use meter.

1.11 MAINTENANCE OF FLOW

A. The Contractor shall, at his own cost, provide for the flow of sewers, drains and water courses interrupted during the progress of the work and shall immediately cart away and remove all offensive matter. The entire procedure of maintaining existing flow shall be fully discussed with the Engineer and Owner well in advance of the interruption of any flow.

1.12 CLEANUP

A. During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. He shall dispose of all residue resulting from the construction work and at the conclusion of the work, he shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures and any other refuse remaining from the construction operations and shall leave the entire site of the work in a neat and orderly condition.

1.13 COOPERATION WITHIN THIS CONTRACT

A. All firms or person authorized to perform any work under this Contract shall cooperate with the General Contractor and his subcontractors or trades and shall assist in incorporating the work of other trades where necessary or required.

B. Cutting and patching, drilling and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

1.14 PROTECTION OF CONSTRUCTION AND EQUIPMENT

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

B. All structures shall be protected in a manner approved by the Engineer. Should any of the floors or other parts of the structures become heaved, cracked, or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor, at his own expense and to the satisfaction of the Engineer. If, in the final inspection of the work, any defects, faults, or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. Further, the Contractor shall be fully responsible for the

satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the warranty period described in the Contract.

C. Further, the Contractor shall take all necessary precautions to prevent damage to any structure due to water pressure during and after construction and until such structure is accepted and taken over by the Owner.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01030

SPECIAL PROJECT PROCEDURES

PART 1 GENERAL

1.01 PERMITS

A. Upon notice of award, the Contractor shall immediately apply for all applicable permits not previously obtained by the Owner to do the work from the appropriate governmental agency or agencies. No work shall commence until all applicable permits have been obtained and copies delivered to the Engineer. The costs for obtaining all permits shall be borne by the Contractor.

1.02 CONNECTIONS TO EXISTING SYSTEM

A. The Contractor shall perform all work necessary to locate, excavate and prepare for connections to the terminus of the existing systems all as shown on the Drawings or where directed by the Owner/Engineer. The cost for this work and for the actual connection to the existing systems shall be included in the price bid for the project and shall not result in any additional cost to the Owner. The termination point for each contract shall be as shown on the Contract Drawings.

1.03 RELOCATIONS

A. The Contractor shall be responsible for the coordination of the relocation of structures, including but not limited to light poles, power poles, signs, sign poles, fences, piping, conduits and drains that interfere with the positioning of the work as set out on the Drawings. No relocation of the items under this Contract shall be done without approval from the Engineer.

1.04 EXISTING UNDERGROUND PIPING, STRUCTURES AND UTILITIES

A. The attention of the Contractor is drawn to the fact that during excavation, the possibility exists of the Contractor encountering various water, sewer, gas, telephone, electrical, or other utility lines not shown on the Drawings. The Contractor shall exercise extreme care before and during excavation to locate and flag these lines as to avoid damage to the existing lines. Cost for relocation of all existing lines shall be included in the price bid for the project. Should damage occur to an existing line, the Contractor shall bear the cost of all repairs.

B. It is the responsibility of the Contractor to ensure that all utility or other poles, the stability of which may be endangered by the close proximity of excavation, are temporarily stayed in position while work proceeds in the vicinity of the pole and that the utility or other companies concerned be given reasonable advance notice of any such excavation by the Contractor.

C. The existing utility locations are shown without express or implied representation, assurance, or guarantee that they are complete or correct or that they represent a true picture of underground piping to be encountered. The Contractor shall be responsible for notifying the various utility companies to locate their respective

utilities in advance of construction in conformance with all requirements provided for in the Florida Underground Facilities Damage Prevention and Safety Act (Florida Statutes, Title XXXIII, Chapter 556).

D. The existing piping and utilities that interfere with new construction shall be rerouted as shown, specified, or required. Before any piping and utilities not shown on the Drawings are disturbed, the Contractor shall notify the Engineer of the location of the pipeline or utility and shall reroute or relocate the pipeline or utility as directed. Cost for relocation of existing pipelines or utilities shall be included in the price bid for the project.

E. The Contractor shall exercise care in any excavation to locate all existing piping and utilities. All utilities which do not interfere with complete work shall be carefully protected against damage. Any existing utilities damaged in any way by the Contractor shall be restored or replaced by the Contractor at his expense as directed by the Engineer and/or the owner of the utility.

F. It is intended that wherever existing utilities such as water, sewer, gas, telephone, electrical, or other service lines must be crossed, deflection of the pipe within recommended limits and cover shall be used to satisfactorily clear the obstruction unless otherwise indicated in the Drawings. However, when in the opinion of the Engineer this procedure is not feasible, he may direct the use of fittings for a utilities crossing as detailed on the Drawings. No deflections will be allowed in gravity sanitary sewer lines or in existing storm sewer lines.

1.05 SUSPENSION OF WORK DUE TO WEATHER

A. Refer to FDOT Standards and Specifications Book, Section 8.

1.06 HURRICANE PREPAREDNESS PLAN

A. Within 30 days of the date of Notice to Proceed, the Contractor shall submit to the Engineer and Owner a Hurricane Preparedness Plan. The plan should outline the necessary measures which the Contractor proposes to perform at no additional cost to the Owner in case of a hurricane warning.

B. In the event of inclement weather, or whenever Engineer shall direct, Contractor shall insure that he and his Subcontractors shall carefully protect work and materials against damage or injury from the weather. If, in the opinion of the Engineer, any portion of work or materials is damaged due to the failure on the part of the Contractor or Subcontractors to protect the work, such work and materials shall be removed and replaced at the expense of the Contractor.

1.07 POWER SUPPLY

A. Electricity as may be required for construction and permanent power supply shall be secured and purchased by the Contractor.

1.08 SALVAGE

A. Any existing equipment or material, including, but not limited to, valves, pipes, fittings, couplings, etc., which is removed or replaced as a result of construction under this project may be designated as salvage by the Engineer or Owner and if so

shall be protected for a reasonable time until picked up by the Owner. Any equipment or material not worthy of salvaging, as directed by the Engineer, shall be disposed of by the Contractor at no additional cost.

1.09 DEWATERING

A. The Contractor shall do all groundwater pumping necessary to prevent flotation of any part of the work during construction operations with his own equipment.

B. The Contractor shall pump out water and wastewater which may seep or leak into the excavations for the duration of the Contract and with his own equipment. He shall dispose of this water in an appropriate manner.

1.10 ADDITIONAL PROVISIONS

A. Before commencing work on any of the existing pipelines, structures or equipment, the Contractor shall notify the Engineer, in writing, at least (ten) 10 calendar days in advance of the date he proposes to commence such work.

B. The Contractor shall provide, at his own expense, all necessary temporary facilities for access to and for protection of, all existing facilities. The Owner's personnel must have ready access at all times to the existing facilities. The Contractor is responsible for all damage to existing structures, equipment and facilities caused by his construction operations and must repair all such damage when and as ordered by the Engineer.

1.11 CONSTRUCTION CONDITIONS

A. The Contractor shall strictly adhere to the specific requirements of the governmental unit(s) and/or agency(ies) having jurisdiction over the work. Wherever there is a difference in the requirements of a jurisdictional body and these Specifications, the more stringent shall apply.

1.12 PUBLIC NUISANCE

A. The Contractor shall not create a public nuisance including but not limited to encroachment on adjacent lands, flooding of adjacent lands, excessive noise or dust.

B. Sound levels must meet Manatee County Ordinance #87-34, (which amends Ordinance 81-3, The Manatee County Noise Control Ordinance). Sound levels in excess of such ordinance are sufficient cause to have the work halted until equipment can be quieted to these levels. Work stoppage by the Engineer or County for excessive noise shall not relieve the Contractor of the other portions of this specification including, but not limited to contract time and contract price.

C. No extra charge may be made for time lost due to work stoppage resulting from the creation of a public nuisance.

1.13 WARRANTIES

A. All material supplied under these Specifications shall be warranted by the Contractor and the manufacturers for a period of three (3) years. Warranty period shall commence on the date of Owner acceptance.

B. The material shall be warranted to be free from defects in workmanship, design and materials. If any part of the system should fail during the warranty period, it shall be replaced at no expense to the Owner.

C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. The Contractor shall be responsible for obtaining warranties from each of the respective suppliers or manufacturers for all the material specified under these contract specifications,

D. In the event that the manufacturer is unwilling to provide a three (3) year warranty commencing at the time of Owner acceptance, the Contractor shall obtain from the manufacturer a four (4) year warranty starting at the time of equipment delivery to the job site. This four (4) year warranty shall not relieve the Contractor of the three (3) year warranty starting at the time of Owner acceptance of the equipment.

1.14 FUEL STORAGE & FILLING

A. If the contractor is storing fuel on site, or doing his own fuel filling of portable equipment (other than hand-held equipment), he is responsible for any required response, clean-up or reporting required, at no additional cost to the county.

B. The Contractor shall prepare and submit a fuel storage/spill abatement plan prior to start of construction if required.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01045

CUTTING AND PATCHING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall be responsible for all cutting, fitting and patching, including excavation and backfill, required to complete the work or to:
   1. Make its several parts fit together properly.
   2. Uncover portions of the work to provide for installation of ill-timed work.
   3. Remove and replace defective work.
   4. Remove and replace work not conforming to requirements of Contract Documents.
   5. Provide penetrations of non-structural surfaces for installation of piping and electrical conduit.

PART 2 PRODUCTS

2.01 MATERIALS

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

PART 3 EXECUTION

3.01 INSPECTION

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

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

C. Report unsatisfactory or questionable conditions to Engineer. Do not proceed with work until Engineer has provided further instructions.

3.02 PREPARATION

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

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

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

3.03 PERFORMANCE

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

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

C. Fit and adjust products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

D. Restore work which has been cut or removed; install new products to provide completed work in accordance with the requirements of the Contract Documents.

E. Replace surfaces airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

F. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes.

END OF SECTION

SECTION 01050

FIELD ENGINEERING AND SURVEYING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall provide and pay for field surveying service required for the project.

B. The Contractor shall furnish and set all necessary stakes to establish the lines and grades as shown on the Contract Drawings and layout each portion of the Work of the Contract.
   1. All survey work required in execution of Project.
   2. All costs of construction layout shall be included in the unit and lump sum prices contained in the respective divisions of the Contract Bid Form.
   3. Civil, structural or other professional engineering services specified or required to execute Contractor's construction methods.

1.02 QUALIFICATION OF SURVEYOR AND ENGINEER

A. All construction staking shall be conducted by or under the supervision of a Florida Registered Professional Surveyor and Mapper approved by the Owner. The Contractor shall be responsible for the layout of all such lines and grades, which will be subject to verification by the Engineer.

1.03 SURVEY REFERENCE POINTS

A. Locate and protect all survey monumentation, property corners and project control points prior to starting work and preserve all permanent reference points during construction. All costs associated with the replacement of all survey monumentation, property corners and project control points shall be borne by the Contractor.

B. Make no changes or relocations without prior written notice to Engineer.

C. Report to Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

D. Require surveyor to replace project control points which may be lost or destroyed.

E. Establish replacements based on original survey control.

1.04 PROJECT SURVEY REQUIREMENTS

A. The Contractor shall establish temporary bench marks as needed, referenced to data established by survey control points.

1.05 RECORDS

A. Maintain a complete, accurate log of all control and survey work as it progresses.

B. The Contractor shall employ a Professional Engineer or Surveyor registered in the State of Florida to verify survey data and properly prepare record drawings per Section 01720.

1.06 SUBMITTALS

A. Submit name and address of Professional Surveyor and Mapper to Engineer for Owner's approval.

B. Submit certificate signed by the Professional Surveyor and Mapper certifying that elevations and locations of improvements are in conformance, or nonconformance, with Contract Documents.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01090

REFERENCE STANDARDS

PART 1 GENERAL

1.01 REQUIREMENTS

Abbreviations and acronyms used in Contract Documents to identify reference standards.

A. Application: When a standard is specified by reference, comply with requirements and recommendations stated in that standard, except when requirements are modified by the Contract Documents, or applicable codes established stricter standards.

B. Publication Date: The most recent publication in effect on the date of issue of Contract Documents, except when a specific publication date is specified.

1.02 ABBREVIATIONS, NAMES AND ADDRESSES OR ORGANIZATIONS

Obtain copies of reference standards direct from publication source, when needed for proper performance of work, or when required for submittal by Contract Documents.

AA	Aluminum Association 818 Connecticut Avenue, N.W. Washington, DC 20006
AASHTO	American Association of State Highway and Transportation Officials 444 North Capital Street, N.W. Washington, DC 20001
ACI	American Concrete Institute Box 19150 Reford Station Detroit, MI 48219
AI	Asphalt Institute Asphalt Institute Building College Park, MD 20740
AISC	American Institute of Steel Construction 1221 Avenue of the Americas New York, NY 10020
AISI	American Iron and Steel Institute 1000 16th Street NW Washington, DC 20036

ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 179l Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
AWS	American Welding Society 2501 N.W. 7th Street Miami, FL 33125
CRSI	Concrete Reinforcing Steel Institute 180 North LaSalle Street, Suite 2110 Chicago, IL 60601
FDEP	Florida Department of Environmental Protection 3900 Commonwealth Blvd. Tallahassee, Florida 32399
FDOT	Florida Department of Transportation Standards Specifications for Road and Bridge Construction Maps & Publication Sales - Mail Station 12 605 Suwannee St. Tallahassee, FL 32399-0450
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Bldg. 197 Washington, DC 20407
MCUOD	Manatee County Utility Operations Department 4410 66th St. W. Bradenton, FL 34210
MLSFA	Metal Lath/Steel Framing Association 221 North LaSalle Street Chicago, IL 60601

MMA	Monorail Manufacturer's Association 1326 Freeport Road Pittsburgh, PA 15238
NAAMM	National Association of Architectural Metal Manufacturers 221 North LaSalle Street Chicago, IL 60601
NEMA	National Electrical Manufacturer's Assoc. 2101 L Street N.W. Washington, DC 20037
OHSA	Occupational Safety and Health Assoc. 5807 Breckenridge Pkwy., Suite A Tampa, FL 33610-4249
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 20076
PCI	Prestressed Concrete Institute 20 North Wacker Drive Chicago, IL 60606
SDI	Steel Door Institute 712 Lakewood Center North Cleveland, OH 44107
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association 8224 Old Court House Road Vienna, VA 22180
SSPC	Steel Structures Painting Council 402 24th Street, Suite 600 Pittsburgh, PA 15213
SWFWMD	Southwest Florida Water Management District 2379 Broad Street Brooksville, FL 34604-6899
UL	Underwriter's Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

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SECTION 01150

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SCOPE

A. The scope of this section of the Contract Documents is to further define the items included in each Bid Item in the Bid Form section of the Contract Documents. Payment will be made based on the specified items included in the description in this section for each bid item.

B. All contract prices included in the Bid Form section will be full compensation for all shop drawings, working drawings, labor, materials, tools, equipment, and incidentals necessary to complete the construction as shown on the Drawings and/or as specified in the Contract Documents to be performed under this Contract. Actual quantities of each item bid on a unit price basis will be determined upon completion of the construction in the manner set up for each item in this section of the Specifications. Payment for all items listed in the Bid Form will constitute full compensation for all work shown and/or specified to be performed under this Contract.

1.02 ESTIMATED QUANTITIES

A. The quantities shown are approximate and are given only as a basis of calculation upon which the award of the Contract is to be made. The Owner/Engineer does not assume any responsibility for the final quantities, nor shall the Contractor claim misunderstanding because of such estimate of quantities. Final payment will be made only for satisfactorily completed quantity of each item.

1.03 WORK OUTSIDE AUTHORIZED LIMITS

A. No payment will be made for work constructed outside the authorized limits of work.

1.04 MEASUREMENT STANDARDS

A. Unless otherwise specified for the particular items involved, all measurements of distance shall be taken horizontally or vertically.

1.05 AREA MEASUREMENTS

A. In the measurement of items to be paid for based on area of finished work, the lengths, and/or widths to be used in the calculations shall be the final dimensions measured along the surface of the completed work within the neat lines shown or designated.

1.06 LUMP SUM ITEMS

A. Where payment for items is shown to be paid for on a lump sum basis, no separate payment will be made for any item of work required to complete the lump sum items.

Lump sum contracts shall be complete, tested and fully operable prior to request for final payment. Contractor may be required to provide a breakdown of the lump sum totals.

1.07 UNIT PRICE ITEM

A. Separate payment will be made for the items of work described herein and listed on the Bid Form. Any related work not specifically listed, but required for satisfactory completion of the work shall be considered to be included in the scope of the appropriate listed work items.

B. No separate payment will be made for the following items and the cost of such work shall be included in the applicable pay items of work. Final payments shall not be requested by the Contractor or made by the Owner until as-built (record) drawings have been submitted and approved by the Engineer.
   1. Shop Drawings, Working Drawings.
   2. Clearing, grubbing, and grading except as hereinafter specified.
   3. Trench excavation, including necessary pavement removal and rock removal, except as otherwise specified.
   4. Dewatering and disposal of surplus water.
   5. Structural fill, backfill, and grading.
   6. Replacement of unpaved roadways, and shrubbery plots.
   7. Cleanup and miscellaneous work.
   8. Foundation and borrow materials, except as hereinafter specified.
   9. Testing and placing system in operation.
   10. Any material and equipment required to be installed and utilized for the tests.
   11. Pipe, structures, pavement replacement, asphalt and shell driveways, and/or appurtenances included within the limits of lump sum work, unless otherwise shown.
   12. Maintaining the existing quality of service during construction.
   13. Maintaining or detouring of traffic.
   14. Appurtenant work as required for a complete and operable system.
   15. Seeding and hydromulching.
   16. As-built Record Drawings.

BID ITEM NO 10 - MISCELLANEOUS WORK AND CLEANUP

Payment for all work included under this Bid Item shall be made at the Contract lump sum price bid listed in the Bid Form and shall represent full compensation for all labor, materials and equipment required to perform all the work as shown on the Contract Drawings and specified herein and any other miscellaneous work not specifically included for payment under other Bid Items obviously necessary to complete the Contract. Partial payments will be based on the breakdown of the Bid Item in accordance with the Schedule of Values submitted by the Contractor and approved by the Engineer. Payment shall also include full compensation for project photographs, as-builts record drawings, project signs, traffic control, rubbish and spoil removal, repair, replacement or relocation of all related items and any and all other items required to complete the project in accordance with Contract Documents.

BID ITEM NO 11 – CLARIFIER MECHANISMS

Payment for all work included under this Bid Item shall represent full compensation in accordance with the unit price bid for all the labor, materials, and equipment required for the demolition and replacement of the Clarifiers 3 and 4 mechanisms, inboard effluent trough, and scum baffle; applying coating to clarifier tanks; installation of new clarifier mechanisms; installation of inboard effluent trough and scum baffle ; installation of blind flange; and installation of miscellaneous piping and valves and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this unit price bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 12 – SCUM SYSTEM

Payment for all work included under this Bid Item shall represent full compensation in accordance with the unit price bid for all the labor, materials, and equipment required for the demolition of scum ejectors and associated piping; installation of new scum pumps; and installation of miscellaneous piping and valves and all other materials and equipment at Clarifier 3 and 4 necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this unit price bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 13 – RAS PUMPS

Payment for all work included under this Bid Item shall represent full compensation in accordance with the unit price bid for all the labor, materials, and equipment required for the demolition of three (3) RAS pumps and associated piping; installation of new three (3) RAS pumps; and installation of miscellaneous piping and valves and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this unit price bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 14 – ELECTRICAL AND INSTRUMENTATION

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the Electrical and Instrumentation work including new conduit and wiring; control panels; MCC (motor control center) modifications, new electrical distribution equipment, variable frequency drives; lighting, manhole, and all other materials and equipment necessary for a complete and fully operable system, including testing and start-up, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval by the Engineer and acceptance by the Owner.

Measurement for periodic payments of this lump sum bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO 15 – STRUCTURAL INSPECTION AND REPAIR ALLOWANCE

Contractor will contract with Crom Corporation to complete structural inspection and repairs for Clarifier 3 and 4 under this bid item. Payment for any structural repairs that are identified by Crom Corporation will be completed by Crom Corporation under this allowance.

BID ITEM NO. 16 - DISCRETIONARY WORK

Payment for all work under this Bid Item and listed in the Bid Form shall be made only at the Owner's discretion in order to satisfactorily complete the project in accordance with the Plans and Specifications.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01152

REQUESTS FOR PAYMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Submit Applications for Payment to the Project Manager or as directed at the preconstruction meeting, in accordance with the schedule established by Conditions of the Contract and Agreement between Owner and Contractor.

1.02 FORMAT AND DATA REQUIRED

A. Submit payment requests in the form provided by the Owner with itemized data typed in accordance with the Bid Form.

B. Provide construction photographs in accordance with Contract Documents.

1.03 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

A. When the Owner or the Engineer requires substantiating data, Contractor shall submit suitable information with a cover letter.

B. Submit one copy of data and cover letter for each copy of application.

1.04 PREPARATION OF APPLICATION FOR FINAL PAYMENT

A. Fill in application form as specified for progress payments.

1.05 SUBMITTAL PROCEDURE

A. Submit applications for payment at the times stipulated in the Agreement.

B. Number: Three (3) copies of each application; all signed and certified by the Contractor.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01200

PROJECT MEETINGS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Owner or Engineer shall schedule the pre-construction meeting, periodic progress meetings and special meetings, if required, throughout progress of work.

B. Representatives of contractors, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.

C. The Contractor shall attend meetings to ascertain that work is expedited consistent with Contract Documents and construction schedules.

1.02 PRE-CONSTRUCTION MEETING

A. Attendance:
   1. Owner's Engineer.
   2. Owner's Project Manager
   3. Contractor.
   4. Resident Project Representative.
   5. Related Labor Contractor's Superintendent.
   6. Major Subcontractors.
   7. Major Suppliers.
   8. Others as appropriate.

B. Suggested Agenda:
   1. Distribution and discussion of:
      a. List of major subcontractors.
      b. Projected Construction Schedules.
      c. Coordination of Utilities
   2. Critical work sequencing.
   3. Project Coordination.
      a. Designation of responsible personnel.
      b. Emergency contact persons with phone numbers.
   4. Procedures and processing of:
      a. Field decisions.
      b. Submittals.
      c. Change Orders.
      d. Applications for Payment.
   5. Procedures for maintaining Record Documents.
   6. Use of premises:
      a. Office, work and storage areas.
      b. Owner's REQUIREMENTS.
   7. Temporary utilities.
   8. Housekeeping procedures.
   9. Liquidated damages.
   10. Equal Opportunity Requirements.

11. Laboratory testing.
12. Project / Job meetings: Progress meeting, other special topics as needed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01310

CONSTRUCTION SCHEDULE & PROJECT RESTRAINTS

PART 1 GENERAL

1.01 GENERAL

A. Construction under this contract must be coordinated with the Owner and accomplished in a logical order to maintain utilization and flow through existing facilities and public properties and rights-of-way and to allow construction to be completed within the time allowed by Contract Documents and in the manner set forth in the Contract.

1.02 CONSTRUCTION SCHEDULING GENERAL PROVISIONS

A. No work shall be done between 7:00 p.m. and 7:00 a.m. nor on weekends or legal holidays without written permission of the Owner. However, emergency work may be done without prior permission.

B. Night work may be established by the Contractor as regular procedure with the written permission of the Owner. Such permission, however, may be revoked at any time by the Owner if the Contractor fails to maintain adequate equipment and supervision for the proper execution and control of the work at night.

C. Due to potential health hazards and requirements of the State of Florida and the U.S. Environmental Protection Agency, existing facilities must be maintained in operation.

D. The Contractor shall be fully responsible for providing all temporary piping, plumbing, electrical hook-ups, lighting, temporary structure, or other materials, equipment and systems required to maintain the existing facility's operations. All details of temporary piping and temporary construction are not necessarily shown on the Drawings or covered in the Specifications. However, this does not relieve the Contractor of the responsibility to insure that construction will not interrupt proper facility operations.

E. The Contractor shall designate an authorized representative of his firm who shall be responsible for development and maintenance of the schedule and of progress and payment reports. This representative of the Contractor shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the commitments of the Contractor's schedule.

1.03 PROGRESS OF THE WORK

A. The work shall be executed with such progress as may be required to prevent any delay to the general completion of the work. The work shall be executed at such times and in or on such parts of the project and with such forces, materials and equipment to assure completion of the work in the time established by the Contract and in the manner set forth in the Contract.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The Contractor shall submit a critical path schedule as described herein.

B. The planning, scheduling, management and execution of the work is the sole responsibility of the Contractor. The progress schedule requirement is established to allow Engineer to review Contractor's planning, scheduling, management and execution of the work; to assist Engineer in evaluating work progress and make progress payments and to allow other contractors to cooperate and coordinate their activities with those of the Contractor.

2.02 FORM OF SCHEDULES

A. Prepare schedules using the latest version of Microsoft Project, or other Owner approved software, in the form of a horizontal bar chart diagram. The diagram shall be time-scaled and sequenced by work areas. Horizontal time scale shall identify the first work day of each week.

B. Activities shall be at least as detailed as the Schedule of Values. Activity durations shall be in whole working days. In addition, man-days shall be shown for each activity or tabulated in an accompanying report.

C. Diagrams shall be neat and legible and submitted on sheets at least 8-1/2 inches by 11 inches suitable for reproduction. Scale and spacing shall allow space for notations and future revisions.

2.03 CONTENT OF SCHEDULES

A. Each monthly schedule shall be based on data as of the last day of the current pay period.

B. Description for each activity shall be brief, but convey the scope of work described.

C. Activities shall identify all items of work that must be accomplished to achieve substantial completion, such as items pertaining to Contractor's installation and testing activities; items pertaining to the approval of regulatory agencies; contractor's time required for submittals, fabrication and deliveries; the time required by Engineer to review all submittals as set forth in the Contract Documents; items of work required of Owner to support pre-operational, startup and final testing; time required for the relocation of utilities. Activities shall also identify interface milestones with the work of other contractors performing work under separate contracts with Owner.

D. Schedules shall show the complete sequence of construction by activities. Dates for beginning and completion of each activity shall be indicated as well as projected percentage of completion for each activity as of the first day of each month.

E. Submittal schedule for shop drawing review, product data, and samples shall show the date of Contractor submittal and the date approved submittals will be required by the Engineer, consistent with the time frames established in the Specifications.

F. For Contract change orders granting time extensions, the impact on the Contract date(s) shall equal the calendar-day total time extension specified for the applicable work in the Contract change orders.

G. For actual delays, add activities prior to each delayed activity on the appropriate critical path(s). Data on the added activities of this type shall portray all steps leading to the delay and shall further include the following: separate activity identification, activity description indicating cause of the delay, activity duration consistent with whichever set of dates below applies, the actual start and finish dates of the delay or, if the delay is not finished, the actual start date and estimated completion date.

H. For potential delays, add an activity prior to each potentially delayed activity on the appropriate critical path(s). Data for added activities of this type shall include alternatives available to mitigate the delay including acceleration alternatives and further show the following: separate activity identification, activity description indicating cause of the potential delay and activity duration equal to zero work days.

2.04 SUPPORTING NARRATIVE

A. Status and scheduling reports identified below shall contain a narrative to document the project status, to explain the basis of Contractor's determination of durations, describe the Contract conditions and restraints incorporated into the schedule and provide an analysis pertaining to potential problems and practical steps to mitigate them.

B. The narrative shall specifically include:
   1. Actual completion dates for activities completed during the monthly report period and actual start dates for activities commenced during the monthly report period.
   2. Anticipated start dates for activities scheduled to commence during the following monthly report period.
   3. Changes in the duration of any activity and minor logic changes.
   4. The progress along the critical path in terms of days ahead or behind the Contract date.
   5. If the Monthly Status Report indicates an avoidable delay to the Contract completion date or interim completion dates as specified in the Agreement, Contractor shall identify the problem, cause and the activities affected and provide an explanation of the proposed corrective action to meet the milestone dates involved or to mitigate further delays.
   6. If the delay is thought to be unavoidable, the Contractor shall identify the problem, cause, duration, specific activities affected and restraints of each activity.
   7. The narrative shall also discuss all change order activities whether included or not in the revised/current schedule of legal status. Newly introduced change order work activities and the CPM path(s) that they affect, must be specifically identified. All change order work activities added to the schedule shall conform with the sequencing and Contract Time requirements of the applicable Change Order.
   8. Original Contract date(s) shall not be changed except by Contract change order. A revision need not be submitted when the foregoing situations arise unless required by Engineer. Review of a report containing added activities will not be construed to be concurrence with the duration or restraints for such

added activities; instead the corresponding data as ultimately incorporated into the applicable Contract change order shall govern.

9. Should Engineer require additional data, this information shall be supplied by Contractor within 10 calendar days.

2.05 SUBMITTALS

A. Contractor shall submit estimated and preliminary progress schedules (as identified in the Terms and Conditions of the Contract and the General Conditions), monthly status reports, a start-up schedule and an as-built schedule report all as specified herein.

B. All schedules, including estimated and preliminary schedules, shall be in conformance with the Contract Documents.

C. The finalized progress schedule discussed in the Contract Documents shall be the first monthly status report and as such shall be in conformance with all applicable specifications contained herein.

D. Monthly Status Report submittals shall include three copies of a time-scaled (days after notice to proceed) diagram showing all contract activities and supporting narrative. The initial detailed schedule shall use the notice to proceed as the start date. The finalized schedule, if concurred with by Owner, shall be the work plan to be used by the contractor for planning, scheduling, managing and executing the work.

E. The schedule diagram shall be formatted as above. The diagram shall include (1) all detailed activities included in the preliminary and estimated schedule submittals, (2) calendar days prior to substantial completion, (3) summary activities for the remaining days. The critical path activities shall be identified, including critical paths for interim dates, if possible.

F. The Contractor shall submit monthly progress schedules with each month's application for payment.

G. Contractor shall submit three monthly status reports which will be retained by the Owner and Engineer.

2.06 MONTHLY STATUS REPORTS

A. Contractor shall submit three copies of detailed schedule status reports on a monthly basis with the Application for Payment. The first such status report shall be submitted with the first Application for Payment and include data as of the last day of the pay period. The Monthly Report shall include a "marked-up" copy of the latest detailed schedule of legal status and a supporting narrative including updated information as described above. The Monthly Report will be reviewed by Engineer and Contractor at a monthly schedule meeting and Contractor will address Engineer's comments on the subsequent monthly report. Monthly status reports shall be the basis for evaluating Contractor's progress.

B. The "marked-up" diagram shall show, for the latest detailed schedule of legal status, percentages of completion for all activities, actual start and finish dates and remaining durations, as appropriate. Activities not previously included in the latest

detailed schedule of legal status shall be added, except that contractual dates will not be changed except by change order. Review of a marked-up diagram by Engineer will not be construed to constitute concurrence with the time frames, duration, or sequencing for such added activities; instead the corresponding data as ultimately incorporated into an appropriate change order shall govern.

2.07 STARTUP SCHEDULE

A. At least 60 calendar days prior to the date of substantial completion, Contractor shall submit a time-scaled (days after notice to proceed) diagram detailing the work to take place in the period between 60 days prior to substantial completion, together with a supporting narrative. Engineer shall have 10 calendar days after receipt of the submittal to respond. Upon receipt of Engineer's comments, Contractor shall make the necessary revisions and submit the revised schedule within 10 calendar days. The resubmittal, if concurred with by Owner, shall be the Work Plan to be used by Contractor for planning, managing, scheduling and executing the remaining work leading to substantial completion.

B. The time-scaled diagram shall use the latest schedule of legal status for those activities completed ahead of the last 60 calendar days prior to substantial completion and detailed activities for the remaining 60-day period within the time frames outlined in the latest schedule of legal status.

C. Contractor will be required to continue the requirement for monthly reports, as outlined above. In preparing this report, Contractor must assure that the schedule is consistent with the progress noted in the startup schedule.

2.08 REVISIONS

A. All revised Schedule Submittals shall be made in the same form and detail as the initial submittal and shall be accompanied by an explanation of the reasons for such revisions, all of which shall be subject to review by Engineer and concurrence by Owner. The revision shall incorporate all previously made changes to reflect current as-built conditions. Minor changes to the approved submittal may be approved at monthly meetings; a minor change is not considered a revision in the context of this paragraph.

B. A revised schedule submittal shall be submitted for review when required by Engineer.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01340

SHOP DRAWINGS, PROJECT DATA AND SAMPLES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall submit to the Engineer for review and approval: working drawings, shop drawings, test reports and data on materials and equipment (hereinafter in this section called data), and material samples (hereinafter in this section called samples) as are required for the proper control of work, including, but not limited to those working drawings, shop drawings, data and samples for materials and equipment specified elsewhere in the Specifications and in the Contract Drawings.

B. Within thirty (30) calendar days after the effective date of the Agreement, the Contractor shall submit to the Engineer, a complete list of preliminary data on items for which Shop Drawings are to be submitted. Included in this list shall be the names of all proposed manufacturers furnishing specified items and the date on which each Shop Drawing shall be submitted. Review of this list by the Engineer shall in no way relieve the Contractor from submitting complete Shop Drawings and providing materials, equipment, etc., fully in accordance with the Specifications. This procedure is required in order to expedite final review of Shop Drawings.

C. The Contractor is to maintain an accurate updated submittal log and will bring this log to each scheduled progress meeting with the Owner and the Engineer. This log should include the following items:
   1. Submittal description and number assigned.
   2. Date to Engineer.
   3. Date returned to Contractor (from Engineer).
   4. Status of Submittal (No exceptions taken, returned for confirmation or resubmittal, rejected).
   5. Date of Resubmittal and Return (as applicable).
   6. Date material released (for fabrication).
   7. Projected date of fabrication.
   8. Projected date of delivery to site.
   9. Projected date and required lead time so that product installation does not delay contact.
   10. Status of O&M manuals submitted.

1.02 CONTRACTOR'S RESPONSIBILITY

A. It is the duty of the Contractor to check all drawings, data and samples prepared by or for him before submitting them to the Engineer for review. Each and every copy of the Drawings and data shall bear Contractor's stamp showing that they have been so checked. Shop drawings submitted to the Engineer without the Contractor's stamp will be returned to the Contractor for conformance with this requirement. Shop drawings shall indicate any deviations in the submittal from requirements of the contract Documents.

B. Determine and verify:
   1. Field measurements.
   2. Field construction criteria.
   3. Catalog numbers and similar data.
   4. Conformance with Specifications and indicate all variances from the Specifications.

C. The Contractor shall furnish the Engineer a schedule of Shop Drawing submittals fixing the respective dates for the submission of shop and working drawings, the beginning of manufacture, testing and installation of materials, supplies and equipment. This schedule shall indicate those that are critical to the progress schedule.

D. The Contractor shall not begin any of the work covered by a drawing, data, or a sample returned for correction until a revision or correction thereof has been reviewed and returned to him, by the Engineer, with No Exceptions Taken or Approved As Noted.

E. The Contractor shall submit to the Engineer all drawings and schedules sufficiently in advance of construction requirements to provide no less than twenty-one (21) calendar days for checking and appropriate action from the time the Engineer receives them.

F. The Contractor shall submit five (5) copies of descriptive or product data submittals to complement shop drawings for the Engineer plus the additional copies if the Contractor requires more than 1 being returned. The Engineer shall retain four (4) sets.

G. The Contractor shall be responsible for and bear all cost of damages which may result from the ordering of any material or from proceeding with any part of work prior to the completion of the review by Engineer of the necessary Shop Drawings.

1.03 ENGINEER'S REVIEW OF SHOP DRAWINGS AND WORKING DRAWINGS

A. The Engineer's review of drawings, data and samples submitted by the Contractor shall cover only general conformity to the Specifications, external connections and dimensions which affect the installation.

B. The review of drawings and schedules shall be general and shall not be construed:
   1. As permitting any departure from the Contract requirements.
   2. As relieving the Contractor of responsibility for any errors, including details, dimensions and materials.
   3. As approving departures from details furnished by the Engineer, except as otherwise provided herein.

C. If the drawings or schedules as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in Contract Price or time for performance, the Engineer may return the reviewed drawings without noting any exception.

D. When reviewed by the Engineer, each of the Shop and Working Drawings shall be identified as having received such review being so stamped and dated. Shop

Drawings stamped "REJECTED" and with required corrections shown shall be returned to the Contractor for correction and resubmittal.

E. Resubmittals will be handled in the same manner as first submittals. On resubmittals, the Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, to revisions other than the corrections requested by the Engineer on previous submissions. The Contractor shall make any corrections required by the Engineer.

F. If the Contractor considers any correction indicated on the drawings to constitute a change to the Contract Drawings or Specifications, the Contractor shall give written notice thereof to the Engineer.

G. The Engineer shall review a submittal/resubmittal a maximum of two (2) times after which cost of review shall be borne by the Contractor. The cost of engineering shall be equal to the Engineer's actual payroll cost.

H. When the Shop and Working Drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

I. No partial submittals shall be reviewed. Incomplete submittals shall be returned to the Contractor and shall be considered not approved until resubmitted.

1.04 SHOP DRAWINGS

A. When used in the Contract Documents, the term "Shop Drawings" shall be considered to mean Contractor's plans for material and equipment which become an integral part of the Project. These drawings shall be complete and detailed. Shop Drawings shall consist of fabrication, drawings, setting drawings, schedule drawings, manufacturer's scale drawings and wiring and control diagrams. Cuts, catalogs, pamphlets, descriptive literature and performance and test data, shall be considered only as supportive to required Shop Drawings as defined above.

B. Drawings and schedules shall be checked and coordinated with the work of all trades involved, before they are submitted for review by the Engineer and shall bear the Contractor's stamp of approval and original signature as evidence of such checking and coordination. Drawings or schedules submitted without this stamp of approval and original signature shall be returned to the Contractor for resubmission.

C. Each Shop Drawing shall have a blank area 3-1/2 inches by 3-1/2 inches, located adjacent to the title block. The title block shall display the following:
   1. Number and title of the drawing.
   2. Date of Drawing or revision.
   3. Name of project building or facility.
   4. Name of contractor and subcontractor submitting drawing.
   5. Clear identification of contents and location of the work.
   6. Specification title and number.

D. If drawings show variations from Contract requirements because of standard shop practice or for other reasons, the Contractor shall describe such variations in his letter of transmittal. If acceptable, proper adjustment in the contract shall be

implemented where appropriate. If the Contractor fails to describe such variations, he shall not be relieved of the responsibility of executing the work in accordance with the Contract, even though such drawings have been reviewed.

E. Data on materials and equipment shall include, without limitation, materials and equipment lists, catalog sheets, cuts, performance curves, diagrams, materials of construction and similar descriptive material. Materials and equipment lists shall give, for each item thereon, the name and location of the supplier or manufacturer, trade name, catalog reference, size, finish and all other pertinent data.

F. For all mechanical and electrical equipment furnished, the Contractor shall provide a list including the equipment name and address and telephone number of the manufacturer's representative and service company so that service and/or spare parts can be readily obtained.

G. All manufacturers or equipment suppliers who proposed to furnish equipment or products shall submit an installation list to the Engineer along with the required shop drawings. The installation list shall include at least five installations where identical equipment has been installed and have been in operation for a period of at least one (1) year.

H. Only the Engineer will utilize the color "red" in marking shop drawing submittals.

1.05 WORKING DRAWINGS

A. When used in the Contract Documents, the term "working drawings" shall be considered to mean the Contractor's fabrication and erection drawings for structures such as roof trusses, steelwork, precast concrete elements, bulkheads, support of open cut excavation, support of utilities, groundwater control systems, forming and false work; underpinning; and for such other work as may be required for construction of the project.

B. Copies of working drawings as noted above, shall be submitted to the Engineer where required by the Contract Documents or requested by the Engineer and shall be submitted at least thirty (30) days (unless otherwise specified by the Engineer) in advance of their being required for work.

C. Working drawings shall be signed by a registered Professional Engineer, currently licensed to practice in the State of Florida and shall convey, or be accompanied by, calculation or other sufficient information to completely explain the structure, machine, or system described and its intended manner of use. Prior to commencing such work, working drawings must have been reviewed without specific exceptions by the Engineer, which review will be for general conformance and will not relieve the Contractor in any way from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error are assumed by the Contractor; the Owner and Engineer shall not have responsibility therefore.

1.06 SAMPLES

A. The Contractor shall furnish, for the review of the Engineer, samples required by the Contract Documents or requested by the Engineer. Samples shall be delivered to the Engineer as specified or directed. The Contractor shall prepay all shipping

charges on samples. Materials or equipment for which samples are required shall not be used in work until reviewed by the Engineer.

B. Samples shall be of sufficient size and quantity to clearly illustrate:
   1. Functional characteristics of the product, with integrally related parts and attachment devices.
   2. Full range of color, texture and pattern.
   3. A minimum of two samples of each item shall be submitted.

C. Each sample shall have a label indicating:
   1. Name of product.
   2. Name of Contractor and Subcontractor.
   3. Material or equipment represented.
   4. Place of origin.
   5. Name of Producer and Brand (if any).
   6. Location in project. (Samples of finished materials shall have additional markings that will identify them under the finished schedules.)
   7. Reference specification paragraph.

D. The Contractor shall prepare a transmittal letter in triplicate for each shipment of samples containing the information required above. He shall enclose a copy of this letter with the shipment and send a copy of this letter to the Engineer. Review of a sample shall be only for the characteristics or use named in such and shall not be construed to change or modify any Contract requirements.

E. Reviewed samples not destroyed in testing shall be sent to the Engineer or stored at the site of the work. Reviewed samples of the hardware in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in work shall match the reviewed samples. If requested at the time of submission, samples which failed testing or were rejected shall be returned to the Contractor at his expense.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01370

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall submit to the Engineer a Schedule of Values allocated to the various portions of the work, within 10 days after date of Notice to Proceed.

B. Upon request of the Engineer, the Contractor shall support the values with data which will substantiate their correctness.

C. The Schedule of Values shall be used only as the basis for the Contractor's Applications for Payment.

1.02 FORM AND CONTENT OF SCHEDULE OF VALUES

A. Schedule of Values will be considered for approval by Engineer upon Contractor's request. Identify schedule with:
   1. Title of Project and location.
   2. Project number.
   3. Name and address of Contractor.
   4. Contract designation.
   5. Date of submission.

B. Schedule of Values shall list the installed value of the component parts of the work in sufficient detail to serve as a basis for computing values for progress payments during construction.

C. Follow the table of contents for the Contract Document as the format for listing component items for structures:
   1. Identify each line item with the number and title of the respective major section of the specification.
   2. For each line item, list sub values of major products or operations under item.

D. Follow the bid sheets included in this Contract Documents as the format for listing component items for pipelines.

E. The sum of all values listed in the schedule shall equal the total Contract sum.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall employ a competent photographer to take construction record photographs or perform video, recording including furnishing all labor, materials, equipment and incidentals necessary to obtain photographs and/or video recordings of all construction areas.

B. Preconstruction record information shall consist of video recordings on digital video disks (DVD).

C. Construction progress information shall consist of photographs and digital photographs on a recordable compact disc (CD-R).

1.02 QUALIFICATIONS

A. All photography shall be done by a competent camera operator who is fully experienced and qualified with the specified equipment.

B. For the video recording, the audio portion should be done by a person qualified and knowledgeable in the specifics of the Contract, who shall speak with clarity and diction so as to be easily understood.

1.03 PROJECT PHOTOGRAPHS

A. Provide two prints of each photograph with each pay application.

B. Provide one recordable compact disc with digital photographs with each pay application.

C. Negatives:
   1. All negatives shall remain the property of photographer.
   2. The Contractor shall require that photographer maintain negatives or protected digital files for a period of two years from date of substantial completion of the project.
   3. Photographer shall agree to furnish additional prints to Owner and Engineer at commercial rates applicable at time of purchase. Photographer shall also agree to participate as required in any litigation requiring the photographer as an expert witness.

D. The Contractor shall pay all costs associated with the required photography and prints. Any parties requiring additional photography or prints shall pay the photographer directly.

E. All project photographs shall be a single weight, color image. All finishes shall be smooth surface and glossy and all prints shall be 8 inches x 10 inches.

F. Each print shall have clearly marked on the back, the name of the project, the orientation of view, the date and time of exposure, name and address of the photographer and the photographers numbered identification of exposure.

G. All project photographs shall be taken from locations to adequately illustrate conditions prior to construction, or conditions of construction and state of progress. The Contractor shall consult with the Engineer at each period of photography for instructions concerning views required.

1.04 VIDEO RECORDINGS

A. Video, recording shall be done along all routes that are scheduled for construction. Video, recording shall include full, recording of both sides of all streets and the entire width of easements plus 10 feet on each side on which construction is to be performed. All video recording shall be in full color.

B. A complete view, in sufficient detail with audio description of the exact location shall be provided.

C. The engineering plans shall be used as a reference for stationing in the audio portion of the recordings for easy location identification.

D. Two complete sets of video recordings shall be delivered to the Engineer on DVD for the permanent and exclusive use of the Engineer prior to the start of any construction on the project.

E. All video recordings shall contain the name of the project, the date and time of the video, recording, the name and address of the photographer and any other identifying information required.

F. Construction shall not start until preconstruction video recordings are completed, submitted and accepted by the Engineer. In addition, no progress payments shall be made until the preconstruction video recordings are accepted by the Engineer.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01410

TESTING AND TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Owner shall employ and pay for the services of an independent testing laboratory to perform testing specifically indicated on the Contract Documents or called out in the Specifications. Owner may elect to have materials and equipment tested for conformity with the Contract Documents at any time.
   1. Contractor shall cooperate fully with the laboratory to facilitate the execution of its required services.
   2. Employment of the laboratory shall in no way relieve the Contractor's obligations to perform the work of the Contract.

1.02 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:
   1. Release, revoke, alter or enlarge on requirements of Contract Documents.
   2. Approve or accept any portion of the Work.
   3. Perform any duties of the Contractor.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel; provide access to Work and/or to Manufacturer's operations.

B. Secure and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.

C. Provide to the laboratory the preliminary design mix proposed to be used for concrete, and other material mixes which require control by the testing laboratory.

D. Materials and equipment used in the performance of work under this Contract are subject to inspection and testing at the point of manufacture or fabrication. Standard specifications for quality and workmanship are indicated in the Contract Documents. The Engineer may require the Contractor to provide statements or certificates from the manufacturers and fabricators that the materials and equipment provided by them are manufactured or fabricated in full accordance with the standard specifications for quality and workmanship indicated in the Contract Documents. All costs of this testing and providing statements and certificates shall be a subsidiary obligation of the Contractor and no extra charge to the Owner shall be allowed on account of such testing and certification.

E. Furnish incidental labor and facilities:
   1. To provide access to work to be tested.
   2. To obtain and handle samples at the project site or at the source of the product to be tested.
   3. To facilitate inspections and tests.

4. For storage and curing of test samples.

F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.
   1. When tests or inspections cannot be performed due to insufficient notice, Contractor shall reimburse Owner for laboratory personnel and travel expenses incurred due to Contractor's negligence.

G. Employ and pay for the services of the same or a separate, equally qualified independent testing laboratory to perform additional inspections, sampling and testing required for the Contractor's convenience and as approved by the Engineer.

H. If the test results indicate the material or equipment complies with the Contract Documents, the Owner shall pay for the cost of the testing laboratory. If the tests and any subsequent retests indicate the materials and equipment fail to meet the requirements of the Contract Documents, the contractor shall pay for the laboratory costs directly to the testing firm or the total of such costs shall be deducted from any payments due the Contractor.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01510

TEMPORARY AND PERMANENT UTILITIES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. The Contractor shall be responsible for furnishing all requisite temporary utilities, i.e., power, water, sanitation, etc. The Contractor shall obtain and pay for all permits required as well as pay for all temporary usages. The Contractor shall remove all temporary facilities upon completion of work.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

A. Comply with National Electric Code (NEC).

B. Comply with Federal, State and Local codes and regulations and with utility company requirements.

C. Comply with County Health Department regulations.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL

A. Materials for temporary utilities may be "used". Materials for electrical utilities shall be adequate in capacity for the required usage, shall not create unsafe conditions and shall not violate requirements of applicable codes and standards.

2.02 TEMPORARY ELECTRICITY AND LIGHTING

A. Arrange with the applicable utility company for temporary power supply. Provide service required for temporary power and lighting and pay all costs for permits, service and for power used.

2.03 TEMPORARY WATER

A. The Contractor shall arrange with Manatee County Utilities Customer Service office to provide water for construction purposes, i.e., meter, pay all costs for installation, maintenance and removal, and service charges for water used.

B. The Contractor shall protect piping and fitting against freezing.

2.04 TEMPORARY SANITARY FACILITIES

A. The Contractor shall provide sanitary facilities in compliance with all laws and regulations.

B. The Contractor shall service, clean and maintain facilities and enclosures.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall maintain and operate systems to assure continuous service.

B. The Contractor shall modify and extend systems as work progress requires.

3.02 REMOVAL

A. The Contractor shall completely remove temporary materials and equipment when their use is no longer required.

B. The Contractor shall clean and repair damage caused by temporary installations or use of temporary facilities.

END OF SECTION

SECTION 01580

PROJECT IDENTIFICATION AND SIGNS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Furnish, install and maintain County project identification signs.

B. Remove signs on completion of construction.

C. Allow no other signs to be displayed except for traffic control and safety.

1.02 PROJECT IDENTIFICATION SIGN (COUNTY)

A. One painted sign, of not less than 32 square feet (3 square meters) area, with painted graphic content to include:
   1. Title of Project.
   2. Name of Owner.
   3. Names and titles of authorities as directed by Owner.
   4. Prime Contractor.

B. Graphic design, style of lettering and colors: As approved by the Engineer and subject to approval of the Owner.

C. Erect on the site at a lighted location of high public visibility, adjacent to main entrance to site, as approved by the Engineer and the Owner

1.03 INFORMATIONAL SIGNS

A. Painted signs with painted lettering, or standard products.
   1. Size of signs and lettering: as required by regulatory agencies, or as appropriate to usage.
   2. Colors: as required by regulatory agencies, otherwise of uniform colors throughout project.

B. Erect at appropriate locations to provide required information.

1.04 QUALITY ASSURANCE

A. Sign Painter: Professional experience in type of work required.

B. Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

1.05 PUBLIC NOTIFICATION

A. Door Hangers: Manatee County Project Management shall generate and the General Contractor shall distribute door hangers to all residents who will be impacted by project construction.

1. Residents impacted include anyone who resides inside, or within 500 feet of project limits of construction.

B. Door Hangers shall be distributed prior to start of construction of the project. Hangers shall be affixed to doors of residents via elastic bands or tape.

EXAMPLE:

PLEASE PARDON THE INCONVENIENCE WHILE THE ROADWAY IS BEING RECONSTRUCTED IN YOUR NEIGHBORHOOD

This project consists of utility improvements and the reconstruction of ??? Boulevard from U.S. ??? to ??? Street West. The project is expected to begin in August, 200X and be completed in July 200X.

Location Map

WE HOPE TO KEEP ANY INCONVENIENCE TO A MINIMUM. HOWEVER, IF YOU HAVE ANY PROBLEMS, PLEASE CONTACT THE FOLLOWING:

A. Contractor
Contractor Address
Contractor Phone (Site Phone)

B. Project Inspector
Inspector Phone Number

C. Project Manager
PM Address
PM Phone No. & Ext.

AFTER HOURS EMERGENCY NUMBER – (941) 747-HELP
THANK YOU FOR YOUR UNDERSTANDING AND PATIENCE
MANATEE COUNTY GOVERNMENT – PROJECT MANAGEMENT DEPT.

PART 2 PRODUCTS

2.01 SIGN MATERIALS

A. Structure and Framing: May be new or used, wood or metal, in sound condition structurally adequate to work and suitable for specified finish.

B. Sign Surfaces: Exterior softwood plywood with medium density overlay, standard large sizes to minimize joints.
1. Thickness: As required by standards to span framing members, to provide even, smooth surface without waves or buckles.

C. Rough Hardware: Galvanized.

D. Paint: Exterior quality, as specified in the Contract Documents.

PART 3 EXECUTION

3.01 PROJECT IDENTIFICATION SIGN

A. Paint exposed surface or supports, framing and surface material; one (1) coat of primer and one (1) coat of exterior paint.

B. Paint graphics in styles, size and colors selected.

3.02 MAINTENANCE

A. The Contractor shall maintain signs and supports in a neat, clean condition; repair damages to structures, framing or sign.

3.03 REMOVAL

A. The Contractor shall remove signs, framing, supports and foundations at completion of project.

END OF SECTION

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SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Material and equipment incorporated into the work:
   1. Conform to applicable specifications and standards.
   2. Comply with size, make, type and quality specified, or as specifically approved in writing by the Engineer.
   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 gages, to be interchangeable.
      c. Two (2) or more items of the same kind shall be identical and manufactured by the same manufacturer.
      d. Products shall be suitable for service conditions.
      e. Equipment capacities, sizes and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing.
   4. Do not use material or equipment for any purpose other than that for which it is specified.
   5. All material and equipment incorporated into the project shall be new.

1.02 MANUFACTURER'S INSTRUCTIONS

A. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including two (2) copies to Engineer. Maintain one (1) set of complete instructions at the job site during installation and until completion.

B. Handle, install, connect, clean, condition and adjust products in strict accordance with such instructions and in conformity with specified requirements. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding. Do not proceed with work without clear instructions.

1.03 TRANSPORTATION AND HANDLING

A. Arrange deliveries of products in accordance with construction schedules, coordinate to avoid conflict with work and conditions at the site.
   1. Deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
   2. Immediately on delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved submittals and that products are properly protected and undamaged.

B. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

1.04 SUBSTITUTIONS AND PRODUCT OPTIONS

A. Contractor's Options:
   1. For products specified only by reference standard, select any product meeting that standard.
   2. For products specified by naming one or more products or manufacturers and "or equal", Contractor must submit a request for substitutions of any product or manufacturer not specifically named in a timely manner so as not to adversely affect the construction schedule.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01614

WIND DESIGN CRITERIA GENERAL SUMMARY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Wind design criteria.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Building code criteria: Design for wind in accordance with 2010 Florida Building Code, local amendments, and errata.
   2. Basic wind speed: 160 miles per hour.
   3. Exposure category: C.
   4. Topographic factor, K_{tz}: 1.0.
      a. Use anchor bolts, bolts, or welded studs for anchors for resisting wind forces. Anchor bolts used to resist wind forces shall have a standard hex bolt head. Do not use anchor bolts fabricated from rod stock with an L or J shape:
         1) Do not use concrete anchors, sleeve anchors, flush shells, chemical anchors, powder actuated fasteners, or other types of anchor unless indicated on the Drawings or accepted in writing by the Engineer.
         2) Wind forces must be resisted by direct bearing on the anchors used to resist wind forces. Do not use connections which use friction to resist wind forces.

1.03 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and wind design calculations where required by Specifications.

B. Calculations shall be signed and stamped by a Civil or Structural Engineer licensed in the state where the work will be installed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01620

STORAGE AND PROTECTION

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Provide secure storage and protection for products to be incorporated into the Work and maintenance and protection for products after installation and until completion of Work.

1.02 STORAGE

A. Store products immediately on delivery and protect until installed in the Work, in accordance with manufacturer's instructions, with seals and labels intact and legible.

B. Exterior Storage
   1. Provide substantial platform, blocking or skids to support fabricated products above ground to prevent soiling or staining.
      a. Cover products, subject to discoloration or deterioration from exposure to the elements, with impervious sheet coverings. Provide adequate ventilation to avoid condensation.
      b. Prevent mixing of refuse or chemically injurious materials or liquids.

C. Arrange storage in a manner to provide easy access for inspection.

1.03 MAINTENANCE OF STORAGE

A. Maintain periodic system of inspection of stored products on scheduled basis to assure that:
   1. State of storage facilities is adequate to provide required conditions.
   2. Required environmental conditions are maintained on continuous basis.
   3. Surfaces of products exposed to elements are not adversely affected. Any weathering of products, coatings and finishes is not acceptable under the requirements of these Contract Documents.

B. Mechanical and electrical equipment which require servicing during long term storage shall have complete manufacturer's instructions for servicing accompanying each item, with notice of enclosed instructions shown on exterior of package.
   1. Equipment shall not be shipped until approved by the Engineer. The intent of this requirement is to reduce on-site storage time prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one (1) month prior to installation without written authorization from the Engineer.
   2. All equipment having moving parts such as gears, electric motors, etc. and/or instruments shall be stored in a temperature and humidity controlled building approved by the Engineer until such time as the equipment is to be installed.
   3. All equipment shall be stored fully lubricated with oil, grease, etc. unless otherwise instructed by the manufacturer.

4. Moving parts shall be rotated a minimum of once weekly to insure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to insure that the equipment does not deteriorate from lack of use.
5. Lubricants shall be changed upon completion of installation and as frequently as required, thereafter during the period between installation and acceptance.
6. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

1.04 PROTECTION AFTER INSTALLATION

A. Provide protection of installed products to prevent damage from subsequent operations. Remove when no longer needed, prior to completion of Work.

B. Control traffic to prevent damage to equipment and surfaces.

C. Provide coverings to protect finished surfaces from damage.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Comply with requirements stated in Conditions of the Contract and in Specifications for administrative procedures in closing out the Work.

1.02 SUBSTANTIAL COMPLETION

A. The Contractor shall submit the following items when the Contractor considers the Work to be substantially complete:
   1. A written notice that the Work, or designated portion thereof, is substantially complete.
   2. A list of items to be completed or corrected.

B. Within a reasonable time after receipt of such notice, the Engineer and Owner shall make an inspection to determine the status of completion.

C. Project record documents and operations and maintenance manuals must be submitted before the project shall be considered substantially complete.

D. If the Engineer determines that the Work is not substantially complete:
   1. The Engineer shall notify the Contractor in writing, stating the reasons.
   2. The Contractor shall remedy the deficiencies in the Work and send a second written notice of substantial completion to the Engineer.
   3. The Engineer shall reinspect the Work.

E. When the Engineer finds that the Work is substantially complete:
   1. He shall prepare and deliver to the Owner a tentative Certificate of Substantial Completion (Manatee County Project Management Form PMD-8) with a tentative list of the items to be completed or corrected before final payment.
   2. The Engineer shall consider any objections made by the Owner as provided in Conditions of the Contract. When the Engineer considers the Work substantially complete, he will execute and deliver to the Owner and the Contractor a definite Certificate of Substantial Completion (Manatee County Project Management Form PMD-8) with a revised tentative list of items to be completed or corrected.

1.03 FINAL INSPECTION

A. When the Contractor considered the Work to be complete, he shall submit written certification stating that:
   1. The Contract Documents have been reviewed.
   2. The Work has been inspected for compliance with Contract Documents.
   3. The Work has been completed in accordance with Contract Documents.
   4. The equipment and systems have been tested in the presence of the Owner's representative and are operational.

5. The Work is completed and ready for final inspection.

B. The Engineer shall make an inspection to verify the status of completion after receipt of such certification.

C. If the Engineer determines that the Work is incomplete or defective:
   1. The Engineer shall promptly notify the Contractor in writing, listing the incomplete or defective Work.
   2. The Contractor shall take immediate steps to remedy the stated deficiencies and send a second written certification to Engineer that the Work is complete.
   3. The Engineer shall reinspect the Work.

D. Upon finding the Work to be acceptable under the Contract Documents, the Engineer shall request the Contractor to make closeout submittals.

E. For each additional inspection beyond a total of three (3) inspections for substantial and final completion due to the incompleteness of the Work, the Contractor shall reimburse the Owner for the Engineer's fees.

1.04 CONTRACTOR'S CLOSEOUT SUBMITTALS TO ENGINEER

A. Project Record Documents (prior to substantial completion).

B. Operation and maintenance manuals (prior to substantial completion).

C. Warranties and Bonds.

D. Evidence of Payment and Release of Liens: In accordance with requirements of General and Supplementary Conditions.

E. Certification letter from Florida Department of Transportation and Manatee County Department of Transportation, as applicable.

F. Certificate of Insurance for Products and Completed Operations.

G. Final Reconciliation, Warranty Period Declaration, and Contractor's Affidavit (Manatee County Project Management Form PMD-9).

1.05 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer.

B. Statement shall reflect all adjustments to the Contract Sum:
   1. The original Contract Sum.
   2. Additions and deductions resulting from:
      a. Previous Change Orders
      b. Unit Prices
      c. Penalties and Bonuses
      d. Deductions for Liquidated Damages
      e. Other Adjustments
   3. Total Contract Sum, as adjusted.
   4. Previous payments.
   5. Sum remaining due.

C. Project Management shall prepare a final Change Order, reflecting approved adjustments to the Contract Sum which were not previously made by Change Orders.

1.06 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment in accordance with procedures and requirements stated in the Conditions of the Contract.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01710

CLEANING

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Execute cleaning during progress of the Work and at completion of the Work, as required by the General Conditions.

1.02 DISPOSAL REQUIREMENTS

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

PART 2 PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

A. Execute periodic cleaning to keep the Work, the site and adjacent properties free from accumulation of waste materials, rubbish and wind-blown debris, resulting from construction operations.

B. Provide on-site containers for the collection of waste materials, debris and rubbish.

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

3.02 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.03 FINAL CLEANING

A. Employ skilled workmen for final cleaning.

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

C. Prior to final completion or Owner occupancy, Contractor shall conduct an inspection of sight-exposed interior and exterior surfaces and all work areas to verify that the entire Work is clean.

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Contractor shall maintain at the site for the Owner one (1) record copy of:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Engineer's field orders or written instructions.
   6. Approved shop drawings, working drawings and samples.
   7. Field test records.
   8. Construction photographs.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Store documents and samples in Contractor's field office apart from documents used for construction.
   1. Provide files and racks for storage of documents.
   2. Provide locked cabinet or secure storage space for storage of samples.

B. File documents and samples in accordance with CSI format.

C. Maintain documents in a clean, dry, legible, condition and in good order. Do not use record documents for construction purposes.

D. Make documents and samples available at all times for inspection by the Engineer.

1.03 MARKING DEVICES

A. Provide felt tip marking pens for recording information in the color code designated by the Engineer.

1.04 RECORDING

A. Label each document "PROJECT RECORD" in neat large printed letters.

B. Record information concurrently with construction progress.

C. Do not conceal any work until required information is recorded.

D. Drawings; Legibly mark to record actual construction:
   1. All underground piping with elevations and dimensions. Changes to piping location. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements. Actual installed pipe material, class, etc. Locations of drainage ditches, swales, water lines and force mains shall be shown every 200 feet (measured along the

centerline) or alternate lot lines, whichever is closer. Dimensions at these locations shall indicate distance from centerline of right-of-way to the facility.
2. Field changes of dimension and detail.
3. Changes made by Field Order or by Change Order.
4. Details not on original contract drawings.
5. Equipment and piping relocations.
6. Locations of all valves, fire hydrants, manholes, water and sewer services, water and force main fittings, underdrain cleanouts, catch basins, junction boxes and any other structures located in the right-of-way or easement, shall be located by elevation and by station and offset based on intersection P.I.'s and centerline of right-of-way. For facilities located on private roads, the dimensioning shall be from centerline of paving or another readily visible baseline.
7. Elevations shall be provided for all manhole rim and inverts; junction box rim and inverts; catch basin rim and inverts; and baffle, weir and invert elevations in control structures. Elevations shall also be provided at the PVI's and at every other lot line or 200 feet, whichever is less, of drainage swales and ditches. Bench marks and elevation datum shall be indicated.
8. Slopes for pipes and ditches shall be recalculated, based on actual field measured distances, elevations, pipe sizes, and type shown. Cross section of drainage ditches and swales shall be verified.
9. Centerline of roads shall be tied to right-of-way lines. Elevation of roadway centerline shall be given at PVI's and at all intersections.
10. Record drawings shall show bearings and distances for all right-of-way and easement lines, and property corners.
11. Sidewalks, fences and walls, if installed at the time of initial record drawing submittal, shall be located every 200 feet or alternate lot lines, whichever is closer. Dimensions shall include distance from the right-of-way line and the back of curb and lot line or easement line.
12. Sanitary sewer mainline wyes shall be located from the downstream manhole. These dimensions shall be provided by on-site inspections or televiewing of the sewer following installation.
13. Elevations shall be provided on the top of operating nuts for all water and force main valves.
14. Allowable tolerance shall be ± 6.0 inches for horizontal dimensions. Vertical dimensions such as the difference in elevations between manhole inverts shall have an allowable tolerance of ± 1/8 inch per 50 feet (or part thereof) of horizontal distance up to a maximum tolerance of ± 2 inch.
15. Properly prepared record drawings on mylar, together with two (2) copies, shall be certified by a design professional (Engineer and/or Surveyor registered in the State of Florida), employed by the Contractor, and submitted to the Owner/Engineer.

E. Specifications and Addenda; Legibly mark each Section to record:
1. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed.
2. Changes made by field order or by change order.

F. Shop Drawings (after final review and approval):
1. Five (5) sets of record drawings for each process equipment, piping, electrical system and instrumentation system.

1.05 SUBMITTAL

A. Prior to substantial completion and prior to starting the bacteria testing of water lines, deliver signed and sealed Record Documents and Record Drawings to the Engineer. These will be reviewed and verified by the inspector. If there are any required changes or additions, these shall be completed and the entire signed and sealed set resubmitted prior to final pay application.

B. The Contractor shall employ a Professional Engineer or Surveyor registered in the State of Florida to verify survey data and properly prepare record drawings. Record drawings shall be certified by the professional(s) (Engineer or Surveyor licensed in Florida), as stipulated by the Land Development Ordinance and submitted on signed and dated mylar drawings together with a recordable compact disk (CD-R).

C. The CD-R shall contain media in AutoCad Version 12 or later, or in any other CAD program compatible with AutoCad in DWG or DXF form. All fonts, line types, shape files or other pertinent information used in the drawing and not normally included in AutoCad shall be included on the media with a text file or attached noted as to its relevance and use.

D. Accompany submittal with transmittal letter, containing:
   1. Date.
   2. Project title and number.
   3. Contractor's name and address.
   4. Title and number of each Record Document.
   5. Signature of Contractor or his authorized representative.

   Note: The data required to properly prepare these Record Drawings shall be obtained at the site, at no cost to the County by the responsible design professional or his/her duly appointed representative. The appointed representative shall be a qualified employee of the responsible design professional or a qualified inspector retained by the responsible design professional on a project-by-project basis.

PART 2 STANDARDS

2.01 MINIMUM RECORD DRAWING STANDARDS FOR ALL RECORD DRAWINGS SUBMITTED TO MANATEE COUNTY

A. Record Drawings shall be submitted to at least the level of detail in the contract documents. It is anticipated that the original contract documents shall serve as at least a background for all record information. Original drawings in CAD format may be requested of the Engineer.

B. Drawings shall meet the criteria of paragraph 1.04 D above.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01730

OPERATING AND MAINTENANCE DATA

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Compile product data and related information appropriate for Owner's maintenance and operation of products furnished under Contract.

B. Prepare operating and maintenance data as specified in this and as referenced in other pertinent sections of Specifications.

C. Instruct Owner's personnel in maintenance of products and equipment and systems.

D. Provide three (3) sets of operating and maintenance manuals for each piece of equipment provided within this Contract.

1.02 FORM OF SUBMITTALS

A. Prepare data in form of an instructional manual for use by Owner's personnel.

B. Format:
   1. Size: 8-1/2 inch x 11 inch
   2. Paper: 20 pound minimum, white, for typed pages
   3. Text: Manufacturer's printed data or neatly typewritten
   4. Drawings:
      a. Provide reinforced punched binder tab, bind in with text.
      b. Fold larger drawings to size of text pages.
   5. Provide fly-leaf for each separate product or each piece of operating equipment.
      a. Provide typed description of product and major component parts of equipment.
      b. Provide indexed tabs.
   6. Cover: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". List:
      a. Title of Project.
      b. Identity of separate structures as applicable.
      c. Identity of general subject matter covered in the manual.

C. Binders:
   1. Commercial quality three-ring binders with durable and cleanable plastic covers.
   2. Maximum ring size: 1 inch.
   3. When multiple binders are used, correlate the data into related consistent groupings.

1.03 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit three (3) copies of complete manual in final form.

B. Content for each unit of equipment and system, as appropriate:
   1. Description of unit and component parts.
      a. Function, normal operating characteristics and limiting conditions.
      b. Performance curves, engineering data and tests.
      c. Complete nomenclature and commercial number of replaceable parts.
   2. Operating Procedures:
      a. Start-up, break-in, routine and normal operating instructions.
      b. Regulation, control, stopping, shut-down and emergency instructions.
      c. Summer and winter operating instructions.
      d. Special operating instructions.
   3. Maintenance Procedures:
      a. Routine operations.
      b. Guide to "trouble-shooting".
      c. Disassembly, repair and reassembly.
      d. Alignment, adjusting and checking.
   4. Servicing and lubricating schedule.
      a. List of lubricants required.
   5. Manufacturer's printed operating and maintenance instructions.
   6. Description of sequence of operation by control manufacturer.
   7. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
      a. List of predicted parts subject to wear.
      b. Items recommended to be stocked as spare parts.
   8. As installed control diagrams by controls manufacturer.
   9. Each contractor's coordination drawings.
      a. As installed color-coded piping diagrams.
   10. Charts of valve tag numbers, with location and function of each valve.
   11. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.
   12. Other data as required under pertinent sections of specifications.

C. Content, for each electric and electronic system, as appropriate:
   1. Description of system and component parts.
      a. Function, normal operating characteristics and limiting conditions.
      b. Performance curves, engineering data and tests.
      c. Complete nomenclature and commercial number of replaceable parts.
   2. Circuit directories of panelboards.
      a. Electrical service.
      b. Controls.
      c. Communications.
   3. As-installed color-coded wiring diagrams.
   4. Operating procedures:
      a. Routine and normal operating instructions.
      b. Sequences required.
      c. Special operating instructions.
   5. Maintenance procedures:
      a. Routine operations.
      b. Guide to "trouble-shooting".
      c. Disassembly, repair and reassembly.
      d. Adjustment and checking.
   6. Manufacturer's printed operating and maintenance instructions.
   7. List of original manufacture's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage.

8. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.

D. Prepare and include additional data when the need for such data becomes apparent during instruction on Owner's personnel.

E. Additional requirements for operating and maintenance data: Respective sections of Specifications.

1.04 SUBMITTAL SCHEDULE

A. Submit one (1) copy of completed data in final form fifteen (15) days prior to substantial completion.
   1. Copy will be returned after substantial completion, with comments (if any).

B. Submit two (2) copies of approved data in final form. Final acceptance will not be provided until the completed manual is received and approved.

1.05 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to final inspection or acceptance, fully instruct Owner's designated operating and maintenance personnel in operation, adjustment and maintenance of products, equipment and systems.

B. Operating and maintenance manual shall constitute the basis of instruction.
   1. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01740

WARRANTIES AND BONDS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Compile specified warranties and bonds.

B. Compile specified service and maintenance contracts.

C. Co-execute submittals when so specified.

D. Review submittals to verify compliance with Contract Documents.

E. Submit to Engineer for review and transmittal to Owner.

1.02 SUBMITTAL REQUIREMENTS

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

B. Number of original signed copies required: Two (2) each.

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

1.03 FORM OF SUBMITTALS

A. Prepare in duplicate packets.

B. Format:
   1. Size 8-1/2 inch x 11 inch punched sheets for standard 3-ring binder. Fold larger sheets to fit into binders.
   2. Cover: Identify each packet with typed or printed title "WARRANTIES AND BONDS". List:
      a. Title of Project.
      b. Name of Contractor.

C. Binders: Commercial quality, three-ring, with durable and cleanable plastic covers.

1.04 TIME OF SUBMITTALS

A. Make submittals within ten (10) days after date of substantial completion and prior to final request for payment.

B. For items of work, where acceptance is delayed materially beyond date of substantial completion, provide updated submittal within ten (10) days after acceptance, listing date of acceptance as start of warranty period.

1.05 SUBMITTALS REQUIRED

A. Submit warranties, bonds, service and maintenance contracts as specified in respective sections of Specifications.

B. Approval by the Owner of all documents required under this section is a pre-requisite to requesting a final inspection and final payment

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01756

TESTING, TRAINING, AND FACILITY START-UP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for equipment and system testing and facility start-up, including the following:
   1. Start-up plan.
   2. Performance testing.
   3. General start-up and testing procedures.
   4. Functional testing.
   5. Operational testing.
   6. Certificate of proper installation.
   7. Services of manufacturer's representatives.
   8. Training of OWNER's personnel.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 15050 - Basic Mechanical Materials and Methods
      b. Section 15958 - Mechanical Equipment Testing.

1.02 GENERAL TESTING, TRAINING, AND START-UP REQUIREMENTS

A. Contract requirements: Testing, training, and start-up are requisite to the satisfactory completion of the Contract.

B. Complete testing, training, and start-up within the Contract Times.

C. Allow realistic durations in the Progress Schedule for testing, training, and start-up activities.

D. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.

E. Provide competent, experienced technical representatives of equipment manufacturers for assembly, installation and testing guidance, and operator training.

1.03 START-UP PLAN

A. Submit start-up plan for each piece of equipment and each system not less than 3 weeks prior to planned initial start-up of equipment or system.

B. Provide detailed sub-network of Progress Schedule with the following activities identified:
   1. Manufacturer's services.
   2. Installation certifications.
   3. Operator training.
   4. Submission of Operation and Maintenance Manual.
   5. Functional testing.
   6. Performance testing.
   7. Operational testing.

C. Provide testing plan with test logs for each item of equipment and each system when specified. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.

D. Provide summary of shutdown requirements for existing systems which are necessary to complete start-up of new equipment and systems.

E. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

1.04 PERFORMANCE TESTING

A. Test equipment for proper performance at point of manufacture or assembly when specified.

B. When source quality control testing is specified:
   1. Demonstrate equipment meets specified performance requirements.
   2. Provide certified copies of test results.
   3. Do not ship equipment until certified copies have received written acceptance from ENGINEER. Written acceptance does not constitute final acceptance.
   4. Perform testing as specified in the equipment sections.

1.05 GENERAL START-UP AND TESTING PROCEDURES

A. Mechanical systems: As specified in the individual equipment Sections and Sections 15050, and 15958:
   1. Remove rust preventatives and oils applied to protect equipment during construction.
   2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.
   3. Flush fuel system and provide fuel for testing and start-up.
   4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
   5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
   6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
   7. Perform cold alignment and hot alignment to manufacturer's tolerances.

8. Adjust V-belt tension and variable pitch sheaves.
9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to insure no leakage, but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.
10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

B. Electrical systems: As specified in the individual equipment Sections:
1. Perform insulation resistance tests on wiring except 120 volt lighting, wiring, and control wiring inside electrical panels.
2. Perform continuity tests on grounding systems.
3. Test and set switchgear and circuit breaker relays for proper operation.
4. Perform direct current high potential tests on all cables that will operate at more than 2,000 volts. Obtain services of independent testing lab to perform tests.
5. Check motors for actual full load amperage draw. Compare to nameplate value.

C. Instrumentation systems: As specified in the individual equipment Sections:
1. Bench or field calibrate instruments and make required adjustments and control point settings.
2. Leak test pneumatic controls and instrument air piping.
3. Energize transmitting and control signal systems, verify proper operation, ranges, and settings.

1.06 FUNCTIONAL TESTING

A. Perform checkout and performance testing as specified in the individual equipment Sections.

B. Functionally test mechanical and electrical equipment, and instrumentation and controls systems for proper operation after general start-up and testing tasks have been completed.

C. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.

D. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation, and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.

E. Conduct continuous 8-hour test under full load conditions. Replace parts which operate improperly.

1.07 OPERATIONAL TESTING

A. After completion of operator training, conduct operational test of the entire facility. Demonstrate satisfactory operation of equipment and systems in actual operation.

B. Conduct operational test for continuous 7-day period.

C. OWNER will provide operations personnel, power, fuel, and other consumables for duration of test.

D. Immediately correct defects in material, workmanship, or equipment which became evident during operational test.

E. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified.

1.08 CERTIFICATE OF PROPER INSTALLATION

A. At completion of Functional Testing, furnish written report prepared and signed by manufacturer's authorized representative, certifying equipment:
   1. Has been properly installed, adjusted, aligned, and lubricated.
   2. Is free of any stresses imposed by connecting piping or anchor bolts.
   3. Is suitable for satisfactory full-time operation under full load conditions.
   4. Operates within the allowable limits for vibration.
   5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
   6. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.

B. Furnish written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:
   1. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.
   2. Control logic for equipment start-up, shutdown, sequencing, interlocks, and emergency shutdown has been tested and is properly operating.
   3. Co-sign the reports along with the manufacturer's representative and subcontractors.

1.09 TRAINING OF OWNER'S PERSONNEL

A. Provide operations and maintenance training for items of mechanical, electrical, and instrumentation equipment. Utilize manufacturer's representatives to conduct training sessions.

B. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more than 2 sessions per week.

C. Provide Operation and Maintenance Manual for specific pieces of equipment or systems 1 month prior to training session for that piece of equipment or system.

D. Satisfactorily complete functional testing before beginning operator training.

E. Training sessions: Provide training sessions for equipment as specified in the individual equipment Sections.

F. The CONTRACTOR shall videotape all training sessions and provide a copy for the OWNER.

G. The CONTRACTOR shall designate and provide 1 or more persons to be responsible for coordinating and expediting his/her training duties. The person or persons so designated shall be present at all training coordination meetings with the OWNER.

H. The CONTRACTOR's coordinator shall coordinate the training periods with OWNER personnel and manufacturer's representatives, and shall submit a training schedule for each piece of equipment or system for which training is to be provided. Such training schedule shall be submitted not less than 21 calendar days prior to the time that the associated training is to be provided and shall be based on the current plan of operation.

1.10 RECORD KEEPING

A. Maintain and submit following records generated during start-up and testing phase of Project:
   1. Daily logs of equipment testing identifying all tests conducted and outcome.
   2. Logs of time spent by manufacturer's representatives performing services on the job site.
   3. Equipment lubrication records.
   4. Electrical phase, voltage, and amperage measurements.
   5. Insulation resistance measurements.
   6. Data sheets of control loop testing including testing and calibration of instrumentation devices and setpoints.

END OF SECTION

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SECTION 02485

SEEDING AND SODDING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials and equipment necessary to satisfactorily return all construction areas to their original conditions or better.

B. Work shall include furnishing and placing seed or sod, fertilizing, planting, watering and maintenance until acceptance by Engineer/Owner.

1.02 RELATED WORK NOT INCLUDED

A. Excavation, filling and grading required to establish elevation shown on the Drawings are included under other sections of these Specifications.

1.03 QUALITY ASSURANCE

A. It is the intent of this Specification that the Contractor is obliged to deliver a satisfactory stand of grass as specified. If necessary, the Contractor shall repeat any or all of the Work, including grading, fertilizing, watering and seeding or sodding at no additional cost to the Owner until a satisfactory stand is obtained. For purposes of grassing, a satisfactory stand of grass is herein defined as a full lawn cover over areas to be sodded or seeded, with grass free of weeds, alive and growing, leaving no bare spots larger than 3/4 square yard within a radius of eight (8) feet.

B. All previously grassed areas where pipelines are laid shall be sodded. All sodding and grassing shall be installed in accordance with these Specifications or as directed by the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fertilizer: The fertilizer shall be of the slow-release type meeting the following minimum requirements: 12 percent nitrogen, 8 percent phosphorus, 8 percent potassium; 40 percent other available materials derived from organic sources. At least 50 percent of the phosphoric acid shall be from normal super phosphate or an equivalent source which will provide a minimum of two units of sulfur. The amount of sulfur shall be indicated on the quantitive analysis card attached to each bag or other container. Fertilizer shall be uniform in composition, dry and free flowing delivered to sites in original unopened containers bearing manufacturer's statement or guarantee.

B. Seeding/Grassing: The Contractor shall grass all unpaved areas disturbed during construction which do not require sod. All grassing shall be completed in conformance with FDOT Specifications, Sections 570 and 981. The grassed areas

shall be mulched and fertilized in accordance with FDOT Specifications, except that no additional payment will be made for mulching, fertilizing and/or watering.

C. Sodding: Sod shall be provided as required on the construction drawings or at locations as directed by the Engineer in accordance with Florida Department of Transportation, Specifications Section 575 and 981. The Contractor shall furnish bahia grass sod or match existing sod. Placement and watering requirements shall be in accordance with FDOT Specifications Section 575, except that no additional payment will be made for placement and/or watering. This cost shall be included in the Contract price bid for sodding.

D. Topsoil: Topsoil stockpiled during excavation may be used as necessary. If additional topsoil is required to replace topsoil removed during construction, it shall be obtained off site at no additional cost to the Owner. Topsoil shall be fertile, natural surface soil, capable of producing all trees, plants and grassing specified herein.

E. Water: It is the Contractor's responsibility to supply all water to the site, as required during seeding and sodding operations and through the maintenance period and until the work is accepted. The Contractor shall make whatever arrangements that may be necessary to ensure an adequate supply of water to meet the needs for his work. He shall also furnish all necessary hose, equipment, attachments and accessories for the adequate irrigation of lawns and planted areas as may be required. Water shall be suitable for irrigation and free from ingredients harmful to plant life.

PART 3 EXECUTION

3.01 INSTALLATION

A. When the trench backfill has stabilized sufficiently, the Contractor shall commence work on lawns and grassed areas, including fine grading as necessary and as directed by the Engineer.

B. Finish Grading: Areas to be seeded or sodded shall be finish graded, raked, and debris removed. Soft spots and uneven grades shall be eliminated. The Engineer shall approve the finish grade of all areas to be seeded or sodded prior to seed or sod application.

C. Protection: Seeded and sodded areas shall be protected against traffic or other use by placing warning signs or erecting barricades as necessary. Any areas damaged prior to acceptance by the Owner shall be repaired by the Contractor as directed by the Engineer.

3.02 CLEANUP

A. Soil or similar materials spilled onto paved areas shall be removed promptly, keeping those areas as clean as possible at all times. Upon completion of seeding and sodding operations, all excess soil, stones and debris remaining shall be removed from the construction areas.

3.03 LANDSCAPE MAINTENANCE

A. Any existing landscape items damaged or altered during construction by the Contractor shall be restored or replaced as directed by the Engineer.

B. Maintain landscape work for a period of 90 days immediately following complete installation of work or until Owner accepts project. Watering, weeding, cultivating, restoration of grade, mowing and trimming, protection from insects and diseases, fertilizing and similar operations as needed to ensure normal growth and good health for live plant material shall be included at no additional cost to the Owner.

3.04 REPAIRS TO LAWN AREAS DISTURBED BY CONTRACTOR'S OPERATORS

A. Lawn areas planted under this Contract and all lawn areas damaged by the Contractor's operation shall be repaired at once by proper soil preparation, fertilizing and sodding, in accordance with these Specifications.

END OF SECTION

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SECTION 02615

DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals required to install ductile iron pipe and restrained joint ductile iron pipe and cast iron or ductile iron restrained joint fittings, complete, as shown on the Drawings and specified in these Standards.

B. Fittings are noted on the drawings for the Contractor's convenience and do not relieve him from laying and jointing different or additional items where required.

C. The Contractor shall furnish all labor, materials, equipment and incidentals required to install push-on joint or restrained joint ductile iron pipe, complete as shown on the Drawings and Specifications.

D. Newly installed pipe shall be kept clean and free of all foreign matter. All DI pipe installed underground shall be poly wrapped unless noted otherwise on the plans.

1.02 SUBMITTALS

A. The Contractor shall submit to the Engineer, within ten (10) days after receipt of Notice to Proceed, a list of materials to be furnished, the names of the suppliers and the appropriate shop drawings for all ductile iron pipe and fittings.

B. The Contractor shall submit the pipe manufacturer's certification of compliance with the applicable sections of the Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ductile iron pipe shall conform to ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51. Thickness of pipe shall be Class 50 or pressure Class 350. All pipe not buried shall be Class 53. All ductile iron pipe shall be clearly marked on the outside of the barrel to readily identify it from cast iron.

B. Unrestrained joint pipe shall be supplied in lengths not to exceed 21 feet. Unless otherwise called for in the Contract Documents, unrestrained joint pipe shall be either the rubber-ring type push-on joint or standard mechanical joint pipe as manufactured by the American Cast Iron Pipe Company, U.S. Pipe and Foundry Company, or approved equal.

C. All fittings shall be pressure rated for 350 psi and meet the requirement of AWWA C110 or AWWA C153. Rubber gaskets shall conform to ANSI A21.11 for mechanical and push-on type joints for diameters up to 14-inch diameter. Gaskets

for 16-inch diameter and larger pipe shall be EPDM (Ethylene-Propylene Dine Monomer) such as the "Fastite Gasket" of American Ductile Iron Pipe Co., or approved equal.

D. Water Mains: All ductile iron pipe and fittings shall have a standard thickness cement lining on the inside in accordance with AWWA/ANSI C104/A21.4 and a coal tar enamel coating on the outside. The coal tar enamel shall be in accordance with ANSI A21.4. All interior linings shall be EPA/NSF approved.

E. Force Main Fittings: All ductile iron fittings shall have a factory applied fusion bonded epoxy or epoxy and polyethylene lining on the inside in accordance with manufacturer's specifications and a coal tar enamel coating on the outside. The coal tar enamel shall be in accordance with ANSI A21.4. The interior lining is to be based on manufacturer's recommendation for long-term exposure to raw sewage. It shall have a minimum ten (10) year warranty covering failure of the lining and bond failure between liner and pipe.

F. Restrained joints shall be provided at all horizontal and vertical bends and fittings, at casings under roads and railroads and at other locations shown on the Contract Drawings. Restrained joint pipe fittings shall be designed and rated for the following pressures: 350 psi for pipe sizes up to and including 24 inch diameter; 250 psi for pipe sizes 30 inch diameter and above.

2.02 IDENTIFICATION

A. Each length of pipe and each fitting shall be marked with the name of the manufacturer, size and class and shall be clearly identified as ductile iron pipe. All gaskets shall be marked with the name of the manufacturer, size and proper insertion direction.

B. Pipe shall be poly wrapped blue for potable water mains, purple for reclaimed water mains and green for sewage force mains. All potable water pipe shall be NSF certified and copies of lab certification shall be submitted to the Engineer.

END OF SECTION

SECTION 02640

VALVES AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.

B. All valves and appurtenances shall be of the size shown on the Drawings and, to the extent possible, all equipment of the same type on the Project shall be from one manufacturer.

C. All valves and appurtenances shall have the name of the manufacturer and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

D. All valves shall have a factory applied, fusion bonded epoxy coating on interior and exterior unless noted otherwise in the plans or this specification.

E. The equipment shall include, but not be limited to, the following:
   1. Pressure Sustaining and Check Valves
   2. Ball Valves for PVC Pipe
   3. Plug Valves
   4. Valve Actuators
   5. Air Release Valves

1.02 DESCRIPTION OF SYSTEMS

A. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of potable water, reclaim water, wastewater, etc., depending upon the applications.

1.03 QUALIFICATIONS

A. All of the types of valves and appurtenances shall be products of well established, reputable firms who are fully experienced and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed and, installed in accordance with the best practices and methods and shall comply with these Specifications as applicable. Valves shall be as covered under mechanical devices in Section 8 of ANSI/NSF Standard 61.

1.04 SUBMITTALS

A. Submit to the Engineer within 30 days after execution of the contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.

B. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer for approval in accordance with the Specifications.

1.05 TOOLS

A. Special tools, if required for normal operation and maintenance shall be supplied with the equipment.

PART 2 PRODUCTS

2.01 PRESSURE SUSTAINING AND CHECK VALVE

A. Pressure sustaining and check valve shall be pilot operated diaphragm actuated valve with cast iron body, bronze trim, and 125-pound flanged ends. The valve shall be hydraulically operated, diaphragm type globe valve. The main valve shall have a single removable seat and a resilient disc, of rectangular cross section, surrounded on three and a half sides. The stainless steel stem shall be fully guided at both ends by a bearing in the valve cover, and an integral bearing in the valve seat. It shall be sleeved at both ends with delrin. No external packing glands are permitted and there shall be no pistons operating the main valve or any controls. The valve shall be equipped with isolation cocks to service the pilot system while permitting flow if necessary. Main valve and all pilot controls shall be manufactured in the United States of America. Valve shall be single chamber type, with seat cut to 5 degrees taper.

B. Valve shall maintain a minimum (adjustable) upstream pressure to a preset (adjustable) maximum. The pilot system shall consist of two direct acting, adjustable, spring loaded diaphragm valves.

C. Valve shall be cast iron (ASTM A48) with main valve trim of brass (QQB-B-626) and bronze (ASTM B61). The pilot control valves shall be cast brass (ASTM B62) with 303 stainless steel trim. All ferrous surfaces inside and outside shall have a 2-part epoxy coating. Valve shall be similar in all respects to CLA-VAL Company, Model 692G-01ABKG, as manufactured by CLA-VAL Company, , or similar pressure sustaining and check valve as manufactured by Golden Alderson; or approved equal.

2.02 BALL VALVES FOR PVC PIPE

A. Ball valves for PVC pipe shall be of PVC Type 1 with union, socket, threaded or flanged ends as required. Ball valves shall be full port, full flow, all plastic construction, 150 psi rated with teflon seat seals and T-handles. PVC ball valves shall be as manufactured by Celanese Piping Systems, Inc., Wallace and Tiernan, Inc., Plastiline, Inc., or approved equal.

B. All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

2.03 PLUG VALVES

A. All plug valves shall be eccentric plug valves capable of sustaining 150 psi in either direction without leaking. Exception: Single direction plug valves may be used if it is

clearly demonstrated they will never be required to resist pressure in both directions either in service or during pipe line testing.

B. Plug valves shall be tested in accordance with current AWWA Standard C-504-80 Section 5. Each valve shall be performance tested in accordance with paragraph 5.2 and shall be given a leakage test and hydrostatic test as described in paragraphs 5.3 and 5.4. The manufacturer shall furnish certified copies of reports covering proof of design testing as described in Section 5.5.

C. Plug valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connections as shown on the Plans. Flanged valves shall be faced and drilled to the ANSI 150 lb. standard. Mechanical joint ends shall be to the AWWA Standard C111-72. Bell ends shall be to the AWWA Standard C100-55 Class B. Screwed ends shall be to the NPT standard.

D. Plug valve bodies shall be of ASTM A126 Class B Semi-steel, 31,000 psi tensile strength minimum in compliance with AWWA Standard C507-73, Section 5.1 and AWWA Standard C504-70 Section 6.4. Port areas for valves 20-inches and smaller shall be 80 percent of full pipe area. Valves 24 inch and larger shall have a minimum port area between 80 and 100 percent of full nominal pipe area. All exposed nuts, bolts, springs, washers, etc. shall be zinc or cadmium plated. Resilient plug facings shall be of Hycar or Neoprene.

E. Plug valves shall be furnished with permanently lubricated stainless steel or oil-impregnated bronze upper and lower plug stem bushings. These bearings shall comply with current AWWA Standards.

2.04 VALVE ACTUATORS

A. General
   1. All valve actuators shall conform to Section 3.8 of the AWWA Standard Specification and shall be either manual or motor operated.
   2. Actuators shall be capable of seating and unseating the disc against the full design pressure and velocity, as specified for each class, into a dry system downstream, and shall transmit a minimum torque to the valve. Actuators shall be rigidly attached to the valve body.
   3. Butterfly valve actuators shall conform to the requirements of Section 3.8 of the AWWA Standard Specifications for Rubber Seated Butterfly Valves, Designated C504, insofar as applicable and as herein specified.

B. Manual Actuators
   1. Manual actuators shall have permanently lubricated, totally enclosed gearing with handwheel and gear ratio sized on the basis of actual line pressure and velocities. Actuators shall be equipped with handwheel, position indicator, and mechanical stop-limiting locking devices to prevent over travel of the disc in the open and closed positions. They shall turn counter-clockwise to open valves. Manual actuators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Actuators shall be fully enclosed and designed to produce the specified torque with a maximum pull of 80 pounds on the handwheel or chainwheel. Actuator components shall withstand an input of 450 foot pounds for 30" and smaller and 300 foot pounds for larger than 30" size valves at extreme actuator positions without damage. Valves located

above grade shall have handwheel and position indicator, and valves located below grade shall be equipped with a 2 inch square AWWA operating nut located at ground level and cast iron extension type valve box. Valve actuators shall conform to AWWA C504, latest revision.

C. Motor Actuators (Modulating)

1. The motor actuated valve controller shall include the motor, actuator unit gearing, limit switch gearing, limit switches, position transmitter which shall transmit a 4-20 mA DC signal, control power transformer, electronic controller which will position the valve based on a remote 4-20 milliamp signal, torque switches, bored and key-wayed drive sleeve for non-rising stem valves, declutch lever and auxiliary handwheel as a self-contained unit.
2. The motor shall be specifically designed for valve actuator service using 480 volt, 60 Hertz, three phase power as shown, on the electrical drawings. The motor shall be sized to provide an output torque and shall be the totally enclosed, non-ventilated type. The power gearing shall consist of helical gears fabricated from heat treated alloy steel forming the first stage of reduction. The second reduction stage shall be a single stage worm gear. The worm shall be of alloy steel with carburized threads hardened and ground for high efficiency. The worm gear shall be of high tensile strength bronze with hobbed teeth. All power gearing shall be grease lubricated. Ball or roller bearings shall be used throughout. Preference will be given to units having a minimum number of gears and moving parts. Spur gear reduction shall be provided as required.
3. Limit switches and gearing shall be an integral part of the valve control. The limit switch gearing shall be made of bronze and shall be grease lubricated, intermittent type and totally enclosed to prevent dirt and foreign matter from entering the gear train. Limit switches shall be of the adjustable type capable of being adjusted to trip at any point between fully opened valve and fully closed valve.
4. The speed of the actuator shall be the responsibility of the system supplier with regard to hydraulic requirements and response compatibility with other components within the control loop. Each valve controller shall be provided with a minimum of two rotor type gear limit switches, one for opening and one for closing. The rotor type gear limit switch shall have two normally open and two normally closed contacts per rotor. Gear limit switches must be geared to the driving mechanism and in step at all times whether in motor or manual operation. Provision shall be made for two additional rotors as described above, each to have two normally open and two normally closed contacts. Each valve controller shall be equipped with a double torque switch. The torque switch shall be adjustable and will be responsive to load encountered in either direction of travel. It shall operate during the complete cycle without auxiliary relays or devices to protect the valve, should excessive load be met by obstructions in either direction of travel. The torque switch shall be provided with double-pole contacts.
5. A permanently mounted handwheel shall be provided for manual operation. The handwheel shall not rotate during electric operations, but must be responsive to manual operation at all times except when being electrically operated. The motor shall not rotate during hand operation nor shall a fused motor prevent manual operation. When in manual operating position, the unit will remain in this position until motor is energized at which time the valve operator will automatically return to electric operation and shall remain in motor position until handwheel operation is desired. This movement from motor operation to handwheel operation shall be accomplished by a positive

declutching lever which will disengage the motor and motor gearing mechanically, but not electrically. Hand operation must be reasonably fast. It shall be impossible to place the unit in manual operation when the motor is running. The gear limit switches and torque switches shall be housed in a single easily accessible compartment integral with the power compartment of the valve control. All wiring shall be accessible through this compartment. Stepping motor drives will not be acceptable.

6. The motor with its control module must be capable of continuously modulating over its entire range without interruption by heat protection devices. The system, including the operator and control module must be able to function, without override protection of any kind, down to zero dead zone.
7. All units shall have strip heaters in both the motor and limit switch compartments.
8. The actuator shall be equipped with open-stop-close push buttons, an auto-manual selector switch, and indicating lights, all mounted on the actuator or on a separate locally mounted power control station.
9. The electronics for the electric operator shall be protected against temporary submergence.
10. Actuators shall be Limitorque L120 with Modutronic Control System containing a position transmitter with a 4-20MA output signal or equal.

D. Motor Actuators (Open-Close)

1. The electronic motor-driven valve actuator shall include the motor, actuator gearing, limit switch gearing, limit switches, torque switches, fully machined drive sleeve, declutch lever, and auxiliary handwheel as a self-contained unit.
2. The motor shall be specifically designed for valve actuator service and shall be of high torque totally enclosed, nonventilated construction, with motor leads brought into the limit switch compartment without having external piping or conduit box.
    a. The motor shall be of sufficient size to open or close the valve against maximum differential pressure when voltage to motor terminals is 10% above or below nominal voltage.
    b. The motor shall be prelubricated and all bearings shall be of the anti-friction type.
3. The power gearing shall consist of helical gears fabricated from heat treated steel and worm gearing. The worm shall be carburized and hardened alloy steel with the threads ground after heat treating. The worm gear shall be of alloy bronze accurately cut with a hobbing machine. All power gearing shall be grease lubricated. Ball or roller bearings shall be used throughout.
4. Limit switches and gearing shall be an integral part of the valve actuator. The switches shall be of the adjustable rotor type capable of being adjusted to trip at any point between fully opened valve and fully closed valve. Each valve controller shall be provided with a minimum of two (2) rotor type gear limit switches, one for opening and one for closing (influent valves require additional contacts to allow stopping at an intermediate position). The rotor type gear limit switch shall have two (2) normally open and two (2) normally closed contacts per toro. Additional switches shall be provided if shown on the control and/or instrumentation diagrams. Limit switches shall be geared to the driving mechanism and in step at all times whether in motor or manual operation. Each valve actuator shall be equipped with a double torque switch. The torque switch shall be adjustable and will be responsive to load encountered in either direction of travel. It shall operate during the complete cycle without auxiliary relays or devices to protect the valve should excessive load be met by

obstructions in either direction of travel. Travel and thrusts shall be independent of wear in valve disc or seat rings.

5. A permanently mounted handwheel shall be provided for manual operation. The handwheel shall not rotate during electric operation except when being electrically operated. The motor shall not rotate during hand operation, nor shall a fused motor prevent manual operation. When in manual operating position, the unit will remain in this position until motor is energized at which time the valve actuator will automatically return to electric operation and shall remain in motor position until handwheel operation is desired. Movement from motor operation to handwheel operation shall be accomplished by a positive declutching lever which will disengage the motor and motor gearing mechanically, but not electrically. Hand operation must be reasonably fast. It shall be impossible to place the unit in manual operation when the motor is running.
6. Valve actuators shall be equipped with an integral reversing controller and three phase overload relays, Open-Stop-Close push buttons, local-remote-manual selector switch, control circuit transformer, three-phase thermal overload relays and two (2) pilot lights in a NEMA 4X enclosure. In addition to the above, a close coupled air circuit breaker or disconnect switch shall be mounted and wired to the valve input power terminals for the purpose of disconnecting all underground phase conductors.
7. The valve actuator shall be capable of being controlled locally or remotely via a selector switch integral with the actuator. In addition, an auxiliary dry contact shall be provided for remote position feedback.
8. Valve A.C. motors shall be designed for operation on a 480 volt, 3-phase service. Valve control circuit shall operate from a fuse protected 120-volt power supply.
9. Motor operators shall be as manufactured by Limitorque Corporation, Type L120 or approved equal.

2.05 AIR RELEASE VALVES

A. The air release valves for use in water or force mains shall be installed as shown on the Drawings. The valves shall have a cast iron body cover and baffle, stainless steel float, bronze water diffuser, Buna-N or Viton seat, and stainless steel trim. The fittings shall be threaded. The air release valves shall be Model 200A or 400A as manufactured by APCO Valve and Primer Corporation or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. All valves and appurtenances shall be installed in the location shown, true to alignment and rigidly supported. Any damage occurring to the above items before they are installed shall be repaired to the satisfaction of the Engineer.

B. After installation, all valves and appurtenances shall be tested at least two hours at the working pressure corresponding to the class of pipe, unless a different test pressure is specified. If any joint proves to be defective, it shall be repaired to the satisfaction of the Engineer.

C. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and he shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.

D. Pipe for use with flexible couplings shall have plain ends as specified in the respective pipe sections.

E. Flanged joints shall be made with high strength, low alloy Corten bolts, nuts and washers. Mechanical joints shall be made with mild corrosion resistant alloy steel bolts and nuts. All exposed bolts shall be painted the same color as the pipe. All buried bolts and nuts shall be heavily coated with two (2) coats of bituminous paint comparable to Inertol No. 66 Special Heavy.

F. Prior to assembly of split couplings, the grooves as well as other parts shall be thoroughly cleaned. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap or graphite paste, and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, the gasket shall be centered properly over the pipe ends with the lips against the pipes. The housing sections then shall be placed. After the bolts have been inserted, the nuts shall be tightened until the housing sections are firmly in contact, metal-to-metal, without excessive bolt tension.

G. Prior to the installation of sleeve-type couplings, the pipe ends shall be cleaned thoroughly for a distance of 8". Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6 inches from the end.

H. Valve boxes with concrete bases shall be installed as shown on the Drawings. Mechanical joints shall be made in the standard manner. Valve stems shall be vertical in all cases. Place cast iron box over each stem with base bearing on compacted fill and the top flush with final grade. Boxes shall have sufficient bracing to maintain alignment during backfilling. Knobs on cover shall be parallel to pipe. Remove any sand or undesirable fill from valve box.

3.02 HYDRANTS

A. Hydrants shall be set at the locations designated by the Engineer and/or as shown on the Drawings and shall be bedded on a firm foundation. A drainage pit on crushed stone as shown on the Drawings shall be filled with gravel or crushed stone and satisfactorily compacted. During backfilling, additional gravel or crushed stone shall be brought up around and 6 inches over the drain port. Each hydrant shall be set in true vertical alignment and shall be properly braced. Concrete thrust blocks shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. Minimum bearing area shall be as shown on the plans. Felt paper shall be placed around the hydrant elbow prior to placing concrete. CARE MUST BE TAKEN TO INSURE THAT CONCRETE DOES NOT PLUG THE DRAIN PORTS. Concrete used for backing shall be as specified herein.

B. When installations are made under pressure, the flow of water through the existing main shall be maintained at all times. The diameter of the tap shall be a minimum of 2 inches less than the inside diameter of the branch line.

C. The entire operation shall be conducted by workmen thoroughly experienced in the installation of tapping sleeves and valves, and under the supervision of qualified personnel furnished by the manufacturer. The tapping machine shall be furnished by the Contractor if tap is larger than 12 inches in diameter.

D. The Contractor shall determine the locations of the existing main to be tapped to confirm the fact that the proposed position for the tapping sleeve will be satisfactory and no interference will be encountered such as the occurrence of existing utilities or of a joint or fitting at the location proposed for the connection. No tap will be made closer than 30 inches from a pipe joint.

E. Tapping valves shall be set in vertical position and be supplied with a 2-inch square operating nut for valves 2 inches and larger. The valve shall be provided with an oversized seat to permit the use of full sized cutters.

F. Tapping sleeves and valves with boxes shall be set vertically or horizontally as indicated on the Drawings and shall be squarely centered on the main to be tapped. Adequate support shall be provided under the sleeve and valve during the tapping operation. Sleeves shall be no closer than 30 inches from water main joints. Thrust blocks shall be provided behind all tapping sleeves. Proper tamping of supporting earth around and under the valve and sleeve is mandatory. After completing the tap, the valve shall be flushed to ensure that the valve seat is clean.

3.03 SHOP PAINTING

A. Ferrous surfaces of valves and appurtenances shall receive a coating of rust-inhibitive primer. All pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation.

3.04 FIELD PAINTING

A. All metal valves and appurtenances specified herein and exposed to view shall be painted.

3.05 INSPECTION AND TESTING

A. Completed pipe shall be subjected to hydrostatic pressure test for two (2) hours at 180 psi. All leaks shall be repaired and lines retested as approved by the Engineer. Prior to testing, the pipelines shall be supported in an approved manner to prevent movement during tests.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Cast-in-place concrete.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete.
   2. ACI Manual of Concrete Practice.

B. American Society for Testing and Materials (ASTM):
   1. C 31 - Practice for Making and Curing Concrete Test Specimens in the Field.
   2. C 33 - Specification for Concrete Aggregates.
   3. C 39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   4. C 40 - Test Method for Organic Impurities in Fine Aggregates for Concrete.
   5. C 42 – Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   6. C 88 - Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   7. C 94 - Specification for Ready-Mixed Concrete.
   8. C 114 - Test Methods for Chemical Analysis of Hydraulic Cement.
   9. C 117 - Test Method for Material Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing.
   10. C 123 - Test Method for Lightweight Particles in Aggregate.
   11. C 131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   12. C 136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   13. C 138 - Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
   14. C 142 - Test Method for Clay Lumps and Friable Particles in Aggregate.
   15. C 143 - Test Method for Slump of Hydraulic Cement Concrete.
   16. C 150 - Specification for Portland Cement.
   17. C 156 - Test Method for Water Retention by Concrete Curing Materials.
   18. C 157 - Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   19. C 171 - Specification for Sheet Materials for Curing Concrete.
   20. C 172 - Practice for Sampling Freshly Mixed Concrete.
   21. C 231 - Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   22. C 260 - Specification for Air-Entraining Admixtures for Concrete.
   23. C 289 - Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).

24. C 295 - Guide for Petrographic Examination of Aggregates for Concrete.
25. C 309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
26. C 311 - Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
27. C 494 - Specification for Chemical Admixtures for Concrete.
28. C 595 - Specification for Blended Hydraulic Cements.
29. C 618 - Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland-Cement Concrete.
30. C 1064 - Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
31. C 1017 - Specification for Chemical Admixtures for use in Producing Flowing Concrete.
32. D 75 - Practices for Sampling Aggregates.

C. NSF International (NSF)
   1. NSF Standard 61 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Alkali: Is defined to mean sum of sodium oxide and potassium oxide calculated as sodium oxide.

B. Hairline Crack: Crack with a crack width of less than 4 thousandths of an inch (0.004 inches).

1.04 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of portland cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.
      b. Proportion materials in a manner that will secure lowest water-cement ratio which is consistent with good workability, plastic, cohesive mixture, and one which is within specified slump range.
      c. Proportion fine and coarse aggregate in manner such as not to produce harshness in placing nor honeycombing in structures.
   2. Watertightness of Concrete Work: It is intent of this Section to secure for every part of the Work concrete and grout of homogeneous structure that, when hardened will have required strength, watertightness, and durability.
      a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.
      b. Construction, control and expansion joints have been positioned in structures as indicated on the Drawings, and curing methods have been specified, to reduce number and size of these expected cracks, due to normal expansion and contraction expected from specified concrete mixes.

c. Class A and Class B Concrete: Watertight: Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
d. Pressure inject visible cracks, other than hairline cracks and crazing, in following areas with epoxy as specified in Section 03931.
1) Floors and walls of water bearing structures.
2) Walls and overhead slabs of passageways or occupied spaces, outsides of which are exposed to weather or may be washed down and are not specified to receive separate waterproof membrane.
3) Other Items Not Specified to Receive Separate Waterproof Membrane: Slabs over water channels, wet wells, reservoirs, and other similar surfaces.
e. Walls or slabs, as specified above, that leak or sweat because of porosity or cracks too small for successful pressure grouting: Seal on water or weather side by coatings of surface sealant system, as specified in this Section.
f. Grouting and Sealing: Continue as specified above until structure is watertight and remains watertight for not less than one year after final acceptance or date of final repair, whichever occurs later in time.

3. Workmanship and Methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318 and ACI Manual of Concrete Practice.

1.05 SUBMITTALS

A. Product Data: Submit data completely describing products.

B. Information on Heating Equipment to Be Used for Cold Weather Concreting: Submit information on type of equipment to be used for heating materials and/or new concrete in process of curing during cold weather.

C. For conditions that promote rapid drying of freshly placed concrete such as low Humidity, high temperature, and wind: Submit corrective measures proposed for use prior to placing concrete.

D. Copies of Tests of Concrete Aggregates: Submit certified copies of commercial laboratory tests not more than 90 days old for samples of each aggregate proposed for use in concrete aggregates.
1. Fine Aggregate:
a. Clay lumps.
b. Reactivity.
c. Shale and chert.
d. Soundness.
e. Color.
f. Decantation.
2. Coarse Aggregate:
a. Clay lumps and friable particles.
b. Reactivity.
c. Shale and chert.
d. Soundness.
e. Abrasion loss.
f. Coal and lignite.

g. Materials finer than 200 sieve.

E. Sieve Analysis: Submit sieve analyses of fine and coarse aggregates being used at least every 3 weeks and at any time there is significant change in grading of materials.

F. Concrete Mixes: Submit full details, including mix design calculations for concrete mixes proposed for use for each class of concrete.
   1. Include information on correction of batching for varying moisture contents of fine aggregate.
   2. Submit source quality test records with mix design submittal.
      a. Include calculations for required average compression strength of concrete (f'_cr) based on source quality test records.

G. If There is Change in Aggregate Source, or Aggregate Quality from Same Source: Submit new set of design mixes covering each class of concrete.

H. Test Batch Test Data:
   1. Submit data for each test cylinder.
   2. Submit data that identifies mix and slump for each test cylinder.

I. Sequence of Concrete Placing: Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements.

J. Curing Compound: Submit complete data on proposed compound.

K. Repair of Defective Concrete: Submit mix design for grout.

L. Acceptance of Method of Concrete Repair: Make no repair until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.

M. If Either Fine or Coarse Aggregate Is Batched from More than One Bin: Submit analyses for each bin, and composite analysis made up from these, using proportions of materials to be used in mix.

N. Cement Mill Tests: Include alkali content, representative of each shipment of cement for verification of compliance with specified requirements.

O. Pozzolan Certificate of Compliance: Identify source of Pozzolan and certify compliance with requirements of ASTM C 618.

P. Admixtures: Manufacturer’s catalog cuts and product data indicating compliance with standards specified.
   1. If air entraining admixture requires test method other than ASTM C 231 to accurately determine air content, make special not of requirements in submittal.

Q. Information on mixing equipment.

R. CONTRACTOR’s report of field quality control testing for slump, temperature, unit weight, and air entrainment. Include designation numbers for associated compressive strength test cylinders with report.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:
   1. Deliver, store, and handle concrete materials in manner as to prevent damage and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.
   3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.

B. Acceptance at Site: Reject material containers or materials showing evidence of water or other damage.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Hot Weather Concreting:
      a. When Ambient Air Temperature Is above 90 Degrees Fahrenheit: Prior to placing concrete, cool forms and reinforcing steel to by water cooling to below 90 degrees Fahrenheit.
      b. Temperature of Concrete Mix at Time of Placement: Keep temperature below 90 degrees Fahrenheit by methods that do not impair quality of concrete.
   2. Cold Weather Concreting:
      a. Concrete placed below ambient air temperature of 45 degrees Fahrenheit and falling or below 40 degrees Fahrenheit: Make provision for heating water.
      b. If materials have been exposed to freezing temperatures to degree that any material is below 35 degrees Fahrenheit: Heat such materials.
      c. Heating Water, Cement, or Aggregate Materials:
         1) Do not heat in excess of 160 degrees Fahrenheit.
      d. Protection of Concrete in Forms:
         1) Protect by means of covering with tarpaulins, or other acceptable covering.
         2) Provide means for circulating warm moist air around forms in manner to maintain temperature of 50 degrees Fahrenheit for at least 5 days.
   3. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Take corrective measures to minimize rapid water loss from concrete.
   4. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature around concrete.

1.08 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in such manner as to complete any single placing operation to construction, contraction, or expansion joint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate:

1. General:
   a. Provide concrete aggregates that are sound, graded as specified, and free of deleterious material in excess of allowable amounts specified.
   b. Test for aggregate gradation in accordance with ASTM D 75 and C 136.
   c. Provide unit weight of fine and coarse aggregate to produce in place concrete with weight of:
      1) Not less than 140 pounds per cubic foot for normal weight concrete.
      2) Not more than 115 pounds per cubic foot for lightweight concrete.
2. Aggregate for Normal Weight Concrete
   a. Fine Aggregate:
      1) Provide fine aggregate conforming to ASTM C 33, except as modified in the following paragraphs.
      2) Deleterious Substances: Not in excess of following percentages by weight.

Item	Test Method	Percent
Shale or Chert	ASTM C 295	1
Clay Lumps	ASTM C 142	1

   b. Coarse Aggregate:
      1) General: Provide coarse aggregate conforming to the requirements of ASTM C 33, except as modified in the following paragraphs.
      2) Weight: Not exceeding 15 percent, for thin or elongated pieces having length greater than 5 times average thickness.
      3) Deleterious Substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

Item	Test Method	Percent
Shale or chert	ASTM C 295	1
Coal and lignite	ASTM C 123	1/4
Clay lumps and friable particles	ASTM C 142	1/4
Materials finer than Number 200 sieve	ASTM C 117	1/2*
* Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.		

      4) Grading:
         a) As specified in ASTM C 33, Size Number 57, unless otherwise specified or authorized in writing by the ENGINEER.
         b) Aggregate for Class CE Concrete for Encasement of Electrical Conduits: Graded as specified in ASTM C 33, Size Number 8.
3. Aggregate for Lightweight Concrete
   a. Fine Aggregate:
      1) Provide fine aggregate conforming to ASTM C330.

b. Coarse Aggregate:
    1) General: Provide coarse aggregate conforming to the requirements of ASTM C330.
    2) Grading: As specified in ASTM C330 for 3/4 inch to No. 4, unless otherwise specified or authorized in writing by the ENGINEER.

B. Portland Cement:
1. General: Conform to specifications and tests for ASTM C 150, Types II or III, Low Alkali, except as specified otherwise.
2. Low Alkali Portland: Have total alkali containing not more than 0.60 percent.
3. Exposed Concrete in Any Individual Structure: Use only one brand of portland cement.
4. Cement for Finishes: Provide cement from same source and of same type as concrete to be finished.

C. Admixtures:
1. General:
    a. Do not use admixtures of any type, except as specified, unless written authorization has been obtained from the ENGINEER.
    b. Admixtures shall be compatible with concrete constituents and with other admixtures. All admixtures in a given mix shall be products of the same manufacturer to ensure compatibility.
    c. Admixtures for concrete that will be in contact with potable water shall be non-toxic and shall not impart taste or odor to the water. Admixtures shall be listed under NSF 61 or carry other approval, that is acceptable to the ENGINEER, for use in contact with potable water
    d. Do not use admixtures containing chlorides calculated as chloride ion in excess of 0.5 percent by weight.
    e. Use in accordance with manufacturer's recommendations and add each admixture to concrete mix separately.
2. Air Entraining Admixture:
    a. Provide entrained air of evenly dispersed air bubbles at time of placement.
    b. Conform to ASTM C 260.
3. Fly Ash Pozzolan Admixture:
    a. Pozzolan:
        1) Conforming to requirements of ASTM C 618, Class F.
        2) Pozzolan may replace portland cement at ratio of 1.0 pound fly ash for each pound of portland cement replaced.
        3) Maximum of 20 percent by weight of minimum quantity of portland cement listed in Table A under paragraph 2.03D may be replaced with pozzolan.
        4) Do not use pozzolan as an admixture in concrete made with portland-pozzolan cement.
    b. Loss on Ignition for Pozzolan: Not exceed four percent.
4. Water Reducing Admixture:
    a. May be used at the CONTRACTOR's option.
    b. Conform to ASTM C 494, Type A.
    c. Not contain air entraining agents.
    d. Liquid form before adding to the concrete mix.
    e. No decrease in cement is permitted as result of use of water reducing admixture.
5. High-Range Water Reducer / Superplasticizer:

a. Conform to ASTM C 494, Type F or ASTM C 1017, Type I. Use shall produce non-segregating plasticized concrete with little bleeding and the physical properties of low water/cement ratio concrete. Admixture shall maintain treated concrete in a plasticized state for not less than 2 hours.

D. Water:
   1. Water for Concrete, Washing Aggregate, and Curing Concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
   2. Chlorides and Sulfate Ions:
      a. Water for Conventional Reinforced Concrete: Use water not containing more than 1,000 (mg/L) of chlorides calculated as chloride ion, nor more than 1,000 (mg/L) of sulfates calculated as sulfate ion.

E. Non-slip Abrasive:
   1. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate, homogenous, non-glazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
   2. Manufacturers: One of the following or equal:
      a. Exolon Company, Tonawanda, New York.
      b. Abrasive Materials, Incorporated, Hillsdale, Michigan.

F. Conduit Encasement Coloring Agent:
   1. Color: Red color concrete used for encasement of electrical ducts, conduits, similar type items.
   2. Manufacturers: One of the following or equal.
      a. Frank D. Davis Company, Red Oxide Number 1117.
      b. I. Reiss Company, Inc., equivalent product.
   3. Conduit Encasement Concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

G. Curing and Finishing Materials
   1. General:
      a. Materials shall be compatible with concrete and with other materials.
      b. Curing and finishing materials for concrete that will be in contact with potable water shall be non-toxic and shall not impart taste or odor to the water. Materials shall be listed under NSF 61 or carry other approval that is acceptable to ENGINEER for use in contact with potable water.
   2. Sprayed Membrane Curing Compound: Clear type with fugitive dye conforming to ASTM C 309, Type 1D.
   3. Evaporation Retardant:
      a. Manufacturers: One of the following or equal:
         1) Master Builders Technologies, Cleveland, Ohio, Confilm.
         2) Eucid Chemical Company, Cleveland, Ohio, Eucobar.
   4. Plastic Membrane Curing: Use polyethylene film conforming to ASTM C 171 unless otherwise noted.
      a. Color: White
      b. Thickness: Minimum 6 mils.
      c. Loss of Moisture: Not exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C 156.

2.02 EQUIPMENT

A. Mixing Concrete:
   1. Mixers may be of stationary plant, paver, or truck mixer type.
   2. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material.
   3. Mixing Equipment:
      a. Capable of combining aggregates, cement, and water within specified time into thoroughly mixed and uniform mass and of discharging mixture without segregation.
      b. Maintain concrete mixing plant and equipment in good working order and operated at loads, speeds, and timing recommended by manufacturer or as specified.
      c. Proportion cement and aggregate by weight.

B. Machine Mixing:
   1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.
   2. If bulk cement is used, weigh it on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
   3. Prevent cement from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
   4. Procedure of mixing cement with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
   5. Retempering of concrete (re-mixing of concrete that has started to take its initial set) will not be permitted.
   6. Discharge entire batch before recharging.
   7. Volume of Mixed Material Per Batch: Not exceed manufacturer's rated capacity of mixer.
   8. Mixers:
      a. Perform mixing in batch mixers of acceptable type.
      b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
      c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing.
         1) Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.

C. Transit-mixed Concrete:
   1. Mix and deliver in accordance with ASTM C 94.
   2. Total Elapsed Time Between Addition of Water at Batch Plant and Discharging Completed Mix: Not to exceed 90 minutes nor 300 revolutions of the mixing drum. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the ENGINEER.
   3. Temperature - Minimum and Maximum Allowable During Mixing and Transporting:
      a. Minimum: 55°F
      b. Maximum: 90°F

4. Equip each truck mixer with device interlocked so as to prevent discharge of concrete from drum before required number of turns and furnish such device that is capable of counting number of revolutions of drum.
5. Continuously revolve drum after it is once started until it has completely discharged its batch.
    a. Do not admit water until drum has started revolving.
    b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The CONTRACTOR will not be entitled to additional compensation because of such increase or decrease.

D. Other Types of Mixers: In case of other types of mixers, mixing shall be as follows:
1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than one cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.03 MIXES

A. Measurements of Materials:
1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the ENGINEER.
2. Furnish apparatus for weighing aggregates and cement that is suitably designed and constructed for this purpose.
3. Accuracy of Weighing Devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within one percent of desired amount of that material.
4. Measuring or Weighing Devices: Subject to review by the ENGINEER, and bear valid seal of the Sealer of Weights and Measures having jurisdiction.
5. Weighing Cement:
    a. Weigh cement separately.
    b. Cement in Unbroken Standard Packages (Sacks): Need not be weighed.
    c. Bulk Cement and Fractional Packages: Weigh such cement.
6. Mixing Water: Measured by volume or by weight.

B. Concrete Proportions and Consistency:
1. Concrete Consistency and Composition:
    a. Provide concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on surface.
    b. Prevent unnecessary or haphazard changes in consistency of concrete.
2. Ratio of Coarse Aggregate to Fine Aggregate: Not less than 1.0 nor more than 2.0 for all concrete Classes, with exception of Class CE.
3. Aggregate:
    a. Obtain aggregate from source that is capable of providing uniform quality, moisture content, and grading during any single day's operation.
4. Concrete Mix Water to Cement Ratio, Minimum Cement Content, and Slump Range: Conform to values specified in Table A in this Section.

5. Concrete Batch Weights: Control and adjust so as to secure maximum yield, and at all times maintain proportions of concrete mix within specified limits.
6. Mixture Modification: If required, by the ENGINEER, modify mixture within limits set forth in this Section.
7. Admixtures: Provide admixtures as specified in this Section.
    a. Air Entraining Admixture
        1) Add agent to batch in portion of mixing water.

C. Concrete Mixes:
1. Proportioning of Concrete Mix: Proportion mixes for required average ~~on~~ compressive strength (f'_cr) as defined in Subparagraph 2.04A2.
2. Mixes:
    a. Adjusting of Water: After acceptance, do not change mixes without acceptance by ENGINEER, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.
    b. Total Water Content of Each Concrete Class: Not exceed those specified in Table A in this Section.
    c. Checking Moisture Content of Fine Aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
3. Change in Mixes: Undertake new trial batch and test program as specified in this Section.

D. Classes of Concrete:
1. Provide concrete classes, referenced herein as Classes A, B, C and CE, and use where specified or indicated on the Drawings.
2. Class A Concrete: Normal weight concrete with minimum weight of 140 pounds per cubic foot. Use Class A concrete at all locations except those where Classes B, C and CE are specified or indicated on the Drawings.
3. Class B Concrete: Normal weight concrete with minimum weight of 140 pounds per cubic foot. Class B concrete may be substituted for Class A concrete, when high-early strength concrete is needed in areas specifically accepted by the ENGINEER and that do not require sulfate resistant concrete.
4. Class C Concrete: Normal weight concrete with minimum weight of 140 pounds per cubic foot. Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
5. Class CE Concrete: Normal weight concrete with minimum unit weight of 140 pounds per cubic foot. Use Class CE for electrical conduit encasements.
6. Class D Concrete: Lightweight concrete with maximum unit weight of 115 pounds per cubic foot. Use Class D for lightweight precast prestressed concrete roof framing including tees, inverted tee beams, rectangular roof beams.

"TABLE A" CONCRETE WITH AIR ENTRAINMENT						
Class	Specified Compressive Strength f'c at 28 Days (pounds per square inch)	Aggregate Type	Ratio of Maximum Net Water to Cementitious Materials	Minimum Cementitious Materials per Cubic Yard of Concrete (by weight - pounds)	Slump Range (Inches)	Entrained Air (Percent)
A (Type II cement)	4,500	Normal weight	0.42	564	2 to 4*	6±1.5
B (Type III cement)	4,500	Normal weight	0.42	564	2 to 4*	6±1.5
C	2,500	Normal weight	0.62	423	3 to 6	5±1
CE	2,500	Normal weight	0.62	564	3 to 6	5±1
D	5,000	Light weight	0.45	658	2 to 4	5±1
* NOTE: Slump for slabs, decks, walks, and beams shall be not more than 3-1/2 inches. Slump for drilled piers shall be 5 inches ±1 inch.						

7. Pumped Concrete: Provide pumped concrete that complies with all requirements of this Section.
8. Do not place concrete with slump outside limits indicated in Table A.
9. Classes:
    a. Classes A, C, and CE Concrete: Make with Type II low alkali cement.
    b. Class B Concrete: Make with Type III low alkali cement.
    c. Class D Concrete: Make with Type II or Type III low alkali cement.

E. Admixtures:
1. Air Entraining Admixture:
    a. Add agent to batch in portion of mixing water.
    b. Batch solution by means of mechanical batcher capable of accurate measurement.

2.04 SOURCE QUALITY CONTROL

A. Tests:
1. Concrete Mixes:
    a. Trial Batches
        1) After concrete mixes have been accepted by ENGINEER, have trial batches of the accepted Class A, Class B, and Class D concrete mix designs prepared by testing laboratory acceptable to the ENGINEER.
        2) Prepare trial batches for each class and slump range required within that class. Use cement and aggregates proposed to be used for the Work.

3) Trial Batches: Provide batches of sufficient quantity to determine slump, workability, consistency, and finishing characteristics, and to provide sufficient test cylinders.
4) Perform test batches and tests required to establish trial batches and acceptability of materials without change in Contract Price.
5) If trial batch tests do not meet specified requirements for slump, strength, workability, consistency, drying shrinkage, and finishing, change concrete mix design proportions and, if necessary, source of aggregate. Make additional trial batches and tests until an acceptable trial batch is produced that meets requirements of this Section.
6) Do not place concrete until the concrete mix design and trial batch have been accepted by ENGINEER.

b. Test Cylinders: Provide cylinders having six-inch diameter by 12-inch length and that are prepared in accordance with ASTM C 31 for tests specified in this Section.
1) Test 8 cylinders from each trial batch for compressive strength in accordance with ASTM C 39.
a) Test 4 cylinders at 7 days and 4 at 28 days.
b) Establish ratio between 7 day and 28 day strength for mix. Seven-day strength may be taken as satisfactory indication of 28-day strength provided effects on concrete of temperature and humidity between 7 day and 28 day are taken into account.
2) Average Compressive Strength of 4 Test Cylinders Tested At 28 Days shall be equal to or greater than required average compressive strength f'cr on which concrete mix design is based.

c. Required Average Compressive Strength:
1) Determine required average compressive strength (f'cr) for selection of concrete proportions for mix design, for each class of concrete, using calculated standard deviation and its corresponding specified compressive strength f'c, in accordance with ACI 318, Part 3, Chapter 5.
2) When test records of at least 30 consecutive tests that span period of not less than 45 calendar days are available, establish standard deviation as described in ACI 318, Part 3, Chapter 5 and modified herein.
3) Provide test records from which to calculate standard deviation that represent materials, quality control procedures, and conditions similar to materials, quality control procedures, and conditions expected to apply to concrete for the Work.
4) Provide changes in materials and proportions within test records that are more restricted than those for the Work.
5) Specified Compressive Strength (f'c) of Concrete Used in Test Records: Within 1,000 pounds per square inch of that specified for the Work.
6) When lacking adequate test records for calculation of standard deviation meeting requirements, determine required average compressive strength f'cr from following Table B.

TABLE B	
Specified Compressive Strength f'_c (pounds per square inch)	**Required Average Compressive Strength f'_cr (pounds per square inch)**
Less than 3,000	f'_c + 1,000
3,000 to 5,000	f'_c + 1,200

2. Pozzolan:
   a. Sampling and Testing:
      1) Sample and test pozzolan in accordance with ASTM C 311.
      2) In Computing Water to Cement Ratio And Cement Content Per Cubic Yard Of Concrete: Consider cement weight to be weight of portland cement plus 100 percent of weight of fly ash.
3. Aggregate:
   a. Testing of concrete aggregate is at CONTRACTOR's expense.
   b. Sieves:
      1) Use sieves with square openings for testing grading of aggregates.
      2) Sieve Analyses: If sieve analyses indicate significant change in materials, the ENGINEER may require that new mix design be submitted and accepted before further placing of concrete.
   c. Sample aggregate in accordance with ASTM D 75 and C 136.
   d. Fine Aggregate:
      1) Provide fine aggregate not containing strong alkali nor organic matter which gives color darker than standard color when tested in accordance with ASTM C 40.
      2) Provide aggregate having soundness complying with requirements of ASTM C 33 when tested in accordance with ASTM C 88.
      3) Provide aggregate complying with reactivity requirements of ASTM C 33 when tested in accordance with ASTM C 289.
   e. Coarse Aggregate:
      1) Soundness when tested in accordance with ASTM C 88: Have loss not greater than 10 percent when tested with sodium sulfate.
      2) Abrasion Loss: Not exceed 45 percent after 500 revolutions when tested in accordance with ASTM C 131.
      3) Reactivity: Not exceed limits specified in Appendix of ASTM C 33 when tested in accordance with ASTM C 289.
   f. Portland Cement:
      1) Determination Alkali Content: Determine by method set forth in ASTM C 114.

PART 3 EXECUTION

3.01 INSTALLATION

A. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, immediately after the concrete has been screeded, coat the surface of the concrete with a liquid evaporation retardant. Apply the evaporation retardant again after each work operation as necessary to prevent drying shrinkage cracks.

Conditions which result in rapid evaporation of moisture may include one or more of the following:

1. Low humidity.
2. Windy conditions.
3. High temperature.

B. Joints and Bonding:
   1. As far as practicable construct concrete work as monolith.
   2. Locations of contraction, construction, expansion, and other joints are indicated on the Drawings or as specified in this Section.
   3. Construction Joints:
      a. Where construction joints are not indicated on the Drawings, provide slabs and walls with construction joints at intervals not greater than 30 feet.
      b. In order to preserve strength and watertightness of structures, make no other joints, except as authorized the ENGINEER.
      c. At construction joints, thoroughly clean concrete of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of heavy sandblasting, and wash surfaces just prior to succeeding concrete placement.
      d. At Horizontal Joints: Immediately prior to resuming concrete placing operations, thoroughly spread bed of grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over horizontal joint surfaces.
   4. Keyways in Joints:
      a. Provide keyways in joints as indicated on the Drawings.
      b. Treat lumber keyway material with form release coating, applied in accordance with manufacturer's instructions.
   5. Take special care to ensure that concrete is well consolidated around, below, and against waterstops and that waterstops are secured in proper position.
   6. Cleaning of Construction Joints:
      a. Wash construction joints free of sawdust, chips, and other debris after forms are built and immediately before concrete or grout placement.
      b. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
      c. Provide cleanout hole at base of each wall and column for inspection and cleaning.
   7. Expansion and Construction Joints
      a. Constructed where and as indicated on the Drawings.
      b. Waterstops, Expansion Joint Material, Synthetic Rubber Sealing Compound, and Other Similar Materials: As specified in Section 03150.
   8. Repair of Concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first coat surface of set concrete with epoxy bonding agent.

C. Conveying and Placing Concrete:
   1. Convey concrete from mixer to place of final deposit by methods that prevent separation or loss of materials.
   2. Use chutes and equipment for pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without separation of materials.

3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of any day's placement.

D. Placing Concrete:
1. Place no concrete without prior authorization of the ENGINEER.
2. Do Not Place Concrete Until:
   a. Reinforcement is securely and properly fastened in its correct position and loose form ties at construction joints have been retightened.
   b. Dowels, bucks, sleeves, hangers, pipes, conduits, bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
   c. Forms have been cleaned and oiled as specified.
3. Placement of concrete in which initial set has occurred, or of retempered concrete, will not be permitted.
4. Place no concrete during rainstorms or high velocity winds.
5. Protect concrete placed immediately before rain to prevent water from coming in contact with such concrete or winds causing excessive drying.
6. Keep sufficient protective covering on hand at all times for protection of concrete.
7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested and accepted by the ENGINEER.
8. Notify the ENGINEER in writing of readiness, not just intention, to place concrete in any portion of the work.
   a. Provide this notification in such time in advance of operations as the ENGINEER deems necessary to make final inspection of preparations at location of proposed concrete placing.
   b. Place forms, steel, screeds, anchors, ties, and inserts in place before notification of readiness is given to the ENGINEER.
   c. Depositing Concrete:
      1) Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
      2) Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
      3) Do not drop concrete freely into place from height greater than 5 feet.
      4) Use tremies for placing concrete where drop is over 5 feet.
      5) Commence placement of concrete on slopes, at bottom of slope.
9. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
10. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached.
11. After placement begins, continue without significant interruption. Take precautions to prevent any delay from exceeding 20 minutes.
12. If concrete is to be placed over previously placed concrete and more than 20 minutes have elapsed, then spread layer of grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over surface before placing additional concrete.
13. Placement of Concrete for Slabs, Beams, or Walkways:
   a. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.

b. Allow set time of not less than one hour for shrinkage.

E. Consolidating Concrete:
1. Place concrete with aid of acceptable mechanical vibrators.
2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.
3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
   a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
   b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
   c. Place no concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
5. Take special care to place concrete solidly against forms so as to leave no voids.
6. Take every precaution to make concrete solid, compact, and smooth, and if for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the ENGINEER.

F. Footings and Slabs on Grade:
1. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the ENGINEER.
2. If necessary, sprinkle subgrade with water not less than 6 nor more than 20 hours in advance of placing concrete.
3. If it becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
4. Place no concrete if subgrade is muddy or soft.

G. Loading Concrete:
1. Green Concrete:
   a. No heavy loading of green concrete will be permitted.
   b. Green concrete is defined as concrete with less than 100 percent of the specified strength.
2. No backfill shall be placed against concrete walls until the concrete has reached the specified strength and the connecting slabs and beams have been cast and have reached the specified strength.
3. Use construction methods, sequencing, and allow time for concrete to reach adequate strength to prevent overstress of the concrete structure during construction.

H. Curing Concrete:
1. General:
   a. Cure concrete by methods specified in this Section.
   b. Cure concrete minimum of 7 days at average daily temperature not less than 50ºF. In no case shall temperature of curing concrete drop below 40ºF.
      1) Average daily temperature is calculated by summing hourly measurements of air temperature in the shade at the face of the concrete, and dividing the sum by 24. In calculating sum of the

temperatures recorded, any measurement less than 50ºF shall be recorded as 0ºF and included in the sum.

c. Cure concrete to be painted or cast against adjacent concrete (including construction joints) with water or plastic membrane.
d. Do not use curing compound on concrete surfaces that are to receive paint or upon which any material is to be bonded.
e. Water cure or plastic membrane cure concrete slabs that are specified to be sealed by concrete sealer or to receive grout topping.
f. Cure other concrete by water curing or sprayed curing membrane at the CONTRACTOR's option.
g. Floor slabs may be cured using plastic membrane curing.

2. Water Curing:
   a. Keep surfaces of concrete being water cured (including tops of walls) constantly and visibly moist day and night for period of not less than 7 days.
   b. Each day forms remain in place may count as 1 day of water curing.
   c. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
   d. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
   e. When steel forms are used, leave forms in place minimum 48 hours. Application of water for curing shall commence only after, but within 1 hour of, the time forms are removed.
3. Sprayed Membrane Curing:
   a. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
   b. If more than 1 hour elapses after removal of forms, do not use membrane curing compound, but apply water curing for full curing period.
   c. If surface requires repairing or painting, water cure such concrete surfaces.
   d. Curing Compound:
      1) Do not remove curing compound from concrete in less than 7 days.
      2) Curing compound may be removed only upon written request by the CONTRACTOR and acceptance by the ENGINEER, stating what measures are to be performed to adequately cure structures.
      3) Remove curing compound placed within construction joint silhouette by heavy sandblasting prior to placing any new concrete.
      4) Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound.
      5) Apply compound in at least 2 coats.
      6) Apply each coat in direction 90 degrees to preceding coat.
      7) Apply compound in sufficient quantity so that concrete has uniform appearance and that natural color is effectively and completely concealed at time of spraying.
      8) Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
      9) Thickness and Coverage of Compound: Provide compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
      10) The CONTRACTOR is cautioned that method of applying curing compound specified herein may require more compound than

normally suggested by manufacturer of compound and also more than is customary in the trade.

11) Apply amounts specified herein, regardless of manufacturer's recommendations or customary practice, if curing compound is used in place of water curing.
12) If the CONTRACTOR desires to use curing compound other than specified compound, coat sample areas of concrete wall with proposed compound and also similar adjacent area with specified compound in specified manner for comparison.
    a) If proposed sample is not equal or better, in opinion of the ENGINEER, in all features, proposed substitution will not be allowed.
13) Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

4. Plastic Membrane Curing:
    a. Polyethylene film may be used to cure slabs. Seal joints and edges with small sand berm.
    b. Install plastic membrane as soon as concrete is finished and can be walked on without damage.
    c. Keep concrete moist under plastic membrane.

3.02 CONCRETE FINISHING

A. Edges of Joints:
    1. Provide joints having edges as indicated on the Drawings.
    2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

3.03 FIELD QUALITY CONTROL

A. Testing Laboratory:
    1. OWNER will designate a testing laboratory for compression testing of field-cast concrete cylinders in accordance with ASTM C 39. Laboratory testing expenses will be paid by OWNER.

B. Testing
    1. During progress of construction, sample concrete in accordance with ASTM C 172 and make tests to determine whether concrete produced complies with project specifications.
    2. CONTRACTOR’s personnel to prepare test report including date and location of placement, name(s) of personnel performing tests, concrete batch delivery ticket number, concrete temperature, slump, unit weight, and air content.
    3. CONTRACTOR shall make, protect, and cure cylinders for compression strength testing in accordance with ASTM C 31.
        a. Label cylinders to indicate location of pour and cylinder numbers.
        b. Required number of cylinders for test set: Not less than 4 cylinder specimens, each 6 inches in diameter by 12 inches long. Two cylinders to be tested at 7 days, and two cylinders to be tested at 28 days.
        c. Required number of test sets:

1) Provide at least one test set for each class of concrete placed each day.
2) Provide at least on test set for each half-day's placement of each class of concrete.
3) Provide at least on test set for each 150 cubic yards of each class placed.

4. Additional testing performed by CONTRACTOR's ACI-certified personnel:
   a. Slump test in accordance with ASTM C 143.
      1) Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to do so by the ENGINEER.
   b. Temperature test in accordance with ASTM C 1064.
   c. Test for unit weight in accordance with ASTM C 138.
   d. Test for air content in accordance with ASTM C 231.
      1) If air entraining admixture used requires testing methods other than ASTM C 231 to accurately determine air content, report testing requirements to ENGINEER well in advance of concrete placement.
      2) Test percentage of entrained air at beginning of each placement, when requested by ENGINEER, and as often as necessary to maintain entrained air within specified range.

C. Enforcement of Specification Requirements
   1. Compressive Strength.
      a. Concrete is expected to reach higher compressive strength than that which is indicated in Table A as specified compressive strength f'c.
      b. Strength Level of Concrete: Will be considered acceptable if following conditions are satisfied.
         1) Average of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength f'c.
         2) No individual strength test (average of 2 cylinders) falls below specified compressive strength f'c by more than 500 pounds per square inch.
         3) Whenever one, or both, of 2 conditions stated above is not satisfied, provide additional curing of affected portion followed by cores taken in accordance with ASTM C 42 and ACI 318 and comply with the following requirements:
            a) If additional curing does not bring average of 3 cores taken in affected area to at least specified compressive strength f'c, designate such concrete in affected area as defective.
            b) The ENGINEER may require the CONTRACTOR to strengthen defective concrete by means of additional concrete, additional reinforcing steel, or replacement of defective concrete, all of the CONTRACTOR's expense.
   2. Slump, Temperature, and Air Entrainment.
      a. Do not use concrete that does not meet specification requirements in regards to slump, temperature, or air entrainment, but remove such concrete from project site.

3.04 ADJUSTING

A. Repair of Defective Concrete:
   1. Remove and replace or repair defective work.

2. Correct defective work as specified in this Article.
3. Do not patch, repair, or cover defective work without inspection by the ENGINEER.
4. Provide repairs having strength equal to or greater than specified concrete for areas involved.
    a. Chip out and key imperfections in the work and make them ready for repair.
5. Dry Pack Method:
    a. Dry Pack Method: Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt, and narrow slots cut for repair.
    b. Smooth Holes: Clean and roughen by heavy sandblasting before repair.
6. Mortar Method of Replacement: Use for following:
    a. Holes too wide to dry pack and too shallow for concrete replacement.
    b. Comparatively shallow depressions, large or small, which extend no deeper than reinforcement nearest surface.
7. Concrete Replacement:
    a. Use: When holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.
    b. Method of Repair for Surfaces of Set Concrete to Be Repaired: First coat with epoxy bonding agent.
8. Acceptable Method of Concrete Repair:
    a. Make no repair until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.

END OF SECTION

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SECTION 06611

FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fiberglass reinforced plastic fabrications including:
   1. Weirs.
   2. Baffles.
   3. Troughs.

PART 2 PRODUCTS

2.01 WEIRS, AND BAFFLES

A. Manufacturers: One of the following or equal:
   1. MFG Water Treatment Products Company
   2. Nefco, Inc.

B. Materials:
   1. Hand lay-up construction.
   2. Minimum corrosion liner:
      a. One "C" or Nexus veil as specified for the service environment.
      b. Remainder 1-1/2 ounce per square foot mat to total minimum thickness of 0.096 inches on surface exposed to the service environment.
   3. Ultraviolet stabilizer: Added to the exterior surface coat of fabrications intended for outside service, in the type and amount recommended by the resin manufacturer.
   4. Resin: Premium grade vinyl ester:
      a. Manufacturers: One of the following or equal: As recommended by the resin manufacturer for the specific operating environment:
         1) Dow Chemical Company, Derakane 411.
         2) Ashland Chemical Company, Hetron 922.
         3) Reichhold Inc., Reichhold Dion VER 9100.
         4) Interplastic Corporation, Interplastic VE 8300.
   5. Color: Natural, unless otherwise specified.

C. Fabrication:
   1. Baffles: Hand lay-up components to specified shape and dimensions.
   2. Weirs:
      a. Match die molded.
      b. Weir plates:
         1) Of shape and dimensions specified.
         2) Provide 2-3/8 inch diameter holes for adjustment.
         3) Resin coat cut edges, and drilled and countersunk holes in fiberglass reinforced plastic fabrications.

c. Furnish fiberglass reinforced plastic butt plates for joints.
d. Washers:
1) Of same material as weirs, with surfaces smooth, free of voids, and without dry spots and crazes.

D. Design criteria and chemical exposure: As specified for the application.

2.02 TROUGHS

A. Manufacturers: One of the following or equal:
1. MFG Water Treatment Products Company
2. Nefco, Inc.

B. Materials:
1. Fabricate trough of premium grade fiberglass reinforced polyester resin, with fiberglass constituting a nominal 30 percent by weight.
2. Glass reinforcement shall be random chopped-strand type with a minimum strand length of 1 inch, and adequate contact molding pressure to provide complete wet-out of the glass fibers.
3. Minimum physical properties:
a. Tensile strength: 14,000 pounds per square inch.
b. Flexural strength: 25,000 pounds per square inch.
c. Flexural modulus: 1.0 times 10^6 pounds per square inch.
d. Trough resin and all accessories shall be suitable for the specific operating environment.
4. All trough supports and hardware shall be Type 316 stainless steel including bolts, nuts washers, straps, etc.

C. Design:
1. Trough shall be laminated of fiberglass reinforced polyester resin to a minimum thickness of 1/4 inch.
2. Inside surface of each trough shall have a smooth gel coat finish, color as selected by the ENGINEER. The outside surface of each trough shall be resin sealed with no exposed glass fiber.
3. Color shall be molded in and an ultraviolet inhibitor shall be used.
4. Troughs shall have flat bottoms and vertical sides, unless otherwise indicated on the Drawings.
5. Top edges of trough shall be straight with no more than 1/8 inch deviation from a true plane.
6. Longitudinal stiffening ribs shall be integrally molded on the outside of the troughs to ensure rigidity.
7. Spacer rods:
a. Sufficient plastic spacer rods shall be included to maintain a uniform width over the length of each trough.
b. Spacer rods shall be spaced to prevent buckling and to provide maximum resistance to water loading on the sidewall of the trough.
8. Fiberglass adjustable weir plates shall be factory assembled to the troughs as indicated on Drawings.

9. Design troughs to span distance between support systems, within stress and deflection limitation, the following loadings:
    a. Gravity load: Downward vertical loads shall include the weight of the trough and appurtenant attachments, such as weir plates and spreader bars, together with the weight of the water to fill the trough. Any additional loads, such as piping shall also be considered.
    b. Buoyant load: The buoyant load shall act vertically upward, its magnitude equal to the weight of displaced water (trough weight neglected). The line of action passes through the centroid of the submerged cross-sectional area.
    c. Lateral load: Loads acting against the trough side walls, specifically those induced by differential water levels on either side of the trough walls. The maximum possible differential, existing when the trough is empty and the tank is full, or when the trough is full and the tank is empty, shall be used when calculating deflection, fiber stress, etc.
    d. Thermal stresses: The troughs shall be designed to accommodate temperature induced stresses resulting from different coefficients of thermal expansion and contraction between the trough and tank/support materials.
    e. Torsional stability: The trough system shall be designed to resist torsional oscillations induced by the flow of water over trough edges. Any or all of the following trough stabilization techniques shall be considered:
        1) Trough to trough stabilization by trough-to-support truss bracing
        2) Torsional stiffness
        3) Support spacing and rigidity
        4) Internal baffles and or flow straighteners.
10. Deflection under load: Maximum vertical deflection under full buoyant load or gravity load shall be less than or equal to L/1,000, where L is defined as the unsupported trough length inches. Under no circumstance shall the maximum vertical deflection, measured at mid-point between trough supports, exceed 3/16 inches.
11. Maximum trough side wall horizontal deflection under full lateral load shall be less than or equal to D/100, where D is defined as the trough depth in inches. Under no circumstances shall the maximum side wall deflection exceed 3/16 inches.
12. Trough bottom deflection (oil canning) under full buoyant load or gravity load shall be less than or equal to W/100, where W is defined as the trough width, in inches. Under no circumstances shall the maximum bottom deflection exceed 3/16 inches.
13. fiber stress limitations: Supplemental to the deflection criteria, the troughs shall also be designed such that the maximum wall stress under the most severe loading conditions is less than or equal to 1,500 pounds per square inch. This stress criterion is equivalent to 7:1 safety factor (approximate) as applied to the tensile and flexural properties of contact molded troughs and launders.
14. Thermal expansion and contraction: The troughs shall be designed to accommodate a thermally induced expansion and contraction of 1/8 inch per 20 feet length of trough over temperature range of 10 degrees Fahrenheit to 100 degrees Fahrenheit, without exceeding the deflection or strain limitations set forth in the proceeding paragraphs.
15. Provide calculations sealed and signed by a registered professional structural engineer registered in the state of Florida for trough support system. All other calculations shall be sealed and signed by a registered professional engineer.

16. Trough manufacturer shall be responsible to design the troughs and all supporting members and accessories required for a complete installation.
17. Design for wind loads in accordance with Section 01614.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for installation of products as specified.

3.02 ERECTION AND INSTALLATION, GENERAL

A. Install products where indicated on the Drawings in accordance with manufacturer's printed instructions.

3.03 TROUGHS

A. Fasten to concrete with existing Type 316 stainless steel anchor bolts.

B. Seal edges between concrete and trough with synthetic rubber.

C. Use Type 316 stainless steel nuts, bolts, and washers.

D. Aligned and leveled to within 1/32-inch maximum variation between any two points on the weir edges.

END OF SECTION

SECTION 09960

COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Field applied coatings.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. D 4262-83 - Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
   2. D 4263-83 - Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   3. D4285-83 - Test Method for Indicating Oil or Water in Compressed Air.
   4. D4541-93 - Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers.

B. NACE International, The Corrosion Society (NACE):
   1. RPO188-99 - Discontinuity (Holiday) Testing of Protective Coatings.

C. National Association of Pipe Fabricators (NAPF):
   1. NAPF 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.

D. NSF International (NSF):
   1. NSF 61 - Drinking Water System Components - Health Effects.

E. SSPC – Society for Protective Coatings:
   1. SSPC SP1 - Solvent Cleaning.
   2. SSPC SP2 - Hand Tool Cleaning.
   3. SSPC SP3 - Power Tool Cleaning.
   4. SSPC SP5 - White Metal Blast Cleaning.
   5. SSPC SP6 - Commercial Blast Cleaning.
   6. SSPC SP7 - Brush-Off Blast Cleaning.
   7. SSPC SP10 - Near-White Blast Cleaning.
   8. SSPC SP 11 - Power Tool Cleaning to Bare Metal.
   9. SSPC-SP 12 - High- and Ultrahigh-Pressure Water Jetting.

F. Underwriters' Laboratory (UL):
   1. UL 3P83 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Submerged Metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.

B. Submerged Concrete and Masonry Surfaces: Surfaces which are or will be:
   1. Underwater.
   2. In structures which normally contain water.
   3. Below tops of walls of water containing structures.

C. Exposed Surface: Any metal or concrete surface, indoors or outdoors that is exposed to view.

D. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils.

E. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.

F. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.

G. Where SSPC surface preparation standards are specified or implied for ductile iron pipe or fittings, the equivalent NAPF surface preparation standard shall be substituted for the SSPC standard.

1.04 PERFORMANCE REQUIREMENTS

A. Coating materials for concrete and metal surfaces shall be especially adapted for use in wastewater treatment plants.

B. Coating for final coats shall be fume resistant, compounded with pigment suitable for exposure to sewage gases, especially to hydrogen sulfide and to carbon dioxide.

C. Pigments shall be materials that do not darken, discolor, or fade due to action of sewage gases.

1.05 SUBMITTALS

A. Shop Drawings: Include schedule of where and for what use coating materials are proposed in accordance with requirements for Product Data.

B. Product Data: Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips.
   1. Regulatory Requirements: Submit data concerning the following:
      a. Volatile organic compound limitations.
      b. Coatings containing lead compounds and PCBs.
      c. Abrasives and abrasive blast cleaning techniques, and disposal.

C. Samples: Include 8-inch square drawdowns or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.

D. Certificates: Submit in accordance with requirements for Product Data.

E. Manufacturer's Instructions: Include the following:
   1. Special requirements for transportation and storage.

2. Mixing instructions.
3. Shelf life.
4. Pot life of material.
5. Precautions for applications free of defects.
6. Surface preparation.
7. Method of application.
8. Recommended number of coats.
9. Recommended dry film thickness (DFT) of each coat.
10. Recommended total dry film thickness (DFT).
11. Drying time of each coat, including prime coat.
12. Required prime coat.
13. Compatible and non-compatible prime coats.
14. Recommended thinners, when recommended.
15. Limits of ambient conditions during and after application.
16. Time allowed between coats (minimum and maximum).
17. Required protection from sun, wind and other conditions.
18. Touch-up requirements and limitations.

F. Manufacturer's Representative's Field Reports.

G. Operations and Maintenance Data:
1. Reports on visits to project site to view and approve surface preparation of structures to be coated.
2. Reports on visits to project site to observe and approve coating application procedures.
3. Reports on visits to coating plants to observe and approve surface preparation and coating application on items that are "shop coated."

H. Quality Assurance Submittals:
1. Quality Assurance plan.
2. Qualifications of coating applicator including List of Similar Projects.

I. Warranty
1. Warrant free of defects in material and workmanship for 3 years from the date of acceptance or date of first beneficial use by the OWNER.

1.06 QUALITY ASSURANCE

A. Applicator Qualifications:
1. Minimum of 5 years experience applying specified type or types of coatings under conditions similar to those of the Work.
   a. Provide qualifications of applicator and references listing five similar projects completed in the past two years.
2. Manufacturer approved applicator when manufacturer has approved applicator program.
3. Approved and licensed by polymorphic polyester resin manufacturer to apply polymorphic polyester resin coating system.
4. Approved and licensed by elastomeric polyurethane (100 percent solids) manufacturer to apply 100 percent solids elastomeric polyurethane system.
5. Applicator of off-site application of coal tar epoxy shall have successfully applied coal tar epoxy on similar surfaces in material, size, and complexity as on the Project.

B. Regulatory Requirements: Comply with governing agencies regulations by using coatings that do not exceed permissible volatile organic compound limits and do not contain lead.

C. Certification: Certify that applicable pigments are resistant to discoloration or deterioration when exposed to hydrogen sulfide and other sewage gases and product data fails to designate coating as "fume resistant."

D. Field Samples: Prepare and coat an area between corners or limits such as control or construction joints of each system. Approved field sample may be part of Work.

E. Compatibility of Coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

F. Services of Coating Manufacturers Representative: Make periodic visits to the project site to provide consultation and inspection services during surface preparation and application of coatings, and to make visits to coating plants to observe and approve surface preparation procedures and coating application of items to be “shop primed and coated”.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturers recommendations.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.

D. Store coatings in well-ventilated facility that provides protection form the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

1.08 PROJECT CONDITIONS

A. Surface Moisture Contents: Do not coat surfaces that exceed manufacturer specified moisture contents, or when not specified by the manufacturer, the following moisture contents:
   1. Masonry, Concrete and Concrete Block: 12 percent.

B. Do Not Apply Coatings:
   1. Under dusty conditions, unless tenting, covers, or other such protection is provided for structures to be coated.
   2. When light on surfaces measures less than 15 foot-candles.
   3. When ambient or surface temperature is less than 50 degrees Fahrenheit unless manufacturer allows a lower temperature.
   4. When relative humidity is higher than 85 percent.
   5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
   6. When surface temperature exceeds the manufacturer's recommendation.

7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
8. Apply clear finishes at minimum 65 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Special Coatings: One of the following or equal:
   1. Ameron: Ameron International, Brea, CA.
   2. Carboline: Carboline, St. Louis, MO.
   3. Devoe: Devoe Coatings, Louisville, KY.
   4. Dudick: Dudick, Inc., Streetsboro, OH.
   5. Sanchem: Sanchem, Chicago, IL.
   6. S-W: Sherwin-Williams Co., Cleveland, OH.
   7. Tnemec: Tnemec Co., Kansas City, MO.

B. Paints, Exterior Exposure: One of the following or equal:
   1. Modified Waterborne Acrylate: One of following or equal:
      a. Tnemec: Enviro-Crete.

2.02 PREPARATION AND PRETREATMENT MATERIALS

A. Metal Pretreatment: As manufactured by one of the following or equal:
   1. Ameron: Galvaprep.
   2. International: Galvaprep 5 or Alumiprep 33.
   3. S-W: P60G2, Wash Primer.
   4. Tnemec: Series N69 Hi-Build Epoxoline II

B. Surface Cleaner and Degreaser: As manufactured by one of the following or equal:
   1. Carboline Surface Cleaner No.3.
   2. Devoe: Devprep 88.
   3. S-W: Clean and Etch.

2.03 COATING MATERIALS

A. Alkali Resistant Bitumastic: As manufactured by one of the following or equal:
   1. Carboline: Bitumastic Super Service Black.
   2. S-W: Corothane I Coal Tar, B65B11.
   3. Tnemec: 46-465.

B. Wax Coating: As manufactured by one of the following or equal:
   1. Sanchem: No-Ox-Id A special.

C. High Solids Epoxy Primer Not less than 80 Percent Solids by Volume: As manufactured by one of the following or equal:
   1. Ameron: Amerlock 400.
   2. Carboline: Super Hi-Gard 891.
   3. Devoe: Bar Rust 233H.
   4. S-W: Macropoxy HS.
   5. Tnemec:
      a. Series 135 Chembuild (non-immersion service).

b. Series 104 HS (immersion service).

D. High Solids Epoxy Not less than 80 Percent Solids by Volume: As manufactured by one of the following or equal:
1. Ameron: Amerlock 400.
2. Carboline: Super Hi-Gard 891.
3. Devoe: Bar Rust 233H.
4. S-W: Macropoxy HS.
5. Tnemec:
   a. Series 135 Chembuild (non-immersion service).
   b. Series 104 HS (immersion service).

E. Aliphatic or Aliphatic-Acrylic Polyurethane: As manufactured by one of the following or equal:
1. Ameron: Amercoat 450HS.
2. Carboline: Carbothane 134HG.
3. Devoe: Devthane 379.
4. S-W: High Solids Polyurethane.
5. Tnemec: Series 73 Endura-Shield II.

F. Asphalt Varnish: AWWA C 500.

G. Protective Coal Tar: As manufactured by one of the following or equal:
1. Carboline: Bitumastic No. 50.
2. S-W: Cooper Black, No. 750.
3. Tapecoat Co.: T.C. Mastic.

H. Coal Tar Epoxy: As manufactured by one of the following or equal:
1. Ameron: 78HB.
2. Carboline: 300-M, Bitumastic.
3. Devoe: Devtar 247.
4. S-W: B69B60 Tar Guard.
5. Tnemec: Series 46H-413.

I. Painting Pretreatment and Primers
1. Concrete, Smooth, Filler/primer: One of following or equal:
   a. S/W: B61W2, Epoxy Ester Masonry Filler/Sealer.
   b. Tnemec: W55 WB, Tneme-Crete.

2.04 MIXES

A. Mix epoxy parts in accordance with manufacturer's instructions.

B. Mix coal tar epoxy in containers furnished by manufacturer for mixing purposes. Mix unit quantities only. Use power mixer for minimum time recommended by manufacturer. Do not include time during pouring or stirring in mixing time.

PART 3 EXECUTION

3.01 GENERAL PROTECTION

A. Protect adjacent surfaces from coatings and damage. Repair damage resulting from inadequate or unsuitable protection:

B. Protect adjacent surfaces not to be coated from spatter and droppings with drop cloths and other coverings.
   1. Mask off surfaces of items not to be coated or remove items from area.

C. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being coated and in particular, surfaces within storage and preparation area.

D. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.

E. Remove electrical plates, surface hardware, fittings and fastenings, prior to application of coating operations. Carefully store, clean and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

3.02 GENERAL PREPARATION

A. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements are specified in this Specification.

B. Protect following surfaces from abrasive blasting by masking, or other means:
   1. Threaded portions of valve and gate stems.
   2. Machined surfaces for sliding contact.
   3. Surfaces to be assembled against gaskets.
   4. Surfaces of shafting on which sprockets are to fit.
   5. Surfaces of shafting on which bearings are to fit.
   6. Machined surfaces of bronze trim, including those slide gates.
   7. Cadmium-plated items except cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment requiring abrasive blasting.
   8. Galvanized items, unless scheduled to be coated.

C. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.

D. Concrete:
   1. Allow new concrete to cure for minimum of 28 days before coating.
   2. Clean concrete surfaces of dust, mortar, fins, loose concrete particles, form release materials, oil, and grease. Fill voids so that surface is smooth. Etch or brush off-blast clean in accordance with SSPC SP-7 to provide surface profile similar to 60 grit sandpaper, or as recommended by coating manufacturer.

E. Ferrous Metal Surfaces:
   1. Remove grease and oil in accordance with SSPC SP-1.
   2. Remove rust, scale, and welding slag and spatter, and prepare surfaces in accordance with appropriate SSPC standard as specified herein.

3. Abrasive blast surfaces prior to coating.
4. When abrasive blasted surfaces rust or discolor before coating, abrasive blast surfaces again to remove rust and discoloration.
5. When metal surfaces are exposed because of coating damage, abrasive blast surfaces before touching-up.

F. Ferrous Metal Surfaces Not to be Submerged: Abrasive blast in accordance with SSPC SP-10, unless blasting may damage adjacent surfaces, prohibited or specified otherwise. Where not possible to abrasive blast, power tool clean surfaces in accordance with SSPC SP-3.

G. Ferrous Metal Surfaces to be Submerged: Unless specified otherwise, abrasive blast in accordance with SSPC SP-5 to clean and provide roughened surface profile of not less than 2 mils and not more than 4 mils in depth when measured with Elcometer 123, or as recommended by the coating manufacturer.

H. Ductile Iron Pipe and Fittings to be Lined or Coated: Abrasive blast clean in accordance with NAPF 500-03.

I. Sherardized, Aluminum, Copper, and Bronze Surfaces: Prepare in accordance with coating manufacturer's instructions.

J. Galvanized Surface:
1. Degrease or solvent clean to remove oily residue.
2. Power tool or hand tool clean or whip abrasive blast.
3. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded physically, such as bolts, nuts, or preformed channels.

K. Shop Primed Metal:
1. Certify that primers applied to metal surfaces in the shop are compatible with coatings to be applied over such primers in the field.
2. Remove shop primer from metal to be submerged by abrasive blasting in accordance with SSPC SP-10, unless greater degree of surface preparation is required by coating manufacturer’s representative.
3. Correct abraded, scratched or otherwise damaged areas of shop prime coat by sanding or abrasive blasting in accordance with SSPC SP-6.
4. When entire shop priming fails or has weathered excessively, or when recommended by coating manufacturer’s representative, abrasive blast shop prime coat to remove entire coat and prepare surface in accordance with SSPC SP-10.
5. When incorrect prime coat is applied, remove incorrect prime coat by abrasive blasting in accordance with SSPC SP-10.
6. When prime coat not authorized by ENGINEER is applied, remove unauthorized prime coat by abrasive blasting in accordance with SSPC SP-10.
7. Shop Applied Bituminous Paint or Asphalt Varnish: Abrasive blast clean shop applied bituminous paint or asphalt varnish from surfaces scheduled to receive non-bituminous coatings.

L. Abrasive blast cadmium-plated, zinc-plated, or sherardized fasteners in same manner as unprotected metal when used in assembly of equipment designated for abrasive blasting .

M. Abrasive blast components to be attached to surfaces which cannot be abrasive blasted before components are attached.

N. Grind sharp edges to approximately 1/16 inch radius before abrasive blast cleaning.

O. Remove and grind smooth all excessive weld material and weld spatter before blast cleaning.

P. FRP Surfaces:
   1. Prepare surfaces to be coated by light sanding and wipe-down with clean cloths, or by solvent cleaning in strict accordance with coating manufacturer's instructions.

Q. Cleaning of Previously Coated Surfaces:
   1. Utilize cleaning agent to remove soluble salts such as chlorides and sulfates from concrete and metal surfaces.
      a. Cleaning Agent: Biodegradable non-flammable and containing no volatile organic compounds.
      b. Manufacturer: Chlor-Rid International, Inc., or accepted equal.
   2. Cleaning of surfaces utilizing the decontamination cleaning agent may be accomplished in conjunction with abrasive blast cleaning, high pressure, washing, or hand washing as approved by the coating manufacturer's representative and the ENGINEER.
   3. Test cleaned surfaces in accordance with the cleaning agent manufacturer's instructions to ensure all soluble salts have been removed. Additional cleaning shall be carried out as necessary.
   4. Final surface preparation prior to application of new coating system shall be made in strict accordance with coating manufacturer's printed instructions

3.03 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Remove grilles, covers and access panels for mechanical and electrical system from location and coat separately.

B. Finish coat primed equipment with color selected by the ENGINEER.

C. Prime and coat insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with prefinished coating.

D. Replace identification markings on mechanical or electrical equipment when coated over or spattered.

E. Coat interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line.

F. Coat exposed conduit and electrical equipment occurring in finished areas with color and texture to match adjacent surfaces.

G. Coat both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them

H. Color code equipment, piping, conduit and exposed ductwork and apply color banding and identification, such as flow arrows, naming and numbering, in accordance with DIVISIONS 15 and 16.

3.04 GENERAL APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer's instructions.

B. Coat metal unless specified otherwise.
   1. Aboveground piping to be coated shall be empty of contents during application of coatings.

C. Verify metal surface preparation immediately before applying coating in accordance with SSPC Pictorial Surface Preparation Standard.

D. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

E. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.

F. Prime shop primed metal surfaces. Spot prime exposed metal of shop primed surfaces before applying primer over entire surface.

G. Apply minimum number of specified coats.

H. Apply coats to thicknesses specified, especially at edges and corners.

I. Apply additional coats when necessary to achieve specified thicknesses.

J. Coat surfaces without drops, ridges, waves, holidays, laps, or brush marks.

K. Remove spatter and droppings after completion of coating.

L. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.

M. Dust coatings between coats. Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.

N. Apply coating by brush, roller, trowel, or spray, unless particular method of application is required by coating manufacturer's instructions or these Specifications.

O. Spray Application:
   1. Stripe coat edges by brush before beginning spray application, as necessary, to ensure specified coating thickness along edges.
   2. When using spray application, apply coating to thickness not greater than that recommended in coating manufacturer's instructions for brush coat application.
   3. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
   4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist or spray.

P. Drying and Recoating:
   1. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
   2. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
   3. Do not allow excessive drying time or exposure which may impair bond between coats.
   4. Recoat epoxies within time limits recommended by coating manufacturer.
   5. When time limits are exceeded, abrasive blast clean prior to applying another coat.
   6. When limitation on time between abrasive blasting and coating cannot be met before attachment of components to surfaces which cannot be abrasive blasted, coat components before attachment.
   7. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
   8. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
   9. Leave no holidays.
   10. Sand and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to naked eye.

Q. Concrete:
   1. Apply first coat (primer) only when surface temperature of concrete is decreasing in order to eliminate effects of off-gassing on coating.

3.05 ALKALI RESISTANT BITUMASTIC

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
   1. Apply in accordance with general application requirements and as follows:
      a. Apply at least 2 coats, 8 to 14 mils dry film thickness each.

3.06 WAX COATING

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
   1. Apply in accordance with general application requirements and as follows:
      a. Apply at least 1/32-inch thick coat with 2 inch or shorter bristle brush.
      b. Thoroughly rub coating into metal surface with canvas covered wood block or canvas glove.

3.07 HIGH SOLIDS EPOXY SYSTEM

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and as follows:

a. Abrasive blast ferrous metal surfaces to be submerged at jobsite in accordance with SSPC SP-5 prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP-10.
b. Abrasive blast non-submerged ferrous metal surfaces at jobsite in accordance with SSPC SP-10, prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP-6.
c. Abrasive blast clean ductile iron surfaces in accordance with SSPC SP-7.

B. Application:
1. Apply coatings in accordance with general application requirements and as follows:
a. Apply minimum 2-coat system with minimum total dry film thickness (DFT) of 12 mils.
b. Recoat or apply succeeding epoxy coats within time limits recommended by manufacturer. Prepare surfaces for recoating in accordance with manufacturer's instructions.
c. Coat metal to be submerged before installation when necessary, to obtain acceptable finish and to prevent damage to other surfaces.
d. Coat entire surface of support brackets, stem guides, pipe clips, fasteners, and other metal devices bolted to concrete.
e. Coat surface of items to be exposed and adjacent 1 inch to be concealed when embedded in concrete or masonry.

3.08 HIGH SOLIDS EPOXY AND POLYURETHANE COATING SYSTEM

A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements and as follows:
a. Prepare concrete surfaces in accordance with general preparation requirements.
b. Touch up shop primed steel and miscellaneous iron.
c. Abrasive blast ferrous metal surfaces at jobsite in accordance with SSPC SP-6, Commercial Blast Cleaning, prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP-6.
d. Degrease or solvent clean, whip abrasive blast, power tool, or hand tool clean galvanized metal surfaces.
e. Lightly sand fiberglass pipe to be coated and wipe clean with dry cloths, or solvent clean in accordance with coating manufacturer's instructions.
f. Abrasive blast clean ductile iron surfaces.

B. Application:
1. Apply coatings in accordance with general application requirements and as follows:
2. Apply 3 coat system consisting of:
a. Primer: 4 to 5 mils dry film thickness high solids epoxy primer,
b. Intermediate Coat: 4 to 5 mils dry film thickness high solids epoxy intermediate coat, and
c. Top Coat: 2.5 to 3.5 mils dry film thickness aliphatic or aliphatic-acrylic polyurethane topcoat.

3. Recoat or apply succeeding epoxy coats within 30 days or within time limits recommended by manufacturer, whichever is shorter. Prepare surfaces for recoating in accordance with manufacturer's instructions.
4. For fiberglass pipe, apply one coat high solids epoxy (4 to 5 mils DFT) and two coats aliphatic or aliphatic-acrylic polyurethane.

3.09 ASPHALT VARNISH

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply minimum 2 coats.

3.10 PROTECTIVE COAL TAR

A. Preparation:
   1. Prepare surfaces in accordance with general preparation coal tar requirements.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply minimum 20 mils dry film thickness coating.

3.11 COAL TAR EPOXY

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and as follows:
      a. Abrasive blast iron or steel surfaces to be coated as submerged metal in accordance with SSPC SP-5. Prepare other metal surfaces to be coated with coal tar epoxy in accordance with epoxy manufacturer's instructions.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply two coats of 8 mils each for a total 16 mils dry film thickness.
      b. Apply coal tar epoxy on blasted steel on same day that steel is blasted.

3.12 FIELD QUALITY CONTROL

A. Each coat will be inspected. Strip and remove defective coats, prepare surfaces and recoat. When approved, apply next coat.

B. Control and check dry film thicknesses and integrity of coatings.

C. Measure dry film thickness with calibrated thickness gauge.

D. Dry film thicknesses on ferrous-based substrates may be checked with Elcometer Type 1 Magnetic Pull-off gage or Positector 6000.

E. Verify coat integrity with low-voltage holiday detector. Allow ENGINEER to use detector for additional checking.

F. Check wet film thickness before coal tar epoxy coating cures on concrete or non-ferrous metal substrates.

G. Arrange for services of coating manufacturer's field representative to provide periodic field consultation and inspection services to ensure proper surface preparation of facilities and items to be coated, and to ensure proper application and curing.
   1. Notify ENGINEER 24 hours in advance of each visit by coating manufacturer's representative.
   2. Provide ENGINEER with a written report by coating manufacturer's representative within 48 hours following each visit.

3.13 SCHEDULE OF ITEMS NOT REQUIRING COATING

A. General: Unless specified otherwise, the following items do not require coating.
   1. Items that have received final coat at factory and not listed to receive coating in field.
   2. Aluminum (except where in contact with concrete), brass, bronze, copper, plastic, rubber, stainless steel, chrome, everdur, or lead.
   3. Buried or encased piping or conduit.
   4. Exterior Concrete.
   5. Galvanized roof decking, electrical conduits, pipe trays, cable trays, and other items.
      a. Areas on galvanized items or parts where galvanizing has been damaged during handling or construction shall be repaired as follows:
         1) Clean damaged areas by SSPC SP-1, SP-2, SP-3, or SP-7 as required.
         2) Apply two coats of a cold galvanizing zinc compound such as ZRC World Wide Inovatie Zinc Technologies of Mansfield, MA or accepted equal, in strict accordance with manufacturer’s instructions.
   6. Grease fittings.
   7. Steel to be encased in concrete or masonry.

3.14 SCHEDULE OF SURFACES TO BE COATED IN THE FIELD

A. In general, apply coatings to steel, iron, galvanized surfaces, and wood surfaces unless specified or otherwise indicated on the Drawings. Coat concrete surfaces and anodized aluminum only when specified or indicated on the Drawings.

B. Following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Verify questionable surfaces.

C. Concrete:
   1. Coal Tar Epoxy:
      a. Interior of existing clarifier tank walls.
   2. Modified Waterborne Acrylate :
      a. Exterior of existing clarifier tanks. Match existing color.

D. Metals:
   1. Alkali Resistant Bitumastic:

a. Aluminum surfaces to be placed in contact with wood, concrete, or masonry.

2. Wax Coating:
   a. Sliding faces of sluice and slide gates and threaded portions of gate stems.
3. High Solids Epoxy and Polyurethane System: exterior non-immersed ferrous metal surfaces including:
   a. Non immersed portions of the clarifier mechanisms.
   b. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports.
   c. Motors and motor accessory equipment.
   d. Drive gear, drive housing, coupling housings, and miscellaneous gear drive equipment.
   e. Valve and gate operators and stands.
   f. Structural steel including galvanized structural steel.
   g. Mechanical equipment supports, drive units, and accessories.
   h. Pumps not submerged.
4. High Solids Epoxy System:
   a. Submerged portions of the clarifier mechanisms.
   b. Field priming of ferrous metal surfaces with defective shop prime coat where no other prime coat is specified; for non-immersion service.
   c. Exterior of submerged piping and valves other than stainless steel or PVC piping.
   d. Submerged pipe supports and hangers.
   e. Stem guides.
   f. Other submerged iron and steel metal unless specified otherwise.
   g. Submerged piping.
5. Asphalt Varnish:
   a. Underground valves and valve boxes.
6. Protective Coal Tar:
   a. Underground pipe flanges, excluding pipe, corrugated metal pipe couplings, flexible pipe couplings and miscellaneous underground metals not otherwise specified to receive another protective coating.

END OF SECTION

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SECTION 11301

HOSE PUMP (SCUM PUMP)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Scum pumps

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01730 - Operating and Maintenance Data
      b. Section 01740 - Warranties and Bonds
      c. Section 09960 - Coatings.
      d. Section 15050 - Basic Mechanical Materials and Methods
      e. Section 15958 - Mechanical Equipment Testing.
      f. Section 16405 - Electric Motors.
      g. Section 16050 – Basic Electrical Materials and Methods
      h. Section 16120 - Conductors

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA).

1.03 DEFINITIONS

A. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.

B. TEFC: Totally Enclosed, Fan Cooled.

C. TENV: Totally enclosed non-ventilated.

D. IEEE: Institute of Electrical and Electronics Engineers.

E. ANSI: American National Standards Institute.

F. NEC: National Electric Code.

1.04 SYSTEM DESCRIPTION

A. General

1. Furnish all labor, materials, equipment and incidentals required to install peristaltic hose-type pumps for scum transfer as specified herein and as shown on the drawings.
2. Pumps shall be complete pump unit, driven as indicated in the process pump schedule located below, and shall conform to the pump requirements described herein.
3. The hose pump shall be suitable for exterior installation.

1.05 SUBMITTALS

A. A copy of this specification section with related addenda to this section shall be submitted with each paragraph check-marked to designate specification compliance or marked to indicate deviation from the specification. If deviations are indicated, these items shall be circled with a detailed written justification for the deviation and any resultant changes required for the proper coordination of this equipment into the system.

B. Certified shop drawings.

C. Data regarding pump and motor characteristic and performance inclusive of guaranteed performance curves showing equipment meets the specified requirements of head, capacity, and horsepower.

D. Certified factory test data showing metering accuracy and repeatability from a minimum of 10 machined hoses of the sizes specified with each hose operating for a minimum of 500 hrs each.

E. Provide characteristic curves for variable speed pumps for both actual maximum pump speed and for speed required to obtain minimum pump flow specified.

F. Shop drawings for all accessory items.

G. Dimensional drawings inclusive of recommended location of anchor bolts.

H. Manufacturer's literature as needed to supplement certified data.

I. Operating and maintenance instruction and parts lists in accordance with Section 01730.

J. Certified results of vacuum testing.

K. Certified bearing life.

L. Schematic control and power wiring.

M. Recommendations for long and short term storage.

N. Use tag numbers for all equipment as indicated and specified.

O. Recommended location and mounting of pulsation dampening devices.

P. Qualifications of factory trained technician and the number of service man-days provided.

Q. P/100 ratio calculation.

R. Provide certification that the pump's materials of construction are compatible with the product being pumped.

1.06 QUALITY ASSURANCE

A. The pump specified under this section is to be manufacturer's standard catalog product, manufactured by a company with no less than ten years experience in the manufacture of such equipment. Upon request by the engineer, the manufacturer shall provide proof of such experience by providing installation lists, brochures, catalog cuts, etc.

B. Shop tests as specified.

C. Pump manufacturer must provide pumps and accessories, which are integral to pump operation, and specified herein as a coordinated package, regardless of manufacturer. This includes pumps, gear reducers, motors, pulsation dampeners, leak detectors, control panels/drives and other such accessories specified under this section as the responsibility of the pump supplier. Equipment specified herein that is not supplied by the pump manufacturer, as an integrated package will be rejected.

D. Pump manufacturer must have at least five operating installations in the United States of the size specified and in the same service as specified for a period of at least three years.

E. Services of a factory trained technician:
   1. One eight (8) hour day of instruction and operator training shall be provided by pump manufacturer.
   2. Technician must be factory certified and specifically trained on the type of equipment specified. Technician must have a minimum of five (5) years direct experience on the size and type of equipment specified. The services of a manufacturer's sales representative will not be accepted to fulfill this requirement.
   3. Pumps shall be assembled in compliance within ISO9002 standards.

1.07 WARRANTY

A. As specified in Section 01740

B. Warrant free of defects in material and workmanship for 3 years from the date of acceptance or date of first beneficial use by the OWNER.

1.08 MAINTENANCE

A. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of the pump system components.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Shipping

1. Ship equipment, material, and spare parts complete, except where partial disassembly is required by transportation regulations or for protection of components.
2. Pack all spare parts in containers bearing labels clearly designating the contents.
3. Deliver spare parts at the same time as pertaining equipment.
4. Pumps shall be shipped with hoses installed. In the event long term on site storage is anticipated, pumps may be shipped with hoses uninstalled for field installation by the Contractor prior to startup if so requested by the Contractor/Engineer at time of submittal approval.

B. Receiving
1. Contractor to inspect and inventory items immediately upon delivery to site and is responsible for storing and safeguarding equipment, material, instructions, and spare parts in accordance with manufacturer's written instructions.

PART 2 PRODUCT

2.01 MANUFACTURERS

A. Watson-Marlow/Bredel Pumps of Wilmington, MA, or approved equal

2.02 PUMP CONSTRUCTION

A. General
1. Horizontal, Positive displacement peristaltic hose pump.
2. Capable of operating in either direction without flow variation.
3. Capable of running dry without damage to pump or hose.
4. Capable of pulling 95% of full vacuum
5. Repeatability: ± 1% accurate
6. Valveless/Glandless design with no dynamic seals in contact with the pumped product.
7. Pump shall be capable of being rotated in 90-degree increments for four (4) different port-mounting configurations.
8. Direct Coupled gear drive arrangement as specified herein.
9. Pump hardware shall be galvanized steel.

B. Hose and Lubricant
1. Hose shall be manufactured of three-layer elastomer with an extruded inner wetted layer compatible with the process fluid, four layers of nylon reinforcement for 25mm-100mm hoses and two layers of nylon reinforcement for 10mm and 15mm, and a Natural Rubber outer layer. Hose outside diameter shall be machined to maintain a wall thickness within + 0.25 mm tolerance for 25mm-100mm and + 0.4 mm for the 10mm and 15mm hoses. The hose external surface shall have a surface roughness of Ra 8± 4m. Hoses must have a smooth extruded internal surface and have tolerance controlled through machining. Hoses that do not meet these minimum requirements are not acceptable.
2. Minimum Static Burst Pressure rating of 800 psi for the 25mm-100mm hoses and 1090 psi for the 10mm and 15mm hoses.
3. 53-68 shore A durometer.

4. Hose must be replaceable without cover or pump removal.
5. Pump housing shall contain a NSF-listed food-grade glycerin based hose lubricant blended to provide a medium for cooling and lubrication.
6. Provide a threaded drain plug at the lowest point of the pumping chamber to allow the complete drainage of lubricant.

C. Pump Housing , Rotor, and Internal Bearing Frame
   a. Housing Construction: Pump housing shall be cast iron and shall be supplied with an internal bearing hub to support the rotor on its own bearings. Provide a threaded drain plug at the lowest point of the pumping chamber to allow complete drainage of lubricant.
      1) 10-15 mm pumps: Cast Iron ASTM A48 Class 40 (DIN GG25)
      2) 25-100 mm pumps: Cast Iron ASTM A48 Class 25
   b. Pump Rotor
      1) Rotor shall be cast iron with two pressing shoes located 180 degrees apart. To perfectly match the pump to the process conditions and eliminate slip, shoe occlusion must be adjustable. Rotors incorporating rollers or fixed occlusion shoes are unacceptable.
         a) 25-100 mm pumps: Cast Iron rotor ASTM A48 Class 25 with adjustable, shimmable shoes constructed of epoxy or extruded aluminum as recommended by the manufacturer. Shims shall be constructed of 316 Stainless Steel with a shim thickness of 0.5mm. The specified manufacturing tolerance of the hose, when compressed, shall not exceed the occlusion setting of one shim.
         b) 10-15 mm pumps: Cast Iron rotor ASTM A48 Class 45B (DIN GG30) with integrally mounted shoes. Occlusion adjustment shall be made through availability of two alternative rotors with High and Low pressure occlusion settings. Manufacturer shall supply the rotor applicable for the conditions in the Pump Schedule.
   c. Internal Bearing Frame
      1) Pump rotor shall be independently supported on its own set of heavy duty ball bearings such that the bearings are located directly under the rotor's load. Bearings shall be supported by the bearing hub located within the pump housing and shall be sealed via a dynamic seal. Bearings shall be sealed and greased for life. Pumps which use pump lubricant to lubricate the bearings, external bearing frames which allow overhung loading and require long coupling configurations, or close coupling where the rotor is not supported by pump bearings are not acceptable.
      2) Gearing shall be direct coupled to the back of the pump housing and shall be completely isolated from the process fluid and pump fluid through the sealed bearing hub. Gear unit and drive components shall be serviceable without removal of the pump rotor.

D. Flanged Connectors
   1. Supply pump with flanged inlet and outlet to ANSI/ASA 150# standards with wetted inserts compatible with the process fluid as indicated in the Process Pump Schedule. Flange construction:
      a. SPX10-15: 316 Stainless Steel
      b. SPX25-100: 316 Stainless Steel

c. Pump hose shall extend from the pumping chamber to allow visual confirmation of hose/flange insert connection. Flange insert shall be secured to the pump hose via a single band clamp. Securing the hose using multiple clamps or internal compression fittings that cannot be visually verified as secure without disassembly of the pump is not acceptable.

2. Flange supports shall be of one piece construction and shall secure to the pump housing via two or four bolts to maintain a compression seal between the pump housing and hose. Flange support construction:
   a. SPX10-15: 316 Stainless Steel
   b. SPX25-100: 316 Stainless Steel

E. Pump Cover
1. Pump cover shall be constructed of Cast Iron
   a. 10-15mm pumps: ASTM A48 class 40
   b. 25-32 mm pumps: ASTM A48 class 25
   c. 40-100 mm pumps: ASTM A245 class 36
2. Viewing Window: Equip cover with a viewing window constructed of PMMA to allow clear visual confirmation of direction of rotation. Window shall be marked with a minimum lubricant registration mark for proper indication of lubricant level when pump is stationary. For 25-100 mm pumps with adjustable shoes, the window shall be large enough to replace pressing shoes and allow shim adjustment without removing pump cover.
3. Cover Mounting: 25-100 mm pump covers shall be bolted along the perimeter to the pump housing and shall seal via a captive quadring seal. 10- 15 mm pumps shall bolt to the pump housing with no more than four bolts and shall be sealed via a gasket seal.

F. Frame
1. Support frame shall be torsion free and constructed of formed hot dipped galvanized steel with a coating thickness of 15 microns. Welded steel or modular adjustable frames are not acceptable.

G. High lubricant leak detector
1. Provide a float type magnetic reed switch located near the top of the pump to detect leakage of pumped product into the pump housing.
2. Supply sensor Normally Closed with the ability for field adjustment to Normally Open
3. Pump manufacturer to supply switch and also responsible for alarm and relay to turn pump off unless otherwise specified herein.
4. Float switch shall be rated to the following maxima:
   Vmax = 240VAC, Imax = 1 Amp, Pmax = 50VA

H. Revolution Sensor
1. Provide magnetic type sensor to detect rotor revolutions. Mount sensor on the rear of the pump housing for 25mm-100mm pumps and between the suction and discharge ports on the 10mm and 15mm pumps.
2. Pump manufacturer to supply sensor only. Contractor is responsible for any additional equipment which may be required to integrate this into their control system.

3. magnetic sensor actuates a non-maintained NO switch when triggering device passes the sensor. When magnetic sensor is powered and pump is in operation a pulse waveform is generated.
4. Magnetic sensor shall be rated to the following maxima: Vmax = 30VDC, Imax = 150 mA, Pmax = 4.5VA

2.03 PUMP DRIVE SYSTEM

A. Direct Coupled Gearing with Fully Protected Drive mounting
   1. Provide gearing with Fully Protected Drive direct-coupled mounting to the pump housing.
      a. The gearbox shall bolt directly to the pump housing which shall include a buffer zone between the gearing and pumphead to prevent gearbox contamination from pump fluid or lubricant in the event of a hose lubricant seal failure. The pump's internal bearing hub shall be vented through the rear of the pump housing to allow visual detection in the event of a hose lubricant seal failure.
      b. Close coupled pump designs which utilize the gearbox to seal the pump housing and expose the gearbox to lubricant or pumpage are not acceptable.
      c. Long coupled pumps which require external couplings, coupling alignment, and coupling guards are not acceptable.
   2. Design gear reduction to match output speed requirement of the pump using two or three-stage gearing and matching torque rating of pumping equipment. Gearing shall be classified for continuous heavy shock duty, 24 hr duty with a minimum of 1.4 service factor.
      a. 10-32 mm pumps: helical gearing with cast iron housing
      b. 40-100 mm pumps: ultra compact, high torque planetary gearing with cast iron housing

B. Motors: As specified in Section 16405 and as specified in this Section.
   1. Provide premium efficient, TEFC or TENV, squirrel-cage induction motors, NEMA C face, conforming to the latest applicable requirements of NEMA, IEEE, ANSI, and NEC standards.
   2. Provide motor HP in accordance with Process Pump Schedule.
   3. Motors are to be designed for continuous duty for 3-phase, 460VAC operation, NEMA Design B with torque and starting currents in accordance with NEMA MG1-1993-12.35 and 12.38. Ratings to be based on a 40 degree C ambient 3,300 feet altitude or lower operation with a maximum temperature rise of 80 degree by resistance C at 1.0 service factor (and 90 degree C rise 1.15 service factor).
   4. Motors shall be furnished with Class F insulation utilizing materials and insulation systems evaluated in accordance with IEEE 117 classification tests. Motors shall have 1.15 service factor but shall be selected for operation within their full load rating without applying the service factor.
   5. Bearings shall be selected to provide L10 rating of 100,000 hrs minimum for C face flexible coupled applications. For frame sizes 56-140, bearings shall be permanently lubricated. For frame sizes 180 and larger, proved capped grease fitting.
   6. For frame sizes 180 and larger, motor enclosure including frame, end brackets locking bearing inner caps, fan guard, and conduit box and cover shall be cast iron, ASTM Type A48, Class 25 or better. Conduit box shall be diagonally split

with tapped NPT threaded conduit entrance hole, neoprene conduit box cover gasket, neoprene lead seal gasket between box and motor frame, and ground lug.For frame sizes 56-140, motor enclosure, fan guard, conduit box, and cover shallbe carbon steel. End shield shall be constructed of aluminum. Conduit box shall be top mounted with F1/F2 conduit entrance holes, grounding lug, and neoprene conduit box gasket between box and motor frame.

7. External cooling fan on TEFC motors shall be corrosion resistant, non-sparking, bi-directional, keyed, clamped, and shouldered on the motor shaft.
8. Motor rotor construction shall be die cast aluminum, fabricated copper, or their respective alloys. Motor shall have copper windings.
9. Motor leads shall be nonwicking type permanently numbered for identification.
10. All motors shall be premium efficient with minimum efficiencies exceeding NEMA MG1-1993 Table 12-10. Motor efficiency shall be determined in accordance with NEMA MG1-1993-2.58.1 and full load efficiency labeled on motor nameplate in accordance with NEMA MG1-1993-12.58.2
11. Motors shall suitable for use with PWM type variable frequency drives. Motors frame size 56-180 shall be rated for 10:1 constant torque continuous duty over 6-60 Hz. Larger frame motors shall be rated for 4:1 constant torque continuous duty over 15-60 Hz. Motors shall have thermal switch as stated in specification 16405.
12. Acceptable Manufacturers - Reliance Electric or approved equal.

2.04 PULSATION DAMPENERS

A. Inlet Pulsation Accumulators

1. Accumulator shall be chargeable, the appendage type, and consist of a two part housing and bell shaped flexible bladder.
   a. For flooded suction applications, provide chargeable accumulator with one-way air inlet valve to prevent product backflow, pressure gauge, and air fill valve. Plastic accumulators shall be rated to 150 psi working pressure. Metal accumulators shall be rated to 300 psi working pressure.
   b. For suction lift applications provide chargeable accumulator with ball valve, Venturi valve, and 30in-30psi compound gauge. Plastic and metal accumulators shall be rated to a maximum of 30 psi.
2. Suction Accumulator shall be designed for vertical tee mounting into the suction line. Contractor shall provide an appropriate flanged tee with vertical leg for mating to pulsation accumulator and horizontal legs for mating to suction source piping and pump inlet piping. For 10 mm pump, provide flow through type accumulator which shall not require a separate tee.

Pump	Model	150# Flanged Inlet	Housing Material	Bladder
10 mm	Sentry III	1/2” Flow through	316SS	Neoprene
15- 25 mm	Sentry II	¾”	316SS	Neoprene
32-65 mm	Sentry I	2”	316SS	Neoprene
80-100 mm	Sentry IV	3”	316SS	Neoprene

3. Contractor shall install suction accumulators in accordance with the manufacturer’s instructions and air-charge the accumulators in accordance with the process requirements as recommended by the manufacturer.

4. Suction accumulators shall be mounted within three feet of the pump inlet port.
5. No other equipment shall be installed between the suction accumulator and pump.
6. Manufacturer by Blacoh, Sentry Model

B. Discharge Pulsation Dampeners
1. Dampener shall be chargeable, the appendage type, and consist of a two part housing and bell shaped flexible bladder.
   a. Provide chargeable dampener with one-way air inlet valve to prevent product backflow, pressure gauge, and air fill valve. Plastic dampeners shall be rated to 150 psi working pressure. Metal dampeners shall be rated to 300 psi working pressure.
2. Dampener shall be designed for vertical tee mounting into the discharge line. Contractor shall provide an appropriate flanged tee with vertical leg for mating to pulsation dampener and horizontal legs for mating to destination discharge piping and pump discharge piping. For 10 mm pump, provide flow through type dampener which shall not require a separate tee.

Pump	Model	150# Flanged Inlet	Housing Material	Bladder
10 mm	Sentry III	1/2" Flow through	316SS	Neoprene
15- 25 mm	Sentry II	¾"	316SS	Neoprene
32-65 mm	Sentry I	2"	316SS	Neoprene
80-100 mm	Sentry IV	3"	316SS	Neoprene

3. Contractor shall install discharge pulsation dampeners in accordance with the manufacturer's instructions and air-charge the dampener in accordance with the process requirements as recommended by the manufacturer.
4. Pulsation Dampener shall be mounted within three feet of the pump discharge port. No other equipment shall be installed between the discharge pulsation dampener and pump.
5. Manufacturer by Blacoh, Sentry Model

2.05 SCUM PUMP CONTROL PANEL

A. Provide a NEMA 4X 316 stainless steel control panel for each scum pump. Power supply for each scum pump control panel is 480V, 3-phase, 60-Hz. Each local control panel shall include a back plate and NEMA contactor full-voltage reversing motor starter, main circuit breaker with external handle, control transformer, selector switches, push buttons, push-to-test LED type indication lights, relays, timer, terminal blocks, wires, phase failure relay, fuses, etc. as necessary for a complete and working scum pump control panel system in place. Provide the following components:
1. Provide running and pump fault indication lamps
2. Provide stop and overload reset push button switches
3. Provide forward/reverse and local/off/remote manual switches.
4. Provide phase failure relay.
5. Provide screw connection terminal blocks
6. Provide heavy duty watertight/oiltight relays, switches and push-to-test LED indicator lamps.
7. Provide control transformer and wire components complete.

B. Refer to Electrical drawings for scum pump control schematic requirements.

2.06 PAINTING

A. Provide pump assembly primed and finish painted within manufacturer's standard paint specification
   1. Primer Coat
      a. Two pack (component) epoxy resin primer
      b. Dry thickness 20-40 micron
   2. Finish Coat
      a. Two pack (component) acrylate isocyanate combination
      b. Dry thickness 20-40 micron
      c. Color- RAL 3011 brown red

2.07 SPARE PARTS

A. Provide spare parts that are identical to and interchangeable with parts installed. Furnish and deliver the following spare parts for each pump:
   1. Two replacement hoses
   2. Two hose lubricant refills

2.08 SHOP TESTING

A. Non-witnessed Inlet Vacuum Testing
   1. Test assembled Pump running on air.
   2. Run test for a minimum of 30 seconds and record vacuum reading which must meet or exceed 28" Hg Vacuum.
   3. In the event that specified tests indicate that the pump does not meet specifications, Engineer has the right to require complete tests for the pump at no additional cost to the owner.
   4. Repeat tests until specified results are obtained.
   5. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Contractor shall install items in accordance with manufacturer's printed instructions and as indicated and specified.

B. Contractor shall install pumping equipment on a concrete pad and make final alignments thereon.

C. Contractor shall install accessories in accordance with manufacturer's written instructions.

D. Contractor shall prove the pump's suction and discharge port connections to process lines are nonleaking and made in a free supported state without need to apply vertical or horizontal pressure to align piping with pump nozzles

3.02 FIELD TESTING

A. By Contractor with assistance of Manufacturer's Field Service Technician

B. After installation of pumping equipment, and after inspection, operation, testing, and adjustment have been completed by the Contractor in the presence of the Manufacturer's Field Service Technician, Contractor shall conduct running test for each pump in the presence of the Engineer to determine its ability to operate within the performance limits specified and to deliver its rated capacity within the pressure requirements specified. Contractor shall provide labor, piping, equipment, and materials necessary for conducting all field tests.

C. Make all adjustments necessary to place equipment in specified and working order atthe time of above tests.

D. Test pumps on product only.

E. Promptly correct or replace all defective equipment revealed by or noted during tests at no additional cost to the Owner and repeat tests until specified results acceptable to Engineer are obtained.

3.03 PUMP SCHEDULE

Tag Numbers	**SP-1070 SP-1080**
Pump Model	Watson-Marlow/Bredel SPX65 Hose Pump
Quantity	Two
Fluid	
Type/concentration	Water – Second Clarifier content with scum and other floatables.
Specific Gravity	1.0
Fluid Temperature	Ambient
Solid Content	Less than 0.5%
Capacity (gpm)	20
Pump RPM	11
Suction Pressure Max Positive Static Head	8ft
Max Discharge Pressure (PSI)	25
Minimum Port Size	2.5”
Pump Pitch Diameter	29.4”
Displacement/Revolution (gal)	1.77
P/100 Ratio (theroretical Max Number of Occlusions/100 Gallons Pumped)	114
Pump Flange Size (ASA 150#)	2.5”
Insert Material	316 Stainless Steel

Tag Numbers	SP-1070 SP-1080
Max Motor HP	5
Power (VAC, Phase, Frequency)	460 VAC, 3 phase, 60Hz
Hose Material	Natural Rubber
Orientation (Facing Pump)	See Construction Drawings

END OF SECTION

SECTION 11312B

HORIZONTAL, CENTRIFUGAL, NON-CLOG PUMPS (RAS PUMPS)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Horizontal, non-clog, flexibly coupled, centrifugal pumps with drivers, and features as specified.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01740 – Warranties and Bonds
      b. Section 01756 – Testing, Training, and Facility Start-Up.
      c. Section 09960 – Coatings.
      d. Section 15050 – Basic Mechanical Materials and Methods.
      e. Section 15958 – Mechanical Equipment Testing.
      f. Section 16262 – Variable Frequency Drive Below 75 Horsepower
      g. Section 16405 – Electric Motors.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

C. ASTM International (ASTM):
   1. A 48 - Standard Specification for Gray Iron Castings.
   2. A 108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished.
   3. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A 283 - Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   5. A 743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
   6. B 148 - Standard Specification for Aluminum-Bronze Sand Castings.

7. B 505 - Standard Specification for Copper Alloy Continuous Castings.
8. B 763 - Standard Specification for Copper Alloy Sand Castings for Valve Applications.
9. E 10 - Standard Test Method for Brinell Hardness of Metallic Materials.

D. Hydraulic Institute (HI):
1. 1.1-1.2 - Centrifugal Pumps for Nomenclature and Definitions.
2. 1.3 - Rotodynamic (Centrifugal) Pumps for Design and Application.
3. 1.6 - Centrifugal Pump Tests.
4. 9.1-9.5 - Pumps - General Guidelines for Types, Definitions, Application and Sound Measurement, and Decontamination.

1.03 DEFINITIONS

A. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 1.1-1.2, 1.3, 1.6, and 9.1-9.5 and as modified in this Section.

B. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 SYSTEM DESCRIPTION

A. Components: Horizontal non-clog (Francis-Vane) or mixed flow pumps, drivers, motors, seals or packing, couplings, base plates, guards, supports, anchor bolts, necessary valves, gauges, taps, lifting eyes, stands, and other items as required for a complete and operational system.

B. Design requirements:
1. Pump performance characteristics: As specified in the Pump Schedule, Pump Performance Characteristics:
   a. As specified in the Pump Schedule.
   b. Performance tolerances shall be the same as the test tolerances specified in Section 15958.
2. Motor characteristics: As specified in the Pump Schedule.

1.05 SUBMITTALS

A. Submit as specified in Section 15050.

B. Torsional analysis: Submit as specified in Section 15050 when scheduled.

C. Furnish motor submittals as specified in Section 16405.

1.06 QUALITY ASSURANCE

A. As specified in Section 15050.

B. Provide pumps specified in this Section from same manufacturer.

C. Require pump manufacturer to furnish and coordinate pump, driver, drive, and pump components as scheduled and to provide written installation and checkout requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 15050.

1.08 PROJECT CONDITIONS

A. Match existing pump installation.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate work with restrictions specified in Section 01310.

1.10 WARRANTY

A. As specified in Section 01740

B. Warrant free of defects in material and workmanship for 3 years from the date of acceptance or date of first beneficial use by the OWNER.

1.11 MAINTENANCE

A. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of the pump system components.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pumps: One of the following or equal:
   1. Aurora Pump Model 611A

2.02 MATERIALS

A. General: Materials in the Pump Schedule shall be the type and grade as specified below.

B. Cast iron: ASTM A 48, Class 30 minimum.

C. Nickel cast iron: ASTM A 48, minimum Class 30, cast iron with 3 percent nickel.

D. Iron-chromium alloy: ASTM A 743, Grade CA40.

E. Bronze or leaded tin bronze: ASTM B 505, Alloy C92700.

F. Aluminum bronze: ASTM B 148 or B 763, Alloy C95200.

G. Stainless steel: ASTM A 276, type as scheduled.

H. Neoprene: Polychloroprene rubber.

I. Structural steel: ASTM A 283, Grade D.

J. Steel: ASTM A 108, Grade as scheduled.

2.03 GENERAL PUMP CONSTRUCTION

A. Type: Heavy-duty, horizontal, non-clog (Francis-Vane) centrifugal type pumps.

B. Other requirements:
   1. Vibration: As specified in Section 15958.

2.04 PUMP CASINGS

A. Type: Center volute section with a separate suction cover with flanged nozzle.

B. Material: As scheduled.

C. Construction: Of sufficient strength, weight, and thickness to provide accurate alignment, prevent excessive deflection.

D. Rotating assembly: Removable without disturbing suction or discharge connections.

E. Design Working Pressure: Minimum 1.10 times maximum shutoff total dynamic head with maximum installable impeller diameter at maximum operating speed plus maximum suction static head.

F. Discharge: Tangential to casing or centered on casing when space permits acceptable rearrangement of piping.

G. Suction and discharge piping connections: Flanged meeting ASME B16.1, Class 125, or ASME B16.5, Class 150, or higher pressure class as required to meet Design Working Pressure.

H. Handholes: Provide to permit inspection and cleaning of pump interior. Provide bolted cover with inner contour that matches contour of casings; minimum 5-inch diameter when pump size permits this size handhole.

I. Vent and taps:
   1. Provide castings with both 3/4-inch threaded high point and low point drain taps.
   2. Provide 1/2 inch threaded tap with valve and pressure gauge on the suction and discharge flanges. Pressure gauge on pumps must have diaphragm type chemical seal.

J. Hydrostatic test: 5-minute hydrostatic test at minimum 1.5 times Design Working Pressure.

2.05 IMPELLERS

A. Type: As scheduled.

B. Material: As scheduled.

C. Maximum number of vanes: As scheduled.

D. Design with smooth water passages to prevent clogging by stringy or fibrous materials. Passages shall be capable of passing solids with sphere size as scheduled.

E. Method of securing to shafts: Keyed and secured by bronze nut locked in place, but readily removable without use of special tools.

F. Adjustment of axial clearance: Through jacking screws and lock nuts placed between frame and outboard bearing housing or by shims held in place by frame housing.

G. Rotation: Clockwise looking from driver, unless otherwise indicated on the Drawings.

H. Balance: As specified in Section 15050 and vibration criteria as specified in Section 15958.

2.06 WEAR RINGS

A. Materials:
   1. Impeller wear ring: As scheduled with a Brinell Hardness Number of 350 to 380 or at least 50 Brinell Hardness Number less than the casing or suction head wear ring Brinell Hardness Number when tested in accordance with ASTM E 10.
   2. Casing or suction head wear ring: As scheduled with a minimum Brinell Hardness Number of 450 when tested in accordance with ASTM E 10.

B. Features:
   1. Able to allow compensation for minimum 1/8 inch wear.
   2. Provided with wearing surfaces normal to axis of rotation (perpendicular to shaft axis).
   3. Removable.
   4. Fastened with recessed screws to prevent relative rotation.

2.07 PUMP SHAFTS

A. Material: As scheduled, turned, ground, and polished.

B. Strength: Able to withstand minimum 1.5 times maximum operating torque and other loads.

C. Resonant frequency: As specified in Sections 15050 and 15958.

D. Deflection: Maximum 0.002 inches under operating conditions.

E. Impeller attachment: Taper fitted or straight at impeller with key and bolt for securing impeller.

F. Shaft sleeve:

1. Material: As scheduled with minimum Brinell Hardness of 450 when tested in accordance with ASTM E 10.
2. Renewable, key locked in stuffing box, gland area, and bearings.
3. Able to protect shaft from pumped liquid and wear.

2.08 STUFFING BOXES

A. Size: As specified in Section 15050.

B. Materials: Same as pump casing.

C. Provide separate stuffing box housing (not integral to the rear liner or wear plate) suitable for shaft seal type scheduled.

D. Shaft seal type: As scheduled and as specified in Section 15050.

2.09 BEARINGS AND BEARING FRAME

A. Bearing type: Anti-friction meeting ABMA standards; self-aligning spherical roller type radial bearings; angular contact ball type, or tapered roller for thrust bearings.

B. Bearing lubrication:
   1. When grease lubrication scheduled, provide:
      a. External grease fittings with grease relief pipe.
      b. Lip type grease seals and labyrinth type grease deflectors at both ends of bearing housings, able to prevent entrance of contaminants.
   2. When oil lubrication scheduled, provide:
      a. Pressure lubricating system or separate oil reservoir type system.
      b. Oil filler pipe.
      c. External level indicator gauge.
   3. Size sufficiently to safely absorb heat energy normally generated in bearing under maximum ambient temperature of 60 degrees Celsius.

C. Bearing life: Minimum L_{10} life of 100,000 hours at rated design point or 24,000 hours in accordance with ABMA 9 or 11 at bearing design load imposed by pump shutoff with maximum sized impeller at rated speed, whichever provides longest bearing life in intended service.

D. Pump bearing frames:
   1. Material: As scheduled.
   2. Provide a 1-piece rigid construction with bearing housing at outboard (pump) end, and end cover or housing at inboard (driver) end.

E. Inboard bearing frame drain hole: Tapped, 3/4 inch NPT, located as low as possible to drain leakage when adjacent to packing or seal.

2.10 COUPLINGS

A. Types: As scheduled and as specified in Section 15050.

B. Flexible coupling life: Infinite at up to 0.3-degree misalignment angle total or per disk for disk type at maximum operating loads.

C. Design coupling to withstand a minimum of 1.5 times the maximum operating torque and other imposed loads.

D. Components for driver connected through intermediate shafting: When scheduled, provide drive shafting, couplings, intermediate bearing supports, U-joints, and separate motor/driver support arranged in accordance with general arrangement indicated on the Drawings.

E. Motor/driver and pump couplings for single intermediate shafts: Flexible disc or other type required to meet torsional vibration requirements.

2.11 SUPPORTS, PEDESTALS, AND BASEPLATES

A. Materials: Same as pump casing or ASTM A 283 steel, and coated as specified in Section 09960.

B. Pump, driver, and intermediate bearing support strength: Able to withstand minimum 1.5 times maximum imposed operating loads or imposed seismic loads, whichever is greater.

C. Configuration: Allow easy access to stuffing boxes, bearing frames, and couplings.

D. Support pump and motor pedestals on a common structural steel baseplate.

2.12 EQUIPMENT GUARDS

A. Provide equipment safety guards as specified in Section 15050.

2.13 DRIVERS

A. Horsepower:
   1. As scheduled.
   2. Listed driver horsepower is the minimum to be supplied.
      a. Increase driver horsepower if required to prevent driver overload while operating at any point of the supplied pump operating head-flow curve including runout.
      b. When scheduled driver is a motor, increase motor horsepower if required to prevent operation in the service factor.
      c. Make all structural, mechanical, and electrical changes required to accommodate increased horsepower.

B. Motors: As specified in Section 16405 and as specified in this Section.
   1. RPM: As scheduled:
   2. Enclosure: As scheduled.
   3. Electrical characteristics: Inverter duty rated and as scheduled.
   4. Efficiency, service factor, insulation, and other motor characteristics: As specified in Section 16405.
   5. Motor accessories: Motor space heater and motor thermostat as specified in Section 16405 and as specified in this Section.
   6. Coordinate motors with the variable frequency drive manufacturer (specification 16262) to ensure compatibility between the motor and variable frequency drive.

C. Other drivers: As scheduled and as specified in sections listed in the Schedule.

D. Non-reverse ratchets, type: When scheduled, able to prevent reverse rotation of pump and driver.

2.14 FINISHES

A. Prepare surfaces and apply protective finishes as specified in Section 09960.

2.15 SOURCE QUALITY CONTROL

A. Witnessing: Source or factory testing shall be witnessed by the ENGINEER or OWNER when scheduled; provide advanced notice of source testing as specified in Sections 01310 and 15958.

B. Equipment performance test: Test level as scheduled; test as specified in Section 15958.

C. Vibration test: Test level as scheduled; test as specified in Section 15958.

D. Noise test: Test level as scheduled; test as specified in Section 15958.

E. Motor factory tests: Test as specified in the variable frequency drive section.

F. Hydrostatic pressure tests: As specified for components in this Section.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions and as specified in Section 15050.

3.02 FIELD QUALITY CONTROL

A. Witnessing: All field-testing shall be witnessed by the ENGINEER; provide advanced notice of field-testing as specified in Sections 01756 and 15958.

B. Inspection and checkout: As specified in Sections 15050 and 15958.

C. Equipment performance test: Test level as scheduled; test as specified in Section 15958.

D. Vibration test: Test level as scheduled; test as specified in Section 15958.

E. Noise test: Test level as scheduled; test as specified in Section 15958.

F. Operational testing: As specified in Section 01756.

3.03 MANUFACTURER'S FIELD SERVICES

A. Require manufacturer to inspect system before initial start-up and certify that system has been correctly installed and prepared for start-up as specified in this section and in Sections 15050 and 15958.

B. Training: As specified in Section 01756.

3.04 PUMP SCHEDULE

Tag Numbers	RAS-1040 RAS-1050 RAS-1060
General Characteristics:	
Service	Recycled Activated Sludge
Quantity	3
Manufacturer - Model Number	Aurora 611A
Maximum Noise, dBA at 3 feet	85
Torsional Analysis	Required
Minimum Pumped Fluid degrees Fahrenheit	50
Maximum Pumped Fluid degrees Fahrenheit	90
Pump Characteristics:	
Impeller Type	Non-clog
Impeller, Maximum Number Vanes	Per Manufacturer
Pass Minimum Sphere Size, Inch	4.75 inch (minimum)
Impeller Bearing Lubrication	Grease
Shaft Seal Type	Single Cartridge Mechanical Seal with Throttle Bushing
Coupling Type	Spacer
Speed Control	Variable Frequency Drive
Maximum Pump rpm	700
Suction Size	10 inches
Discharge Size	10 inches
Rated Design Point (at Maximum Revolutions per Minute):	
Flow, gpm	3,500
Total Dynamic Head, Feet	21
Minimum Efficiency, Percent	76
Shut Off Head, Feet	34.3

Tag Numbers	RAS-1040 RAS-1050 RAS-1060
NPSHr at Maximum Flow, Feet	16.5
Pump Materials:	
Impeller Casing	Cast Iron
Impeller	Cast Iron
Impeller Wear Ring	420 Stainless Steel
Casing or Suction Head Wear Ring	420 Stainless Steel
Shaft	Carbon Steel
Shaft Sleeve	Hardened 440C Stainless Steel
Pump Bearing Frame	Cast Iron
Driver Characteristics:	
Driver Type	Motor
Drive Arrangement	Horizontal, Coupled
Minimum Driver Horsepower	30
Maximum Driver rpm	900
Motor Characteristics (when motor is driver type):	
Inverter Duty Rated	Yes
Motor Voltage/Phases/Hertz	460/3/60
Enclosure Type	TEFC
Source Quality Control Testing:	
Test Witnessing	Certified
Performance Test Level	1
Vibration Test Level	1
Noise Test Level	1
Field Quality Control Testing:	
Performance Test Level	1
Vibration Test Level	1
Noise Test Level	1

END OF SECTION

SECTION 11353

CIRCULAR SECONDARY CLARIFIER EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Specification of equipment for installation in circular secondary clarifiers of center feed, peripheral overflow design.
   2. Clarifier Accessories:

B. Related Sections
   1. Section 01614 Wind Design Criteria
   2. Section 01740 Warranties and Bonds
   3. Section 15120 Piping Specialties
   4. Section 15265 Plastic Piping and Tubing
   5. Section 16050 Basic Electrical Materials and Methods
   6. Section 16480 Low Voltage Motor Control
   7. Section 16120 - Conductors

1.02 REFERENCES

A. American Gear Manufacturers Association (AGMA):
   1. 201.02 - Tooth Proportions for Coarse-Pitch Involute Spur Gears.
   2. 390.03a - Handbook - Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Wormgearing and Racks Only as Unassembled Gears.
   3. 908 - Information Sheet - Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth.
   4. 2000 - Gear Classification and Inspection Handbook - Tolerances and Measuring Methods for Unassembled Spur and Helical Gears (Including Metric Equivalents).
   5. 2001 - Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
   6. 2004 - Gear Materials and Heat Treatment Manual.
   7. 6019 - Standard for Gearmotors Using Spur, Helical, Herringbone, Straight Bevel or Spiral Bevel Gears.
   8. 6022 - Design Manual for Cylindrical Wormgearing
   9. 6034 - Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
   10. 9005 - Industrial Gear Lubrication.

B. American Institute of Steel Construction (AISC):
   1. Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design.
   2. Code of Standard Practice for Steel Bridges and Buildings.

C. American National Standards Institute (ANSI):
   1. ANSI/ASME B29.1M - Precision Power Transmission Roller Chains, Attachments And Sprockets.

D. American Society for Testing and Materials (ASTM):
   1. A 36/A 36M - Specifications for Structural Steel.
   2. A 48 - Specification for Gray Iron Castings.
   3. A 148/A 148M - Specification for Steel Castings, High Strength, for Structural Purposes.
   4. A 325 - Specification for High-Strength Bolts for Structural Steel Joints.
   5. A 536 - Specification for Ductile Iron Castings.

E. American Welding Society (AWS):
   1. D 1.1 - Structural Welding Code for Steel.

F. American Bearing Manufacturers Association (ABMA):
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

G. Florida Building Code (FBC)

H. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 - Enclosures for Electrical Equipment (1,000 volts maximum).

I. Underwriter Laboratories, Inc (UL)
   1. UL 508 – Industrial Control Equipment

1.03 DEFINITIONS

A. Continuous Operation: 24 hour-per-day operation for design life of not less than 20 years, which equals 175,200 hours.

B. Intermittent Operation: Periodic operation, including starts and stops, and prolonged periods of resting.

C. Subassemblies: Includes, but may not be limited to, complete center column, drive cage, drive assembly, truss arms, and scum skimming system.

D. Set: Equipment necessary to completely furnish 2 clarifiers.

E. Continuous Running Torque: The 100 percent AGMA torque, assumed to be continuously applied, 24 hours a day, to the drive system. Bearing life, gear strength, gear durability, gear rating, mechanism structural design, and alarm and shutdown setpoints are specified as a percentage of the continuous running torque.

F. Momentary Peak Torque: The maximum torque for rating yield strength or ultimate strength of center drive mechanism components. The numerical value for momentary peak torque shall be 2.0 x continuous running torque.

1.04 SYSTEM DESCRIPTION

A. Nominal Clarifier Dimensions:
   1. Tank Diameter: 125 feet.

2. Side Water Depth: 14 feet.
3. Bottom Slope: As indicated on the Drawings.

B. Sludge Collector Mechanism:
   1. Supply as a complete and operational system by a single manufacturer.
   2. Equipment to include, but not be limited to, the following components:
      a. Walkways and access bridges with guardrail and grating.
         1) Tank wall to center column for Clarifiers No. 3 and 4.
      b. Center column.
      c. Influent well.
      d. Flocculating well.
      e. Center drive cage.
      f. Sludge collector truss arms.
      g. Sludge collection draw-off pipes.
      h. Scum skimming system.
      i. Electrical control panel
      j. Other components necessary to provide a complete system.
   3. Process Description:
      a. Mixed liquor enters the clarifier through a center column and is discharged into the influent well through openings in the center column.
      b. The influent well dissipates the kinetic energy of the influent mixed liquor flow. Peripheral outlet ports in the influent well create a controlled tangential discharge of the mixed liquor into the flocculating well to enhance flow distribution and flocculation.
      c. The flocculating well promotes flocculation of the mixed liquor suspended solids and allows for a gradual redirection of the flow velocity into the clarifier.
      d. Clarifier Nos. 3 & 4:
         1) A central drive mechanism mounted on a center column supports and rotates a center cage with two truss arm assemblies, each supporting a scraper blade and a surface skimming arm.
         2) The sludge collection draw-off pipes withdraw the sludge accumulated on the clarifier bottom and conveys it to a sludge collection center manifold for continuous removal.
      e. The scum skimming system consists of a skimming arm that collects secondary scum from the surface of the clarifier and deposits it into the scum collection trough.

C. Design Requirements:
   1. Operating Parameters:
      a. Maximum Allowable Headloss through the Center Column, the Influent Well, and the Flocculating Well at Peak Flow = 3 inches.
      b. Mixed Liquor Suspended Solids Concentration Range = 1,000 mg/L to 4,000 mg/L.
   2. Mechanical Design:
      a. Design for a continuous running torque of 32,000 foot pounds.
      b. Design collector mechanism to operate at a tip speed, measured at the ends of the rake arms, of approximately 8 feet per minute.
      c. Use no chains, sprockets, bearings, or gears below the water surface for the sludge collector mechanism.
   3. Structural Design:

a. Design the sludge collector mechanism in accordance with the Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design, except:
    1) Provide a 1/4 inch minimum thickness for all members, except where specifically modified in PART 2 under EQUIPMENT COMPONENTS.
    2) Include stresses in members caused by bending and twisting due to eccentricities of members at joints.
b. Slenderness Ratio (Kl/r) using K Value of 1.0 shall not exceed the values specified below:
    1) Tension Members: Not greater than 240.
    2) Compression Members: Not greater than 200.
c. Corrosion Allowance:
    1) For all structural members and center column, add 1/8 inch to the thickness used for the final design calculations to check member stresses and buckling. This corrosion allowance is to be applied to the design thickness and not to the minimum member thickness specified earlier. The final member thickness shall be the greater of the specified minimum thickness or the sum of the design thickness and the corrosion allowance.
d. Base member weights used for design on final full member thickness.
e. Full member thicknesses may be used for performing deflection calculations.
f. Design the center cage and the truss arms as an integral structure. Design the center cage and the connections to the truss arms for the reactions from the truss arms.
g. Do not include live load where its inclusion results in lower stresses in a member under investigation.
h. Load Combinations: Design each structural member of the sludge collector mechanism for the most critical load combination resulting from the following load combinations:
    1) Dead load + live load + continuous running torque.
    2) Dead load + live load + torque due to cut-out torque test.
    3) Other load combinations selected by the manufacturer.
    4) Truss Arm Load Cases: Use the following load cases on the truss arms for load combinations:
        a) Equal uniform horizontal load along the full length of both truss arms which results in a combined torque equal to the continuous running torque.
        b) Uniform horizontal loads along the full length of both truss arms which results in 70 percent of the torque from one truss arm and 30 percent of the torque from the other truss arm for a combined torque equal to the continuous running torque.
        c) Load on truss arm(s) due to cut-out torque load test.
i. Deflections:
    1) The horizontal deflection of the truss arm, due to truss arm deflection plus rotational deflection of the center cage for load cases which contain continuous running torque, shall not exceed a deflection equal to the radius of the clarifier divided by 400 (L/400). Not more than 60 percent of the total horizontal deflection shall be due to center cage rotation. Horizontal deflection of the truss arm shall be measured at the end of the truss arm furthest from the center column.

2) The vertical deflection of the truss arm due to equipment dead load shall not exceed the length of the truss arm divided by 800 (L/800).

1.05 SUBMITTALS

A. Submit product data and shop drawings, operation and maintenance manuals, and test reports as detailed herein.

B. Product Data and Shop Drawings:
   1. Shop drawings shall consist of a cover sheet indicating the drawing number and specification page and number to which referenced, intended use and data summary, outline drawings, cut-away drawings, parts lists, material specification lists, and all information required to substantiate that the proposed equipment meets the specifications. Shop drawing submittals will not be considered complete if cut-away or assembly drawings with part and material specification lists are not included.
   2. General arrangement drawings showing the complete assembly, part numbers, and materials list.
   3. Detailed Drawings:
      a. Sludge collector mechanism indicating dimensions, member sizes and thicknesses, welding, and connection details.
   4. Shop primer and coating data.
   5. Electrical Control Panel System data, including:
      a. Control Panel front view and dimensions
      b. Control. schematics, and wiring diagrams
      c. Data for control devices, including power disconnect switch, motor starter, control push buttons, indicating lights, alarm horn/strobe light and any required pertinent instrument.
   6. Spare parts list.
   7. Qualifications and resume of installation engineer.
   8. Training course outlines.
   9. Manufacturer’s experience and reference list as specified in Article Quality Assurance.

C. Manufacturer's Installation Instructions.

D. Calculations: Include, without necessarily being limited to:
   1. Structural Calculations: Calculations shall be prepared and signed by a registered structural engineer in the state of Florida demonstrating compliance with structural criteria specified in this Section. Submit design calculations with complete shop drawings.

E. Reference List: Include the following information as a minimum:
   1. Name and location of installation.
   2. Name and telephone number of the person in direct responsible charge of the equipment.
   3. Month and year the equipment was placed in operation.
   4. Size of equipment.
   5. Number of units installed.
   6. Service.

F. Test Reports:

1. Method of conducting cut-out torque test and verification that method of testing will not impose stresses in any member which exceeds maximum allowable stresses specified in this Section.
2. Results of field torque tests on sludge collector mechanism.

G. Operation and Maintenance Manuals.

H. Certificates: Manufacturer's certification that equipment was installed in accordance with the manufacturer's instructions, inspected by the manufacturer, serviced with the proper initial lubricants, and equipped with applicable safety equipment and controls.

I. Technician's Qualifications Resume: Submit resume of technician to perform Manufacturers Field Service.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Experience: Demonstrate minimum 10 years experience in manufacture of clarifiers which have been successfully utilized in domestic wastewater applications.
2. References: Provide a reference list of at least 5 different installations in domestic wastewater treatment plants of not less than 5 million gallons per day in the continental United States, where the manufacturer has supplied equipment substantially similar in design and characteristics to that proposed here. The installations listed must:
   a. Have been designed and fabricated by the manufacturer.
   b. Be at least 100 feet in diameter.
   c. Have been in operation for last 5 years.
   d. Include in the list the name, address, and telephone number of the OWNER, the design flow of plant, the sludge collector dimensions, and the time in operation.

B. Welding and Welder Qualifications:
1. Perform welding and qualify and certify welders in accordance with AWS D1.1.
2. Welds:
   a. Use shielded arc welding.
   b. Conform to requirements of design loads.
   c. Conform to information indicated on the Drawings.
   d. Use continuous watertight seal welds.
   e. Use a minimum weld size of 1/4 inch.
   f. Field welding is permitted only for bridge splice (if required).

C. Equipment Subassemblies: Mark parts with erection match marks for ease of field erection. Lubricate moving parts before shipment. When necessary to disassemble parts for shipping, coat uncoated exposed machine surfaces with suitable, easily removable, rust-preventive compound before shipping.

1.07 PROJECT CONDITIONS

A. Environmental Project Conditions:
1. Installation in a wastewater treatment plant.
2. Moderate quantities of commercial and industrial waste.

3. Exposure to industrial solvents and petroleum products.
4. Operation at approximately 15 to 20 feet above mean sea level.
5. Ambient Air Temperature:
    a. Maximum 110 degrees Fahrenheit.
    b. Minimum 20 degrees Fahrenheit.
6. Wastewater temperature:
    a. Maximum 90 degrees Fahrenheit.
    b. Minimum 50 degrees Fahrenheit.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:
1. All materials shall be suitably packaged and braced to protect against damage during transit, handling, and unloading.
2. Manufacturer shall package equipment, be responsible for, and make good, any and all damage until the equipment is delivered to the job site.
3. Accessories shall be packaged separately in containers clearly marked “ACCESSORIES ONLY”.
4. A packing list, listing the contents of each container, shall be placed in a moistureproof envelope and securely fastened to the outside of the container.
5. Provide written storage procedures for all equipment.

B. Delivery to Job Site:
1. Manufacturer shall fabricate and deliver materials to the job site in conformance with the CONTRACTOR’s construction schedule to minimize handling and on-site storage of equipment.

C. Storage and Protection: Protect the system components at the site and during installation prior to project completion. As a minimum, provide cover, ventilation, and proper stacking to prevent warping of any equipment stored on-site. Prevent rotating equipment from prolonged idle periods of no more than 15 days to prevent bearing damage.

1.09 MAINTENANCE

A. Spare Parts: Furnish the following spare parts suitably packaged and marked. Include a price list and name, address, and telephone number of local supplier:
1. 4 sets of shear pins.
2. 1 set of scum skimmer wipers.
3. 1 set each of oil seals for the worm shaft and pinion shaft.

B. Special Tools: Provide the following special tools:
1. Tools required to assemble, disassemble, repair, and maintain equipment, and that have been specifically made for use on the equipment.
2. Necessary eyebolts, hooks, and rods for handling equipment parts.
3. List of tools with the maintenance and operation data describing the uses of the tools.

1.10 WARRANTY

A. As specified in Section 01740

B. Warrant free of defects in material and workmanship for 3 years from the date of acceptance or date of first beneficial use by the OWNER.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sludge Collector Mechanism: All equipment components of the sludge collector mechanism including the walkways and access bridges, center column, influent well, flocculating well, center drive cage, sludge collector truss arms, scum skimming system, sludge draw-off pipes, and electrical controls, shall be furnished by the same manufacturer. Some equipment may require modification from the manufacturer's standard. Exercise care to assure that the electrical, mechanical, structural, and miscellaneous systems comply with the requirements specified herein or in other referenced sections.
   1. Manufacturers: One of the following or equal:
      a. Ovivo.

B. Inboard Effluent Trough and Scum Baffle:
   1. Manufacturers: One of the following or equal:
      a. MFG Water Treatment Products Company
      b. Nefco, Inc.

2.02 MATERIALS

A. For all components, unless specified otherwise, use the materials of construction specified below.

B. Structural Steel:
   1. ASTM A 36.
   2. Grind all edges of steel members to approximately 1/16 inch minimum radius using standard workmanship and a grinder.

C. Anchor Bolts: Type 316 stainless steel.

D. Inboard Effluent Trough Systems including weirs, scum baffles, and drop box: Fiberglass reinforced plastic as specified in Section 06611.

E. Inboard Effluent Trough Support Brackets: Type 316 stainless steel.

F. Fasteners and Washers: Type 304 stainless steel, except for bolts which will be removed during installation and any high-strength bolts.

G. High strength bolts: Use ASTM A 325 hot-dip galvanized high strength bolts in attaching truss arms to cage, and cage to center drive gear casting.

H. Do not use cadmium plated parts and fasteners.

I. Dissimilar Metals: All aluminum components shall be isolated from steel components to prevent electrolysis.

2.03 SLUDGE COLLECTOR MECHANISM

A. Walkways and Access Bridges:
   1. Materials:
      a. Welded steel truss construction.
   2. Design:
      a. Tank wall to center column for Clarifiers No. 3 and 4.
      b. Composed of 2 main members laterally braced together.
      c. Minimum live load of 100 pounds per square foot.
      d. Maximum deflection not to exceed span length divided by 360 (L/360) for dead plus live loads.
      e. Support light standards and fixtures as indicated on the Drawings.
      f. Supported Using:
         1) For Clarifiers No. 3 and 4, center column at one end and the outer concrete clarifier wall at the other.
         2) Make allowance at outer concrete wall for expansion and contraction of walkway due to temperature changes.
            a) Use self-lubricating bearings.
            b) Do not use non-lubricated metal-to-metal slide plates or direct metal-to-concrete bearing.
            c) Prevent lateral movement of bridge at outer wall.
      g. Provide additional structural supports as required to support scum spray and other piping on the bridge.
   3. Platform at the Center Turntable: Provide a minimum clearance of 2 feet 6 inches around all sides of drive mechanism and allow uninhibited access to all parts of the drive unit.
   4. Guardrail with Kickplate:
      a. On both sides of walkway and all around center turntable platform.
      b. Truss may be as the walkway guardrail if it meets FBC and OSHA requirements. Provide guard as specified in 05500 around center column access platform.
   5. Walking Surface:
      a. Materials: Aluminum treadplate.
      b. Location: Over entire bridge and center turntable platform.

B. Center Column:
   1. Materials:
      a. Vertically mounted, cylindrical steel column.
         1) Inside Diameter: As designed by the manufacturer.
         2) Wall Thickness: 1/2-inch minimum.
   2. Design:
      a. Support the entire sludge collector mechanism including inboard end of bridge.
      b. Size and anchor the center column to be capable of resisting design loads when the tank is empty or full.
   3. Center Column Anchorage:
      a. Mount the center column over the influent port at the center of the clarifier floor. Connect the base flange of the center column to the concrete foundation using the existing anchor bolts.
      b. If existing anchor bolts are unusable, as determined by the Engineer, or replacement is required:
         1) Cut existing anchor bolts flush with existing concrete floor.

2) Drill and epoxy anchor new anchor bolts. Use a rigid steel template to accurately locate anchor bolts for the center column.
3) Supplier shall coordinate with the CONTRACTOR to ensure proper anchor bolt location.
4) Center column base anchor bolts:
a) Not less than 8 in number.
b) Not less than 15 bolt diameters of embedment length.
c) Not less than 1.5 inches in diameter.
d) Use a minimum edge distance for anchor bolts of the larger of 6 inches or 6 anchor bolt diameters, and as required to clear reinforcing bars located around opening.

4. Outlet Ports: Provide outlet ports in the upper end of the center column to disperse influent flow into the influent well. Provide the following:
a. A total of 4 ports.
b. Appropriately reinforced port openings.
c. Port Dimensions: Not less than 264 square inches.
5. Flange and stiffen the top of the center column for supporting the sludge collector mechanism, the drive mechanism, and the access bridge. Attach the center column to the drive assembly using bolts.
6. Drain Holes: Provide two 2 inch holes at bottom to allow column to drain into the tank.

C. Influent Well:
1. Materials:
a. Structural steel plate and members.
b. Reinforced with steel stiffening angles where necessary.
2. Design:
a. Closed-bottom tub concentric with the center column.
b. Supported around the outside of the center drive cage.
c. Diffuse influent flow into the clarifier tangentially, evenly, and efficiently without excessive disturbances.
d. Outlet Gates:
1) Shall direct and control tangential flow into the clarifier.
2) Dimensions: As designed by the manufacturer.
e. Dimensions: 16 foot inside diameter.
f. Provide two 2-inch orifices in the bottom to allow the well to drain as the clarifier is emptying.

D. Flocculating Well:
1. Materials:
a. Structural steel plate and members.
b. Reinforced with steel stiffening angles where necessary.
2. Design:
a. Dimensions: 30 foot inside diameter.
b. Equip with a minimum of 4 baffled slots to allow for removal of floating material in the well.
c. Support from center cage using rigid connection. Other methods of connection such as swinging supports or breakaway supports are not permitted.

E. Center Drive Cage:
1. Materials:

a. Structural steel members.

2. Design:
   a. Box truss design.
   b. Design to carry load from the truss arms plus its own dead load.
   c. Fasten center drive cage to spur gear assembly using bolted connection.
   d. Design to support and rotate the truss arm assemblies with the surface skimming arm and sludge draw-off pipes.

F. Sludge Collector Truss Arms:
   1. Materials:
      a. Structural steel.
   2. Design:
      a. Truss design. Tie rods not permitted.
      b. Maintain width of the truss arm the same as the width of center drive cage to ensure alignment and proper connection.
      c. Rigidly connect truss arm to the center drive cage.
      d. Conform truss arm to slope of tank floor.
      e. Use the truss arm to support the scum skimmer arm and sludge draw-off pipes.
      f. Provide five (5) 8-inch diameter draw-off pipes on each truss arm for a total of 10 draw-off pipes.

G. Scum Skimming System:
   1. Each clarifier shall be equipped with two full radius skimmer arm assemblies to collect and discharge surface scum into a full radius scum trough cantilevered from the tank wall.
   2. Each skimmer arm shall be either a structural steel truss assembly or a fabricated tube assembly connected to the center cage and cantilevered from the rotating feedwell. Tie rods shall be properly located to allow adjustment of the skimmer arm as well as to resist horizontal forces.
   3. Each skimmer arm shall be equipped with a hinged 1/2 inch 60 durometer neoprene wiper blade extending the full width of the arm. The neoprene blade shall be fastened to the arm with stainless steel fasteners with steel back up bars.
   4. The full radius scum trough shall be fabricated from 1/4 inch steel plate and shall be supported from the tank wall as shown on the drawings. The trough and support structure shall be designed for all dead loads plus a 200 hundred pound point load at the feedwell end of the trough with no more than 1/2 inch deflection. The approach ramp of the trough shall be of radial design, having a tapered width and a variable slope that will enable the full length of the skimmer wiper to make simultaneous and continuous contact with the entire ramp along a radial line, at each revolution of the skimmer arm. The trough shall be 8 inches wide with a uniformly sloped bottom to allow scum to discharge toward the tank wall. Fabrication of the trough shall be true and free of warpage. A standard pipe flanged connection for scum discharge pipe shall be provided and size as indicated on the Drawings.
   5. The manufacturer shall provide a position switch/limit switch and solenoid valve to control spray water into the scum trough. SUPPLIER shall determine location of the position switch and coordinate with the CONTRACTOR for mounting. The flush valve assembly shall be adjustable to allow 0 to 20 gallons of clarified effluent to enter the scum trough as the skimmer assembly passes over the scum box. The assembly shall consist of a stainless steel

lever, UHMW seal plate and neoprene diaphragm mounted to the scum trough. The diaphragm shall be opened and closed by an easily adjustable, submerged actuation arm mounted to the rotating feedwell. The flush volume adjustment mechanism shall be above the water level and shall include at least three settings. Upon tripping the position switch, the solenoid shall open for an operator adjustable time. Solenoid valve shall be 120VAC, energized to open, heavy duty and mounted on a NEMA 4X housing. Solenoid valve shall be activated by the limit switch and cycle timer. Solenoid valves shall be Automatic Switch Company (Series 8210), Skinner Electric Valve Division (Series C), or equal. Limit switch shall be form Z type, Model 43-100D as manufactured by General Equipment & Manufacturing Co. or equal. Case shall be hermetically sealed, epoxy coated brass. Adjustable reset cycle timer shall be Eagle Signals CE 500 series, or equal and energize a 120V solenoid valve.

H. Electrical Controls:
   1. Local Control Panel: (LCP-1300 and LCP-1400)
      a. Enclosure: Weatherproof NEMA 4X 316 stainless steelwith drip shield kit, door gasket and three (3) point stainless steel latch, handle with nylon rollers and drip edge. Internal components shall be mounted on an interior dead-front panel. Power supply for each Clarifier local control panel shall be 480V, 3-phase, 60-Hz. The control panel shall be provided with a main breaker, surge protective device (SPD), selector switches, timer relays, indication lights, terminal blocks, etc. as stated here in and as shown on drawings. Refer to electrical drawings for clarifier local control panel control wiring schematic and instrumentation drawings for signals required to interface with the Plant PLC system.
      b. Provide enclosure with sunshields on top, back and two sides.
      c. Provide moisture drain fitting at the bottom.
      d. Safety Disconnect Main Breaker with lockout means/external handle per requirements specified in section 16050
      e. Full Voltage Non-reversing NEMA Motor Starter, per requirements specified in Section 16480.
      f. Low voltage circuit breakers per requirements specified in Section 16050
      g. Surge Protection Device (SPD) on the 3 phase, 480 volts circuit and the 120 volt control circuit, per requirements specified in section 16050
      h. Provide appropriate control transformer, time delay relays, control relays, Terminal Blocks, Alarm Horns, and Nameplates per requirements specified in Section 16050.
      i. Provide selector switches, LED type indicating lights and miscellaneous control devices as stated herein and as shown on drawings.
      j. Provide all necessary controls and devices to control the spray water system and to monitor the high and hi-hi torque switches of the clarifier drive.
      k. Manufacture the control panel according to the requirements of UL-508 for Industrial Control Panels and provide the panel with the UL-508 label.
      l. Mount local control panel near drive mechanism on self supporting heavy duty aluminum pedestal with back-mounting plate and stainless steel unistrut as indicated on the Drawings..
   2. Electrical wiring conforming to requirements specified in Division 16.

2.04 CLARIFIER ACCESSORIES

A. Spray Systems:
   1. The clarifier manufacturer shall provide a spray ring with nozzles to control foam/scum buildup in the flocculating well as shown on the drawings. The spray ring shall run continuously.
   2. The clarifier manufacturer shall provide a spray system with nozzles to control spray water into the scum trough. The spray system shall be controlled as specified in 2.03, G, 5.
   3. Nozzles as specified in Section 15120.
   4. Pipe and fittings shall be SCH 80 PVC as specified in Section 15265.

2.05 FINISHES

A. Field Finishing:
   1. Sludge Collector Mechanisms: Perform surface preparation and coating as specified in Section 09960.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install sludge collector mechanism and clarifier accessories as indicated on the Drawings and in accordance with the manufacturer's installation instructions and recommendations.

B. Field Welding:
   1. Field welding is permitted only for the bridge splice.
   2. Use shielded arc welding and conform to requirements of design loads.

C. Guardrail with Kickplate: Install on both sides of walkway and around center turntable.

D. Scum Skimming System: Install counterweights designed and located by the manufacturer.

E. Center Column: Mount center column vertically over influent port at center of basin floor.

3.02 FIELD QUALITY CONTROL

A. Testing, Training, and Startup: As specified in the requirements below.

B. Tests:
   1. General: Conduct tests in presence of the ENGINEER.
   2. Working under Direction of Manufacturer's Engineer, Perform Field Tests on Each Mechanism as Follows:
      a. Cut-out Torque Test:
         1) Perform cut-out torque test prior to placement of grout topping on concrete slab.

2) The manufacturer shall propose a method of conducting this test and shall verify that the method of testing will not impose stresses in members that exceed allowable stresses.

b. Adjustments and Settings to Overload Device:
   1) Adjustments and Settings: Perform necessary adjustments and settings to overload device to ensure that sludge collector mechanism will sound an alarm and switch off the drive motor when specified overload conditions occur in tank.
   2) Test Run: Perform test run following completion of adjustments and settings of overload device to confirm effectiveness of overload device.

c. Dry Test Run of Equipment:
   1) Special Attention: Give attention during dry test run of equipment to operation of scum skimming device.
   2) Settings of Skimmer Boom to Scum Box Lip and Rubber Wiping and Sealing Strips: Set as required to ensure that adequate volume of scum is discharged under normal operating conditions.

d. Electrical Functional Test:
   1) Provide functional testing of the clarifier drive together with the control panel.

C. Required Results:
1. Sludge Collector Mechanism:
   a. In event mechanism fails to meet field quality control test requirements of this Section, make necessary changes and retest mechanism.
   b. If mechanism remains unable to meet test requirements to satisfaction of the ENGINEER, remove and replace such mechanism with satisfactory mechanism at no additional cost.

D. Manufacturer's Field Service:
1. CONTRACTOR to coordinate field service work with the manufacturer's service representative, OWNER, and ENGINEER prior to initiating such work.
2. Manufacturer's Service Representative:
   a. Manufacturer is to furnish services of representative experienced in erection and operation of the sludge collector mechanism.
   b. Period of Services: The manufacturer shall include in his bid a minimum of four 8 hour days and 2 trips. The specified durations are the minimum required time on the job site and do not include travel time.
   c. Services are to include the following:
      1) Installation consultation and advice.
      2) Checking and supervision of the collector installation.
      3) Inspection and certification that unit is ready to sweep in grout prior to grouting operation.
      4) Final inspection and adjustments prior to testing.
      5) Supervision of testing.
      6) Instruction of personnel on operation and maintenance of equipment.

END OF SECTION

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic design and performance requirements for mechanical equipment.

1.02 REFERENCES

A. American Gear Manufacturer's Association (AGMA) Standards:
   1. AGMA 2001-B88 - Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
   2. AGMA 6000-A88 - Specification for Measurement of Linear Vibration on Gear Units.
   3. AGMA 6010-E88 - Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives.
   4. AGMA 6019-E89 - Standard for Gear motors using Spur, Helical, Herringbone, Straight Bevel or Spiral Bevel Gears.
   5. AGMA 6025-C90 - Sound for Enclosed Helical, Herringbone, and Spiral Bevel Gear Drives.

B. American Society of Mechanical Engineers (ASME):
   1. ASME PTC 8.2 - Performance Test Code for Centrifugal Pumps.
   2. ASME PTC 10 - Performance Test Code - Compressors and Exhausters.
   3. ASME PTC 17 - Performance Test Code - Reciprocating Internal-Combustion Engines.
   4. ASME PTC 11 - Performance Test Code - Measurement of Shaft Horsepower - Instruments and Apparatus.

C. American Bearing Manufactures Association (ABMA) Standards:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

D. American Society for Testing and Materials (ASTM):
   1. A 36 - Standard Specification for Structural Steel.
   2. A 48 - Standard Specification for Gray Iron Castings.
   3. A 526 - Standard Specification for Steel Sheet, Zinc Coated by the Hot Dip Process, Commercial Quality.
   4. B 61 - Standard Specification for Steam or Valve Bronze Castings.
   5. B 62 - Standard specification for Composition Bronze or Ounce Metal Castings.
   6. E 527 - Standard Practice for Numbering Alloys and Metals (UNS).

E. Hydraulic Institute Standards (HI):
   1. HI 1.1-1.5 - Centrifugal Pumps - Nomenclature, Definitions, Application, and Operation.

2. HI 1.6 - Centrifugal Pump Tests.
3. HI 2.1-2.5 - Vertical Pumps - Nomenclature, Definitions, Application, and Operation.
4. HI 2.6 - Vertical Pump Tests.
5. HI 3.1-1.5 - Rotary Pumps - Nomenclature, Definitions, Application, and Operation.
6. HI 3.6 - Rotary Pump Tests.
7. HI 4.1-4.6 - Sealless Rotary Pumps - Nomenclature, Definitions, Application, Operation, and Test.
8. HI 5.1-1.6 - Sealless Centrifugal Pumps - Nomenclature, Definitions, Application, Operation, and Test.
9. HI 6.1-6.5 - Reciprocating Power Pumps - Nomenclature, Definitions, Application, and Operation.
10. HI 7.1-7.5 - Controlled Volume Pumps - Nomenclature, Definitions, Application, and Operation.
11. HI 9.1-9.5 - Pumps - General Guidelines for Types, Definitions, Application, and Sound Measurement.

F. American Petroleum Institute (API):
1. ANSI/API 682 - Shaft Sealing Systems for Centrifugal and Rotary Pumps.

1.03 DEFINITIONS

A. Special Tools: Tools that have been specifically made for use on unit of equipment for assembly, disassembly, repair, or maintenance.

B. Resonant Frequency: That frequency at which a small driving force produces an ever-larger vibration if no dampening exists.

C. Rotational Frequency: The revolutions per unit of time usually expressed as revolutions per minute.

D. Critical Frequency: Same as resonant frequency for the rotating elements or the installed machine and base.

E. Peak Vibration Velocity: The root mean square average of the peak velocity of the vibrational movement times the square root of 2 in inches per second.

F. Rotational Speed: Same as rotational frequency.

G. Maximum Excitation Frequency: The excitation frequency with the highest vibration velocity of several excitation frequencies that are a function of the design of a particular machine.

H. Critical Speed: Same as critical frequency.

I. Free Field Noise Level: Noise measured without any reflective surfaces (an idealized situation); sound pressure levels at 3 feet from the source unless specified otherwise.

J. Operating Weight: The weight of unit plus weight of fluids or solids normally contained in unit during operation.

1.04 SYSTEM DESCRIPTION

A. General:
   1. Provisions specified under each technical equipment specification prevail over and supersede conflicting provisions as specified in this Section.
   2. Provide equipment and parts that are suitable for stresses, which may occur during fabrication, transportation, erection, and operation.
   3. Provide equipment that has not been in service prior to delivery, except as required by tests.
   4. Like parts of duplicate units are to be interchangeable.
   5. When 2 or more units of equipment for the same purpose are required, provide products of same manufacturer.
   6. Equipment manufacturer's responsibility extends to selection and mounting of gear drive units, motors or other prime movers, accessories, and auxiliaries required for proper operation.
   7. When necessary, modify manufacturer's standard product to conform to specified requirements or requirements indicated on the Drawings and contained in Laws and Regulations.

B. Material Requirements:
   1. Materials: Suitable for superior corrosion resistance and for services under conditions normally encountered in similar installations.
   2. Dissimilar Metals: Separate contacting surfaces with dielectric material.

C. Power Transmission Systems:
   1. Power Transmission Equipment: V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints are to be rated for 24 hour-a-day continuous service or frequent stops-and-starts intermittent service, whichever is most severe, and sized with a minimum service factor of 1.5.
      a. Apply 1.5 service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
      b. Apply service factors higher than 1.5 when recommended for continuous 24 hour-per-day operation and shock loadings specified in AGMA 6010-E88, other applicable AGMA standards, or other applicable referenced standards.
      c. When manufacturer recommends service factor greater than 1.5, manufacturer's recommendation takes precedence.

D. Vibration:
   1. Resonant Frequency: Ensure there are no natural resonant torsional, radial, or axial frequencies within 25 percent above or below the operating rotational frequencies or multiples of the operating rotational frequencies that may be excited by the equipment design.
   2. Design, balance and align equipment to meet the vibration criteria specified in Section 15958.

E. Equipment Mounting and Anchoring:
   1. Mount equipment on cast iron or welded steel bases with structural steel support frames. Utilize continuous welds to seal seams and contact edges between steel members. Grind welds smooth.
   2. Provide bases and supports with machined support pads, dowels for alignment of mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits.
   3. Provide jacking screws in bases and supports for equipment weighing over 1,000 pounds.
   4. Anchorage of Equipment to Concrete: Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
   5. Provide bolt sleeves for anchor bolts for heavy equipment. Adjust bolts to final location and fill sleeve with non-shrink grout.
   6. Anchorage of Equipment to Metal Supports: Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.
   7. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load, and other loads as required for proper operation of equipment.

F. Equipment Units Weighing 50 Pounds or More: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.

1.05 SUBMITTALS

A. Product Data:
   1. For Each Item of Equipment:
      a. Design features.
      b. Load capacities.
      c. Efficiency ratings.
      d. Material designations by UNS alloy number or ASTM Specification and Grade.
      e. Data needed to verify compliance with the Specifications.
      f. Catalog data.
      g. Name plate data.
      h. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
   2. Gear Reduction Units:
      a. Engineering information per applicable AGMA standards.
      b. Gear mesh frequencies.

B. Shop Drawings:
   1. Drawings for Equipment:
      a. Drawings that include outline drawings, cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
   2. Outline drawings showing equipment, driver, driven equipment, pumps, seal, motor(s) or other specified drivers, variable frequency drive, shafting, U-joints, couplings, drive arrangement, gears, baseplate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
   3. Installation and checkout instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial start-up procedures.

4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer based controls.
5. Recommended or normal operating parameters such as temperatures and pressures.
6. Alarm and shutdown set points for all controls furnished.

C. Calculations:
1. Calculations and other information to substantiate equipment base plates, supports, bolts, anchor bolts, and other connections meet minimum design strength requirements.
2. Bearing L_{10} life calculations in accordance with ABMA 9 or ABMA 11 calculation methods for drivers, pumps, gears, shafts, motors, and other drive line components with bearings.
3. Calculations and other information to substantiate that operating rotational frequencies meet the requirements of this Section.
4. Torsional Analysis of Power Transmission Systems: When torsional analysis specified in the equipment Sections, provide:
   a. Sketch of system components identifying physical characteristics including mass, diameter, thickness, and stiffness.
   b. Results of analysis including first and second critical frequencies of system components and complete system.
5. Calculations shall be signed and stamped by a civil or structural engineer registered to practice in the state where the Project is located.

D. Quality Control Submittals:
1. Source quality control reports and certified test data as specified in Section 15958.
2. Submit factory test reports before shipment.
3. Certified static and dynamic balancing reports for rotating equipment.
4. Field quality control reports and test data as specified in Section 15958.
5. Start-Up Plan: Proposed plan for field-testing equipment.
6. Certificate of Proper Installation.
7. Submit material test reports a specified in the equipment sections.

E. Operation and Maintenance Manuals:
1. Submit prior to training of OWNER's personnel.
2. Make available at project site complete copy of manuals for use by field personnel and ENGINEER during start-up and testing of equipment.
3. Include manufacturer and model number of every bearing; include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.
4. Include motor rotor bar pass frequencies.

1.06 QUALITY ASSURANCE

A. Manufacturer's Field Service:
1. Furnish services of authorized representative specially trained in installation of equipment.
   a. Visit project site and perform tasks necessary to certify installation.
   b. Furnish Certificate of Proper Installation.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:
   1. Equipment: Pack in boxes, crates, or otherwise protect from damage and moisture, dust, or dirt during shipment, handling, and storage.
   2. Bearings: Separately pack or otherwise suitably protect during transport.
   3. Spare Parts: Deliver in boxes labeled with contents, equipment to which spare parts belong, and name of CONTRACTOR.

B. Storage:
   1. Equipment Having Bearings: Store in enclosed facilities. Rotate units at least once per month or more often as recommended by the manufacturer to protect rotating elements and bearings.
   2. Gear Boxes: Oil filled or sprayed with rust preventive protective coating.

C. Protection:
   1. Equipment: Protect equipment from deleterious exposure.
   2. Painted Surfaces: Protect against impact, abrasion, discoloration, and other damage.

1.08 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Equipment for project include:
      a. Installation in a wastewater treatment plant.
      b. Moderate quantities of commercial and industrial waste.
      c. Ambient Temperatures: 20 to 110 degrees Fahrenheit.
      d. Relative Humidities: 50 to 100 percent.
      e. Site Elevation: Approximately approximately 15-20 feet above mean sea level.

1.09 SEQUENCING AND SCHEDULING

A. Equipment Anchoring: Obtain anchoring material and templates or setting drawings from equipment manufacturers in adequate time for anchors to be cast-in-place when concrete is placed.

B. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

C. General Start-Up and Testing of Equipment:
   1. Perform general start-up and testing procedures after operation and maintenance manuals for equipment have been received.
   2. Conduct functional testing of mechanical or electrical systems when each system is substantially complete and after general start-up and testing procedures have been successfully completed.
   3. Functional testing requirements as specified in Section 15958 and the equipment sections.

1.10 MAINTENANCE

A. Special Tools:
   1. When specified, provide special tools required for operation and maintenance.
   2. Mark or tag and list such tools in maintenance and operations instructions. Describe use of each tool.

B. Spare Belts:
   1. When spare belts are specified, furnish 1 spare belt for every different type and size of belt-driven unit.
      a. Where 2 or more belts are involved, furnish matched sets.
      b. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.
      c. Package in boxes labeled with identification of contents.

C. Spare Parts:
   1. Assume responsibility until turned over to OWNER.
   2. Store in enclosed facilities.
   3. Furnish itemized list and match identification tag attached to every part.
   4. List parts by generic title and identification number.
   5. Furnish name, address, and telephone number of supplier and spare parts warehouse.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ferrous Materials:
   1. Steel for Members used in Fabrication of Assemblies: ASTM A 36.
   2. Iron Castings: ASTM A 48, tough, close-grained gray iron, free from blowholes, flaws, and other imperfections.
   3. Galvanized Steel Sheet: ASTM A 526, minimum 0.0635 inch (16 gauge).
   4. Expanded Metal: ASTM A 36, 13 gauge, 1/2-inch flat pattern expanded metal.

B. Nonferrous Materials:
   1. Stainless Steel: Type 304 or 316 as specified. Provide L grade where welding required.
   2. Bronze in Contact with Liquid: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C83600, C92200 or C92700 in accordance with ASTM B 61, B 62, B 505, or B 584, when not specified otherwise.

C. Dielectric Materials for Separation of Dissimilar Metals:
   1. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials.

D. Anchors Bolts: As specified.

2.02 SHAFT COUPLINGS

A. General:

1. Type and Ratings: Provide nonlubricated type, designed for not less than 50,000 hours of operating life.
2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, and type of service.
3. Use: Use of couplings specified in this Section does not relieve CONTRACTOR of responsibility to provide precision alignment of driver-driven units as required by equipment manufacturer and alignment criteria specified elsewhere in this section.

B. Shaft Couplings - Close Coupled: Shaft couplings for close coupled electric motor driven equipment 1/2 horsepower or larger and subject to sudden torque reversals or shock loading:
1. Manufacturers: One of the following or equal:
   a. T.B. Woods, Dura-Flex, L-Jaw C-Jaw or G-Jaw.
   b. Lovejoy, S-Flex.
2. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
3. Manufacture flexible component of coupling from synthetic rubber, or urethane.
4. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
5. Do not allow metal-to-metal contact between driver and driven equipment.
6. Examples of loads where sudden torque reversals may be expected:
   a. Reciprocating pumps, blowers, and compressors.
   b. Conveyor belts.
   c. Reversing equipment.

C. Shaft Couplings - Direct Connected: Shaft couplings for direct connected electric motor driven equipment 1/2 horsepower or larger and subject to normal torque, non-reversing applications:
1. Manufacturers: One of the following or equal:
   a. Falk, WA Torus.
   b. T.B. Woods, Dura-Flex, Sure-Flex or Form-Flex.
2. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.
3. Provide flexible connecting element of rubber and reinforcement fibers.
4. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.

D. Spacer Couplings: Where cartridge type mechanical seals or non-split seals are specified, provide a spacer type coupling of sufficient length to remove the seal without disturbing the driver or driven equipment unless noted otherwise in the individual equipment specifications.

E. Specialized Couplings: Where requirements of equipment dictate specialized features, supply coupling recommended for service by manufacturer.

2.03 STUFFING BOX, SEAL CHAMBER, AND SHAFT SEALS

A. General:
1. Unless otherwise noted in the equipment section, provide cartridge type, double mechanical shaft seals for pumps.
2. Provide a stuffing box large enough for a double mechanical seal.

3. Where packing is specified, provide stuffing box large enough to receive a double mechanical seal.
4. Provide seal or packing flush connections, (3/4-inch size unless another size is indicated on the Drawings).
5. Provide and route leakage drain line to nearest equipment floor drain indicated on the Drawings.
6. For pumps with packing, design packing gland to allow adjustment and repacking without dismantling pump except to open up packing box.
7. Seal or packing flush requirements shall be in accordance with API Standard 682 requirements. Unless otherwise indicated, specified or required by the equipment and seal manufacturers, the following API flushing Plan arrangements shall be utilized as appropriate for the application:
    a. Single seal, clean water applications: Plan 11 (Discharge bypass to seal).
    b. Single seal, vertical pump applications: Plan 13 (Seal bypass to suction).
    c. Single seal, clean hot water (greater than 180 degrees Fahrenheit) applications: Plan 23 (Seal cooler and pumping ring).
    d. Single seal, solids, or contaminants containing water applications: Plan 32 (External seal water- see Carollo typical detail # M262).
    e. Double seal applications: Plan 54 (External seal water- see Carollo typical detail # M262).

B. Packing: When specified in the equipment section of the specifications, provide the following type of packing:
    1. Wastewater, water, and sludge applications:
        a. Asbestos free.
        b. PTFE (Teflon) free.
        c. Braided graphite.
        d. Manufacturers: One of the following or equal:
            1) Chesterton, 1400.
            2) John Crane Inc., equivalent product.
    2. Drinking water service:
        a. Approved by the FDA or NSF.
        b. Asbestos free.
        c. Material: Braided PTFE (Teflon).
        d. Manufacturers: One of the following or equal:
            1) Chesterton, 1725.
            2) John Crane, Inc., equivalent product.

C. Mechanical seals: Provide seal types specified in the equipment sections and as specified.
    1. Provide seal types meeting the following requirements:
        a. Balanced hydraulically.
        b. Spring: Stationary, out of pumping fluid, Hastelloy C; Type Elgiloy or 17-7 PH stainless steel for split seals.
        c. O-ring: Viton 747.
        d. Gland: Type 316L stainless steel.
        e. Set screws: Type 316L stainless steel.
        f. Faces: Reaction bonded, Silicon Carbide.
        g. Seal designed to withstand 300 pounds per square inch gauge minimum differential pressures in either direction; no requirement for seal buffer pressure to be maintained when pump is not operational even though process suction head may be present in pump.

2. Cartridge type single mechanical: Manufacturers: One of the following or equal:
    a. Chesterton, S10.
    b. John Crane, 5610 Series.
3. Cartridge type double mechanical: Manufacturers: One of the following or equal:
    a. Chesterton, S20.
    b. John Crane, 5620 Series.
4. Split face single mechanical: Manufacturers: One of the following or equal:
    a. Chesterton, 442.
    b. John Crane, 3710.

2.04 GEAR REDUCTION UNITS

A. Type: Helical or herringbone, unless otherwise specified.

B. Design:
1. Made of alloys treated for hardness and for severe service.
2. AGMA Class II Service:
    a. Use more severe service condition when such is recommended by unit's manufacturer.
3. Cast iron housing with gears running in oil.
4. Anti-friction bearings.
5. Thermal horsepower rating based on maximum horsepower rating of prime mover not actual load.
6. Manufactured in accordance with applicable AGMA standards.

C. Planetary gear units are not to be used.

2.05 BEARINGS

A. Type: Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.

B. Oil Lubricated Bearings: Provide either pressure lubricating system or separate oil reservoir splash type system.
1. Size oil lubrication systems to safely absorb heat energy generated in bearings when equipment is operating under normal conditions and with the ambient temperature 15 degree Fahrenheit above the maximum ambient temperature specified elsewhere in this Section.
2. Provide an external oil cooler when required to satisfy the specified operating conditions. Provide air cooled system if a water cooling source is not indicated on the Drawings. Equip oil cooler with a filler pipe and external level gauge.

C. Grease Lubricated Bearings, Except Those Specified to Be Factory Sealed: Fit with easily accessible grease supply, flush, drain, and relief fittings.
1. Lubrication Lines and Fittings:
    a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
    b. Multiple Fitting Assemblies: Mount fittings together in easily accessible location.
    c. Use standard hydraulic type grease supply fittings.
        1) Manufacturers: One of the following or equal:
            a) Alenite.

b) Zurk.

D. Ratings: Rated in accordance with ABMA 9 or ABMA 11 for L_{10} rating life of not less than 50,000 hours.
   1. Higher ratings, when specified in other Sections, supersede preceding requirement.

2.06 SAFETY GUARDS

A. Drive Assemblies: Enclose sprockets, belts, drive chains, gearings, couplings, and other moving parts on drive assemblies in safety enclosures that are in compliance with applicable Laws and Regulations.

B. Shafts: Provide guards that protect personnel from rotating shafts or components within 7.5 feet of floors or operating platforms.

C. Guard Requirements:
   1. Allow visual inspection of moving parts without removal.
   2. Allow access to lubrication fittings.
   3. Prevent entrance of rain or dripping water for outdoor locations.
   4. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of one belt.

D. Materials:
   1. Sheet Metal: Carbon steel, 12 gauge minimum thickness, hot-dip galvanized after fabrication.
   2. Fasteners: Type 304 stainless steel.

2.07 SPRING VIBRATION ISOLATORS

A. Design Requirements:
   1. Telescopic top and bottom housing with vertical stabilizers to resist lateral and vertical forces.
   2. Use steel coil springs.

B. Performance Requirements: Minimum spring deflection of 1 inch under static load and capable of limiting transmissability to10 percent maximum at design operating load.

C. Manufacturers: One of the following or equal:
   1. California Dynamics Corporation, Type RJSD.
   2. Mason Industries, equivalent product.

D. Materials:
   1. Fabricate isolators using welded steel or shatterproof ductile iron in accordance with ASTM A 536 Grade CS-45-12.
   2. Spring Steel: ASTM A 125.

2.08 WARNING SIGNS

A. Provide for equipment that starts automatically or remotely.

B. Material and Size: Metal as specified.

C. Colors: Black lettering on yellow background.

D. Text: As specified.

2.09 FABRICATION

A. Nameplates:
   1. Engraved or stamped on Type 304 stainless steel and fastened to equipment at factory in an accessible and visible location.
   2. Indicate Following Information as Applicable:
      a. Manufacturer's name.
      b. Equipment model number and serial number.
      c. Maximum and Normal rotating speed.
      d. Horsepower.
      e. Rated capacity.
      f. Service class per applicable standards.
   3. Nameplates for Pumps: Include:
      a. Rated total dynamic head in feet of fluid.
      b. Rated flow in gallons per minute.
      c. Impeller, gear, screw, diaphragm, or piston size.
   4. Gear Reduction Units: Include:
      a. AGMA Class of service.
      b. Service factor.
      c. Input and output speeds.

B. Bolt Holes in Equipment Support Frames: Do not exceed bolt diameter by more than 25 percent, up to limiting maximum diameter oversize of 1/4 inch.

C. Shop Finishing:
   1. Provide factory and field coating as specified in Section 09960. If not specified in Section 09960, provide coating as follows:
      a. Bases and Support Frames in Contact with Concrete or Other Material: Coat contacting surfaces with minimum of 2 coats of zinc chromate primer before installation or grouting.
      b. Shop Primer for Steel and Iron Surfaces, Unless Specified Otherwise:
         1) Manufacturers: One of the following or equal:
            a) Ameron, Amercoat 185 Universal Primer.
            b) Cook, 391-N-167 Barrier Coat.
            c) Kop-Coat, Pug Primer.
            d) Tnemec, 37-77 Chem-Prime.
            e) Valspar, 13-R-28 Chromox Primer.
      c. Coat machined, polished, and nonferrous surfaces which are not to be painted with rust-preventive compounds.
         1) Manufacturers: One of the following or equal:
            a) Houghton, Rust Veto 344.
            b) Rust-Oleum, R-9.
      d. Coating for Ferrous Metal Surfaces, Except Stainless Steel: High solids polyamine epoxy.
      e. Finish Painting of Motors: Shop finish paint with manufacturer's standard coating, unless otherwise specified in Section 09960.

2.10 SOURCE QUALITY CONTROL

A. As specified in Section 15958 for testing requirements and the individual equipment sections of the Specifications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components for shipping damage, conformance to specifications, and proper torques and tightness of fasteners.

3.02 PREPARATION

A. Metal Work Embedded in Concrete:
   1. Accurately place and hold in correct position while concrete is being placed.
   2. Clean surface of metal in contact with concrete immediately before concrete is placed.

B. Concrete Surfaces Designated to Receive Grout:
   1. Heavy sandblast concrete surface in contact with grout.
   2. Clean surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bonding of grout.
   3. Concrete Saturation: Saturate concrete with water. Concrete shall be saturated surface damp at time grout is placed.

C. Field Measurements:
   1. Prior to fabrication of equipment, take measurements for installation of equipment and verify dimensions indicated on the Drawings. Ensure equipment and ancillary appurtenances fit within available space.

3.03 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions and recommendations.

B. Lubrication Lines and Fittings:
   1. Lines from Fittings to Point of Use: Support and protect.
   2. Fittings:
      a. Bring fittings to outside of equipment in manner such that they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
      b. Mount fittings together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
      c. Fittings for Underwater Bearings: Bring fittings above water surface and mount on edge of structure above.

C. Alignment of Drivers and Equipment:
   1. Where drive motors or other drivers are connected to driven equipment by flexible coupling, disconnect coupling halves and align driver and equipment after complete unit has been leveled on its foundation.
   2. Comply with procedures of appropriate Hydraulic Institute Standards, AGMA Standards, alignment tolerances of equipment manufacturers and the following requirements to bring components into angular and parallel alignment:

a. Maximum Total Coupling Offset (not the per plane offset): Not to exceed 0.5 mils per inch of coupling length for spacer couplings based on coupling length (not dial separation).
b. Utilize jacking screws, wedges, or shims as recommended by the equipment manufacturer and as specified in the equipment sections.

3. Use reverse-indicator arrangement dial type or laser type alignment indicators: Mount indicators on the driver/coupling flange and equipment/coupling flange. Alignment instrumentation accuracy shall be sufficient to read angular and radial misalignment at 10 percent or less of the manufacturer's recommended acceptable misalignment.
4. Alignment and calculations shall include measurement and allowance for thermal growth, spacer coupling length, indicator separation and axial spacing tolerances of the coupling.
5. When alignment satisfies most stringent tolerance of system components, grout between base and foundation. Allow minimum 48 hours for grout to harden. After grout hardens, remove jacking screws, tighten anchor bolts and other connections, and recheck alignment. Correct alignment as required.
6. After operational testing is complete, dowel motor or drivers and driven equipment. Comply with manufacturer's instructions.

D. Special Techniques: Use applicable special tools and equipment, including precision machinist levels, dial indicators, and gauges as required in equipment installations.

E. Tolerances:
1. Completed Equipment Installations: Comply with requirements for intended use and specified vibration and noise tolerances.

F. Warning Signs: Mount securely with stainless fasteners at equipment that can be started automatically or from remote locations.

3.04 FIELD QUALITY CONTROL

A. Test equipment as specified in Section 15958 and the individual equipment Section of the Specifications.

3.05 MANUFACTURER'S REPRESENTATIVE

A. Field Checkout: Before field-testing and start-up, provide services of factory-trained field service representative to certify the equipment has been installed, aligned, and checked in accordance with the manufacturer’s instructions and the Specifications.

B. Testing: Provide services of factory trained representative to observe and advise the CONTRACTOR during field quality control testing.

C. Training: When training is specified, provide services of factory-trained representative to perform training as specified.

END OF SECTION

SECTION 15052

BASIC PIPING MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic piping materials and methods.

1.02 REFERENCES

A. American Society of Testing and Materials (ASTM):
   1. F 37 - Standard Test Methods for Sealability of Gasket Materials.

1.03 DEFINITIONS

A. Buried Pipe: Pipe that is buried in the soil, or cast in a concrete pipe encasement that is buried in the soil.

B. Exposed Pipe: Pipe that is located above ground, or pipe that is located inside a structure, supported by a structure, or case into a concrete structure.

C. Underground Piping: Piping actually buried in soil or cast in concrete.

D. Underwater Piping: Piping below tops of walls in basins or tanks containing water.

E. Wet Wall: Wall with water on at least 1 side.

1.04 SUBMITTALS

A. Product Data:
   1. Link -type seals.
   2. Gaskets.

PART 2 PRODUCTS

2.01 LINK TYPE SEALS

A. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
   2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
   3. Provide a nylon polymer pressure plate with 316 Stainless Steel hardware. Isolate pressure plate from contact with wall sleeve.

B. Manufacturers: One of the following or equal:
   1. Calpico, Incorporated.

2. Pipeline Seal and Insulator, Inc., Link-Seal.

2.02 GASKETS

A. Gaskets for Non-Steam Cleaned Ductile Iron and Steel Piping:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to or less than 250 degrees Fahrenheit, and raw sewage service.
   2. Gasket Material:
      a. Neoprene elastomer with minimum Shore A hardness value of 70.
      b. Reinforcement: Inserted 13-ounce nylon fabric cloth for pipes 20 inch or larger.
      c. Thickness: Minimum 3/32-inch thick for less than 10-inch pipe; minimum 1/8 inch thick for 10-inch and larger pipe.
   3. Manufacturers: One of the following or equal:
      a. Pipe less than 20 inches in diameter:
         1) Garlock, Style 7797.
         2) John Crane, similar product.
      b. Pipe 20 inches in diameter and larger:
         1) Garlock, Style 8798.
         2) John Crane, similar product.

B. Gaskets for Flanged Joints in Polyvinyl Chloride and Polyethylene Piping:
   1. Suitable for pressures equal to or less than 150-pounds per square inch gauge, with low flange bolt loadings, temperatures equal and less than 120 degrees Fahrenheit, and polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine including fluorochemicals and gaseous fluorine.
   2. Material: 0.125-inch thick Viton rubber.
   3. Manufacturers: One of the following or equal:
      a. Garlock.
      b. John Crane, similar product.

C. Gaskets for Flanged Joints in Ductile Iron or Steel Water Piping:
   1. Suitable for hot or cold water, pressures equal to or less than 150 pounds per square inch gauge, and temperatures equal to or less than 160 degrees Fahrenheit.
   2. Material:
      a. Neoprene elastomer, compressed, with non-asbestos fiber reinforcement.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Bluegard 3300.
      b. John Crane, similar product.

D. Gaskets for any other fluids or any other pressure or temperature conditions shall be suitable for the specific fluids and pressure and temperature conditions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Existing Conditions:

1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions that may affect construction of underground piping before starting excavation for new underground piping and appurtenances.
2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.02 INSTALLATION

A. General:
   1. Piping Drawings:
      a. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.
      b. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
         1) Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.
   2. Piping Alternatives:
      a. Provide piping as specified in this Section, unless indicated on the Drawings or specified otherwise.
      b. Alternative Pipe Ratings: Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price. Piping of different material may not be substituted in lieu of specified piping.
      c. Valves in Piping Sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.
      d. For flanged joints, where one of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.

B. Wall and Slab Penetrations:
   1. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, unless specified or otherwise indicated on the Drawings.
   2. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.
      a. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
      b. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
      c. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
      d. Seal spaces between pipes and sleeves with link-type seals when not otherwise specified or indicated on the Drawings.

e. Seal openings around piping running through interior walls and floors of chlorine rooms and chlorine storage rooms gastight with synthetic rubber sealing compound.

C. Exposed Piping:
1. Install exposed piping in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings.
a. Install piping runs plumb and level, unless otherwise indicated on the Drawings. Slope plumbing drain piping with a minimum of 1/4 inch per foot downward in the direction of flow. Slope digester gas piping to drip traps or low-point drains at a minimum of 1/2 inch per foot where condensate flows against the gas, or at a minimum of 1/4 inch per foot where condensate flows with gas.
2. Install exposed piping after installing equipment and after piping and fitting locations have been determined.
3. Support Piping
a. Do not transfer pipe loads and strain to equipment.
4. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
5. Assemble piping without distortion or stresses caused by misalignment.
a. Match and properly orient flanges, unions, flexible couplings, and other connections.
b. Do not subject piping to bending or other undue stresses when fitting piping. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
c. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
d. Alter piping assembly to fit, when proper fit is not obtained.
e. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

D. Buried Piping:
1. Bury piping with minimum 2-foot cover without air traps, unless otherwise indicated on the Drawings.
2. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.
3. Laying Piping:
a. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
b. Place piping with top or bottom markings with markings in proper position.
c. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
d. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
e. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.

E. Connections to Existing Piping:
   1. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings.
      a. Protect domestic water/potable water supplies from contamination.
         1) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
         2) Provide devices approved by OWNER of domestic water supply system to prevent flow from other sources into the domestic supply system.
   2. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
   3. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
   4. For flanged connections, provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

F. Connections to In-Service Piping:
   1. Where operation and maintenance of existing facilities require that a shutdown be made during hours other than normal working hours, perform the related work in coordination with the hours of actual shutdown.

G. Connections Between Ferrous and Nonferrous Metals:
   1. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
   2. Nonferrous metals include aluminum, copper, and copper alloys.

H. Flanged Connections Between Dissimilar Metals Such as Ductile Iron Pipe and Steel Pipe:
   1. Provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

3.03 CLEANING

A. Piping Cleaning:
   1. Upon completion of installation, clean piping interior of foreign matter and debris. Perform special cleaning when required by the Contract Documents.

3.04 PIPING SCHEDULE

A. Abbreviations:
   1. The following abbreviations used in the column of test method refer to the respective methods as specified in Section 15956.

      AM Air method

      GR Gravity method

      HH High head method

      LH Low head method

      SC Special case

   2. Abbreviations to designate piping include the following:

ASPH	Asphaltic Base Coating
CE	Ceramic Epoxy
CI	Cast iron
CL	Class, followed by the designation
CM	Cement Mortar
CTE	Coal Tar Epoxy
DIP	Ductile iron piping
F	Flanged Joint
FBE	Fusion Bonded Epoxy
GA	Gauge, preceded by the designation
GE	Grooved end joint
HSE	High Solids Epoxy System
HSE/P	High Solids Epoxy and Polyurethane Coating System
MJ	Mechanical Joint
NPS	Nominal pipe size, followed by the number in inches
PJ	Push-On Joint
psi	pounds per square inch
psig	pounds per square inch gauge
PVC	Polyvinyl Chloride
SCH	Schedule, followed by the designation
SST	Stainless steel

PIPING SCHEDULE								
Pipe Service Abbrev.	**Service**	**Nominal Diameter (inches)**	**Materials**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**
CE/CI	Clarifier Effluent/ Clarifier Influent							
	Underground	All	DIP	Class 50	Restrained MJ or Restrained PJ	150 psig/HH	FBE	ASPH
	Aboveground	All	DIP	Class 53	F	150 psig/HH	FBE	HSE/P
RAS	Return activated sludge							
	Underground	All	DIP	Class 50	Restrained MJ or Restrained PJ	150 psig/HH	FBE	ASPH
	Aboveground	All	DIP	Class 53	F	150 psig/HH	FBE	HSE/P
S	scum							
	Underground	All	DIP	Class 50	Restrained MJ or Restrained PJ	50 psig/HH	FBE	ASPH
	Aboveground	All	DIP	Class 53	F	50 psig/HH	FBE	HSE/P
SW	Plant Service Water	1-3	PVC	SCH 80	SW	150 psig/HH	None	None

Notes:
1. All exposed piping shall be painted and/or coated in accordance with Section 09960.

END OF SECTION

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SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Mechanical Identification including the following:
   1. Equipment nameplates.
   2. Pipe identification by color and legend.
   3. Underground Warning Tape
   4. Identification of equipment and components of systems with paint, brands, tags, and signboards.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit Following:
   1. Product data.
   2. Samples.
   3. Manufacturer's installation instructions.
   4. Submit following:
      a. Operation and Maintenance Data.
      b. Warranty.

PART 2 PRODUCTS

2.01 EQUIPMENT NAMEPLATES

A. Material and Fabrication:
   1. Stainless steel sheet engraved or stamped with text, holes drilled, or punch for fasteners.

B. Fasteners:
   1. Number 4 or larger oval head stainless steel screws or drive pins.

C. Text:
   1. Manufacturers name, equipment model number and serial number, identification tag number, and when appropriate, drive speed, motor horsepower with rated capacity, pump rated total dynamic head and impeller size.

2.02 PIPE IDENTIFICATION

A. Manufacturers:

1. One of the following or equal:
   a. Seton, Opti Code Pipe Markers.
   b. Lab Safety Supply.

B. Materials:
1. Pipe Markers: Self-adhesive vinyl, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; meet ANSI A13.1 requirements.
   a. Lettering:

Nominal Pipe Diameter	Lettering Size
Less than 1.5	1/2 inch
1.5 inches to 2 inches	3/4 inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

   b. Marker Colors:

Service	Lettering	Background
Flammables, chemicals, toxics	Black	Yellow
Water, nontoxic solutions or low hazard liquids	White	Green
Nonflammable or nontoxic gases	White	Blue
Fire quenching fluids (foam, fire water, CO_2 Halon)	White	Red

2. Coating: As specified in Section 09960.
3. Pipe Identification Tags: Aluminum or stainless steel with stamped-in 1/4 inch high identifying lettering.
4. Pipe Identification Tag Chains: Aluminum or stainless steel.
5. Snap-on Markers: Markers with 3/4 inch high letters for 3/4 to 4 inch pipe or covering, or 5 inch high letters for 5 inch or larger pipe or cover, as manufactured by one of following:
   a. Brady Bradysnap-On B-915.
   b. Seton Setmark.

2.03 UNDERGROUND WARNING TAPE

A. Manufacturer:
1. One of the following or equal:
   a. Seton Name Plate Company, Branford, CT.

B. Material:
1. Metallic detection tape; minimum 4 mil thick by 6 inches wide polyethylene film with wording, “Caution” with name of service followed by words, “Line Buried Below” repeated continuously along tape length, with alternate metallic and color strips. Colors as follows:

a. Water: Blue.
b. Telephone: Orange.
c. Sewer: Green.
d. Gas and Other Services: Yellow.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified.

3.02 PREPARATION

A. Prepare and coat surfaces as specified in Section 09960.

B. Prepare surface in accordance with product manufacturer's instructions.

3.03 PIPING IDENTIFICATION

A. Identify exposed piping, valves, and accessories, and piping, in accessible chases with lettering or tags designating service of each piping system with flow directional arrows and color code.

B. Color Code:
1. Coat piping scheduled to be color coded completely with specified colors.
2. Coat segments of pipe specified to be unpainted with specified coding color long enough to accommodate required lettering and arrows.

C. Coat piping specified to be coated to match adjacent surfaces, unless otherwise directed.

D. Lettering and Flow Direction Arrows:
1. Stencil lettering on painted bands or use snap-on markers on pipe to identify pipe. When stenciling, stencil 3/4 inch high letters on 3/4 through 4-inch pipe or coverings, or 5-inch high letters on 5-inch and larger pipe or coverings.
2. Provide lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee, and at intervals of not more than 50 feet in straight runs of pipe.

E. Where scheduled, space 6-inch wide bands along stainless steel pipe at 10-foot intervals and other pipe at 5-foot intervals.

F. Metal Tags:
1. Where outside diameter of pipe or pipe covering is 5/8 inch or smaller, provide metal pipe identification tags instead of lettering.
2. Fasten pipe identification tags to pipe with chain.
3. Where tags are used, color code pipe as scheduled.

G. Underground Warning Tape:

1. Place warning tape in pipe trench, 12 inches above the pipe.

3.04 APPLICATION

A. Identify piping with legend markers, directional arrow markers, and number markers; use self adhesive arrow roll tape to secure ends of piping markers and indicate flow direction.

B. Provide legend markers, directional arrow markers and number markers where piping passes through walls or floors, at piping intersections and at maximum 15 foot spacing on piping runs.

C. Provide piping marker letters and colors as scheduled.

D. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere.

END OF SECTION

SECTION 15094

PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals and install pipe hangers, supports, concrete inserts and anchor bolts including all metallic hanging and supporting devices for supporting exposed piping.

1.02 QUALIFICATIONS

A. Hangers and supports shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for pipe supports shall be five (5) times the ultimate tensile strength of the material.

B. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, the Contractor shall submit a certification stating that such requirements have been complied with.

1.03 SUBMITTALS

A. Submit to the Engineer for approval, as provided in the Contract Documents, shop drawings of all items to be furnished under this Section.

B. Submit to the Engineer, for approval, samples of all materials specified herein.

C. All pipe hangers, supports, hanger rods, clamps, concrete inserts and wall brackets, etc., whether specified or not, shall be submitted (together with load calculations) to the Engineer for approval, if requested.

PART 2 PRODUCTS

2.01 GENERAL

A. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, and fittings and to support and secure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. All pipe supports shall be approved prior to installation.

B. All materials used in manufacturing hangers and supports shall be capable of meeting the respective ASTM Standard Specifications with regard to tests and physical and chemical properties, and be in accordance with MSS SP-58.

C. Hangers and supports shall be spaced in accordance with ANSI B31.1.0 except that the maximum unsupported span shall not exceed ten (10) feet unless otherwise specified herein.

D. Unless otherwise specified herein, pipe hangers and supports shall be as manufactured by Grinnell Co., Inc., Carpenter and Patterson, Inc., or equal. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary. Any item comparable in type, style, quality, design and performance will be considered for approval.

2.02 PIPE HANGERS AND SUPPORTS FOR METAL PIPE

A. Suspended single pipes shall be supported by hangers suspended by steel rods from galvanized concrete inserts, beam clamps, or ceiling mounting bolts.

B. The following sizes are minimum requirements and are subject to the Engineer's approval:
   1. Hanger rods shall be rolled steel machine threaded with load ratings conforming to ASTM Specifications and the strength of the rod shall be based on root diameter. Hanger rods shall have the following minimum diameters:

Pipe Size (inches)	Minimum Rod Diameter (inches)
Less than 2 1/2	3/8
2 1/2 - 4	1/2
4	5/8
6	3/4
8 -12	7/8
14 - 18	1
20 - 30	1 1/4

   2. Where applicable, structural attachments shall be beam clamps. Beam clamps, for rod sizes 1/2-inch through 3/4-inch shall be equal to Grinnell Fig. No. 229, and for rod sizes 7/8-inch through 1-1/4 inches shall be equal to Grinnel Fig. No. 228, or equal.
   3. Concrete inserts for pipe hangers shall be continuous metal inserts designed to be used in ceilings, walls or floors, spot insets for individual pipe hangers, or ceiling mounting bolts for individual pipe hangers and shall be as manufactured by Unistrut Corp., Wayne, Michigan; Carpenter and Patterson, Inc., Richmond or equal and shall be as follows:
      a. Continuous concrete inserts shall be used where applicable and/or as shown on the Drawings and shall be used for hanger rod sizes up to and including 3/4-inch diameter. Inserts to be used where supports are parallel to the main slab reinforcement shall be Series P3200 by Unistrut Corp., Fig. 1480 Type 2 by Carpenter and Patterson, Inc. or equal. Inserts to be used where supports are perpendicular to the main slab reinforcement shall be Series P3300 by Unistrut Corp., Fig. 1480 Type I by Carpenter and Patterson, Inc., or equal.
      b. Spot concrete inserts shall be used where applicable and shall be used for hanger sizes up to and including 7/8-inch diameter. Inserts shall be Fig. 650 by Carpenter and Patterson, Inc. for hanger rod sizes 1/2-inch through

and including 3/4-inch and Fig. 266 by Carpenter and Patterson, Inc., for 7/8-inch hanger rods.

c. Ceiling mounting bolts shall be used where applicable and be for hanger rod sizes 1-inch through and including 1-1/4 inches shall be Fig. 104M as manufactured by Carpenter and Patterson, Inc. or equal.

d. All pipe hangers shall be capable of vertical adjustment under load and after erection. Turnbuckles, as required and where applied, shall be equal to Grinnell Fig. No. 230.

4. Wall or column supported pipes shall be supported by welded steel brackets equal to Grinnell Fig. 194, 195 and 199 as required, for pipe sizes up to and including 20-inch diameter. Additional wall bearing plates shall be provided where required.

   a. Where the pipe is located above the bracket, the pipe shall be supported by an anchor chair and U-bolt assembly supported by the bracket for pipes 4-inches and larger or by a U-bolt for pipes smaller than 4-inches. Anchor chairs shall be equal to Carpenter and Patterson Fig. 127. U-bolts shall be equal to Grinnell Fig. 120 and 137.

   b. Where the pipe is located below the bracket, the pipes shall be supported by pipe hangers suspended by steel rods from the bracket. Hangers and steel rods shall be as specified above.

   c. Wall or column supported pipes 2-inches and smaller may be supported by hangers equal to Carpenter and Patterson Figures 74, 179 or 237 as required.

5. Floor supported pipes 3-inches and larger in diameter shall be supported by either cast-in-place concrete supports or adjustable pipe saddle supports as directed by the Engineer. In general, concrete supports shall be used when lateral displacement of the pipes is probable (unless lateral support is provided), and adjustable pipe saddle type supports shall be used where lateral displacement of the pipes is not probable.

   a. Each concrete support shall conform to the details shown on the Drawings. Concrete shall be poured after the pipe is in place with temporary supports. Top edges and vertical corners of each concrete support shall have 1-inch bevels. Each pipe shall be secured on each concrete support by a wrought iron or steel anchor strap anchored to the concrete with cast-in-place bolts or with expansion bolts. Where directed by the Engineer, vertical reinforcement bars shall be grouted into drilled holes in the concrete floor to prevent overturning or lateral displacement of the concrete support. Unless otherwise approved by the Engineer, maximum support height shall be five (5) feet.

   b. Concrete piers used to support base elbows and tees shall be similar to that specified above.

      1) Piers may be square or rectangular.

   c. Each adjustable pipe saddle support shall be screwed or welded to the corresponding size 150 lb. companion flanges or slip-on welding flanges respectively. Supporting pipe shall be of Schedule 40 steel pipe construction. Each flange shall be secured to the concrete floor by a minimum of two (2) expansion bolts per flange. Adjustable saddle supports shall be equal to Grinnell Fig. No. 264. Where used under base fittings, a suitable flange shall be substituted for the saddle.

   d. Floor supported pipes less than 3-inches shall be supported by fabricated steel supports.

6. Vertical piping shall be supported as follows:

a. Where pipes change from horizontal to vertical, the pipes shall be supported on the horizontal runs within two feet of the change in direction by pipe supports as previously specified herein.
b. For vertical runs exceeding 15 feet, pipes shall be supported by approved pipe collars, clamps, brackets, or wall rests at all points required to insure a rigid installation.
c. Where vertical piping passes through a steel floor sleeve, the pipe shall be supported by a friction type pipe clamp which is supported by the pipe sleeve. Pipe clamps shall be equal to Grinnell Fig. 262.

7. Anchor bolts shall be equal to Kwik-Bolt as manufactured by Hilti Fastening Systems, or Wej-it manufactured by Wej-it Expansion Products, Inc.
8. All rods, hangers, inserts, brackets, and components shall be furnished with galvanized finish.

2.03 PIPE HANGERS AND SUPPORTS FOR PLASTIC PIPE

A. Single plastic pipes shall be supported by pipe supports as previously specified herein.

B. Multiple, suspended, horizontal plastic pipe runs, where possible, and rubber hose shall be supported by ladder type cable trays such as the Electray Ladder by Husky-Burndy, the Globetray by the Metal Products Division of United States Gypsum, or equal. Ladder shall be of mild steel construction. Rung spacing shall be approximately 18-inches for plastic pipe and 12-inches for rubber nose. Tray width shall be approximately 6-inch for single runs of rubber hose and 12-inches for double runs of rubber hose. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc. required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners equal to Globe Model M-CAC, Huskey-Burndy Model SCR or equal. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe.

C. Individual clamps, hangers, and supports in contact plastic pipe shall provide firm support, but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

PART 3 EXECUTION

3.01 INSTALLATION

A. All pipes, horizontal and vertical, shall be rigidly supported from the building structure by approved supports. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or specified herein. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless it is so indicated on the Drawings, or specifically directed or authorized by the Engineer.

B. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement, and pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces. Prior to installation, all pipe supports shall be approved by the Engineer.

C. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings, and sleeve type couplings and to minimize all pipe forces to pump housings. Pump housings shall not be utilized to support connecting pipes.

D. Pipe supports shall be provided as follows:
   1. Cast iron and ductile iron shall be supported at a maximum support spacing of 10-feet 0-inches with a minimum of one (1) support per pipe section at the joints.
   2. Supports for multiple PVC pipes shall be continuous wherever possible. Individually supported PVC pipes shall be supported as recommended by the manufacturer except that support spacing shall not exceed five (5) feet.

E. Pipe supports shall not result in point loadings, but shall distribute pipe loads evenly along the pipe circumference.

F. Effects of thermal expansion and contraction of the pipe shall be accounted for in pipe support selection and installation.

G. Inserts for pipe hangers and supports shall be installed on forms before concrete is poured. Before setting these items, all drawings and figures shall be checked which have a direct bearing on the pipe locations. Responsibility for the proper location of pipe supports is included under this Section.

H. Continuous metal inserts shall be embedded flush with the concrete surface.

3.02 PRIME COATING

A. Prior to prime coating, all pipe hangers and supports shall be thoroughly clean, dry, and free from all mill-scale, rust, grease, dirt, paint, and other foreign substances to the satisfaction of the Engineer.

B. All submerged pipe supports shall be prime coated with TNEMEC 69-1211 Epoxy Primer or equal. All other pipe supports shall be prime coated with TNEMEC 66-1211, or equal.

C. Finish coating shall be compatible with the prime coating used and shall be applied as specified in the Contract Documents.

END OF SECTION

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SECTION 15120

PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Piping specialties including:
   1. Spray nozzles.

1.02 SUBMITTALS

A. Product Data:
   1. Manufacturer's certificate attesting successful performance of specified tests.
   2. Manufacturer's published installation instructions.

PART 2 PRODUCTS

2.01 SPRAY NOZZLES

A. Design:
   1. Operating pressure 10 pounds per square inch gauge, at which pressure each nozzle discharges not less than 3.5 gallons per minute, nor more than 5.0 gallons per minute.
      a. Spray: Flat, heavy sheet, fan with uniform distribution.
      b. Fan width at the water surface not less than 6.5 feet at 10 pounds per square inch gauge.
      c. Spray deflection with a replaceable deflector insert free to rotate away from the orifice opening and mechanically locked in place and counterweighted.
   2. Spray nozzles structurally suitable for pressure up to 200 pounds per square inch gauge.
   3. Nozzles, easy flush type.

B. Materials:
   1. Spray Nozzles: Leaded bronze.
   2. Nozzles provided with 1/4 inch national pipe thread, and the orifice diameter not less than 1/4 inch.
   3. Replaceable Spray Deflector: Neoprene rubber.

PART 3 EXECUTION

3.01 INSTALLATION

A. Spray Nozzles:
   1. Install spray nozzles so that elevation of the nozzles is 18 inches above the water surface.

END OF SECTION

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SECTION 15265

PLASTIC PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Plastic pipe, tubing, and fittings.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. B 16.12 - Cast Iron Threaded Screwed Drainage Fittings.

B. American Society for Testing and Materials (ASTM):
   1. D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load.
   2. D 1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
   3. D 1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   4. D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   5. D 1869 - Standard Specification for Rubber Rings for Asbestos-Cement Pipe.
   6. D 2321 - Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   7. D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   8. D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   9. D 2467 - Standard Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   10. D 2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
   11. D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   12. D 2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
   13. D 2657 - Heat Joining Polyolefin Pipe and Fittings.
   14. D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
   15. D 2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
   16. D 2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
   17. D 2855 - Standard Practice for Making Solvent-cemented Joints with Poly (Vinyl Chloride)(PVC) Pipe and Fittings.
   18. D 3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

19. D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
20. D 3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
21. D 3350 - Standard Specification for Polyethylene Plastic Pipes and Fittings Materials.
22. D 4101 - Specification for Propylene Plastic Injection and Extrusion Materials.
23. F 439 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
24. F 441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
25. F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
26. F 483 - Standard Test Method for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals.
27. F 493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
28. F 645 - Guide for Selection, Design and Installation of Thermoplastic Water Pressure Piping Systems.
29. F 679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
30. F 714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

C. American Water Works Association (AWWA):
   1. C900 - Polyvinyl/Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water Distribution.

D. Code of Federal Regulations:
   1. Title 49 - Transportation.

E. Plastics Pipe Institute (PPI).
   1. TR 31 - Underground Installation of Polyolefin Piping.

F. United States Department of Transportation:
   1. Materials Transportation Bureau.

1.03 ABBREVIATIONS

A. DR: Dimension Ratio.

B. ID: Inside Diameter of piping or tubing.

C. NPS: Nominal Pipe Size followed by the size designation.

D. NS: Nominal Size of piping or tubing.

E. PVC: Polyvinyl Chloride.

F. SDR: Standard Dimension Ratio; the Outside Diameter divided by the pipe wall thickness.

1.04 SUBMITTALS

A. Product Data: Describe materials, pipe, fittings, gaskets and solvent cement.

B. Manufacturer's Published Installation Instructions.

C. Certificates:
   1. Submit manufacturer's certificate attesting that plastic pipe, tubing, and fitting types meet specified requirements.
   2. Manufacturer's certification of date of manufacture of plastic pipe and tubing for each lot delivered.
   3. Copies of solvent cement manufacturer's report and certification in accordance with ASTM D 2564 for PVC piping, and ASTM F 493 for CPVC piping.

1.05 QUALITY ASSURANCE

A. Mark plastic pipe with nominal size, type, class, schedule, or pressure rating, manufacturer and all markings required by applicable ASTM and AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and Molding Material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except that fittings used in drain, waste and vent piping systems need not be pressure rated.

C. Unions 2-1/2 Inches and Smaller: Socket end screwed unions. Make unions 3 inches and larger of socket flanges with 1/8-inch full face soft neoprene gasket.

2.02 PVC PIPING, SCHEDULE TYPE

A. Materials:
   1. PVC Schedule Type Piping: Designation PVC 1120 in accordance with ASTM D 1785 and appendices thereto.
      a. Pipe and Fittings: Extruded from Type I, Grade 1, Class 12454-B material in accordance with ASTM D 1784.
      b. PVC Schedule Type Piping: Schedule 80 unless otherwise indicated on the Drawings.
   2. Fittings:
      a. Supplied by pipe manufacturer.
      b. Pressure Fittings: In accordance with ASTM D 2466 or ASTM D 2467.

c. DWV Fittings: In accordance with ASTM D 2665.
3. Solvent Cement: In accordance with ASTM D 2564.

2.03 PVC PIPING, CLASS TYPE

A. PVC Pipe, Class Type: In accordance with ASTM D 2241.
1. Thermoplastic Pipe Materials Designation Code: PVC 1120, 1220 or 2120.
2. PVC Compound: Class 12454-B in accordance with ASTM D 1784.
3. Standard Dimension Ratio: SDR not greater than 17.

B. Fittings: Ductile iron with transition gasket sized to accommodate the outside pipe diameter.

2.04 SOURCE QUALITY CONTROL

A. PVC Piping, Schedule Type:
1. Mark pipe and fittings in accordance with ASTM D 1785.

B. PVC Piping, Class Type:
1. Test pipe to withstand, without failure, 600 pounds per square inch, gauge, hydrostatic pressure for a minimum of 5 seconds.
2. Test integral bell with the pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Where not otherwise specified, install piping in accordance with ASTM F 645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.
3. Locate unions where required for adequate access and assembly of the piping system.
4. Provide serrated nipples for transition from plastic pipe to rubber hose.

B. Installation of PVC Piping, Schedule Type:
1. Solvent weld joints in accordance with ASTM D 2855.
2. Install piping in accordance with manufacturer's published instructions.

C. Installation of PVC Piping, Class Type:
1. Install piping in accordance with the Appendix of AWWA C 900 complemented with manufacturer's published instructions.

3.02 FIELD QUALITY CONTROL

A. Leakage Test for PVC Piping, Class Type:
1. Polyvinyl-Chloride (PVC) Piping, Class Type: Subject to visible leaks test and to pressure test with maximum leakage allowance, as specified in Section 15956.

2. Pressure Test with Maximum Leakage Allowance: Perform test after backfilling.
   a. Pressure: 125 pounds per square inch, gauge.
   b. Maximum leakage allowance as follows, wherein the value for leakage is in gallons per 100 joints per hour:

NPS, Inches	**1-1/2**	**2**	**2-1/2**	**3**	**4**	**6**	**8**	**10**	**12**
Leakage	0.41	0.52	0.63	0.76	0.98	1.45	1.88	2.35	2.80

3. Test Procedure: Pull the mandrel through the line under test by one person, by hand, with reasonable effort, without the aid of mechanical equipment.
4. Failing Test: Where the mandrel test is not successful, remove and replace the section of piping with the obstruction, and test the piping again, including visible leaks test, pressure test with maximum leakage allowance, mandrel tests, and other specified tests:
   a. Correction of excessive deflection or obstructions by methods other than removal of the affected piping and replacement of the removed piping with new piping will not be accepted.

END OF SECTION

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SECTION 15956

PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Test requirements for piping systems.

1.02 REFERENCES

A. Uniform Plumbing Code (UPC).

B. Uniform Mechanical Code (UMC).

1.03 TESTING REQUIREMENTS

A. General Requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 15052; are specified in the specifications covering the various types of piping; and are specified herein.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the Uniform Plumbing Code, and UL requirements.
   4. When testing with water, the specified test pressure is considered to be the pressure at the highest point of the piping section under test. Lower test pressure as necessary to prevent testing the lowest point above a safe test pressure.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for Testing, Cleaning, and Disinfecting:
   1. Water for testing, cleaning, and disinfecting will be provided by the OWNER.

D. Pipes to be Tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful Tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test Completion: Drain and leave piping clean after successful testing.

G. Test Water Disposal: Dispose of testing water in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site.

1.04 SUBMITTALS

A. Schedule and Notification of Tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of Readiness to Test: Immediately before testing, notify ENGINEER in writing of readiness, not just intention, to test piping. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.05 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

C. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

D. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping schedule.

B. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment or piping specialties in test sections if test pressure exceeds the valve, equipment or piping specialty safe test pressure allowed by the item's manufacturer.
   4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
   5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.

6. When Test Results Indicate Failure of Selected Sections, Limit Tests to Piping:
   a. Between valves.
   b. Between a valve and the end of the piping.
   c. Less than 500 feet long.
7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing Procedures:
1. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where noted on the Piping Schedule
2. Before pressurizing for the tests, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
3. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure Test with Maximum Leakage Allowance:
1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
2. Pressure test piping after completion of visible leaks test.
3. For piping systems using joint designs other than flanged threaded or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
   a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
   b. Successful completion of the pressure test with maximum leakage allowance shall have been achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
   c. When leakage is allowed, calculate the allowable leakage by the following formula:

      $L = S \times D \times P^{1/2} \times 133{,}200^{-1}$

      wherein the terms shall mean:

      L = Allowable leakage in gallons per hour.

      S = Length of the test section in feet.

      D = Nominal diameter of the piping in inches.

      P = Average observed test pressure in pounds per square inches, gauge, at the lowest point of the test section, corrected for elevation of the pressure gauge.

      x = The multiplication symbol.

END OF SECTION

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SECTION 15958

MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Testing of mechanical equipment and systems.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01756 - Testing, Training, and Facility Start-Up.
      b. Section 15956 - Piping Systems Testing.
      c. Section 16405 - Electric Motors.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. S1.4 Specification for Sound Level Meters.

B. Hydraulic Institute (HI).

1.03 SUBMITTALS

A. Schedule of factory tests and field tests as specified in Section 01756 and this Section.

B. Test instrumentation calibration data.

C. Start-up plan as specified in Section 01756.

D. Test plan specified in this Section.

E. Test result reports.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 QUALITY CONTROL TESTING AND REPORTING

A. Scheduling and notification:
   1. Witnessed source quality control tests: Schedule test date and notify ENGINEER at least 30 days prior to start of test.
   2. Field quality control tests: Schedule test date and notify ENGINEER at least 7 days prior to start of test.

B. Testing levels:
   1. Test equipment based on test levels specified in the equipment section of this Project.
   2. Requirements for Test Levels 1 to 4 are defined below.
   3. Test levels apply for both Source (Factory) Quality Control Tests and Field Quality Control Tests as specified in the equipment sections of this Project.
   4. If testing is not specified in the equipment section, provide Level 1 testing.

C. Witnessing: Source Quality Control Tests not witnessed unless specified otherwise in the equipment section; Field Quality Control Tests shall be witnessed.

D. Instrumentation: Provide necessary test instrumentation which has been calibrated within 1 year from date of test to recognized test standards traceable to the National Institute of Standards and Technology, Washington, D.C. or approved source. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for Field Quality Control Tests.

E. Temporary facilities and labor: Provide necessary fluids, utilities, temporary piping, temporary supports, temporary access platforms or access means and other temporary facilities and labor necessary to safely operate the equipment and accomplish the specified testing. With OWNER's permission, some utilities may be provided by fully tested permanently installed utilities that are part of the Work.

F. Test fluids:
   1. Factory tests: Use water or air as appropriate at ambient conditions unless specified otherwise in the equipment section.
   2. Field tests: Use specified process fluid at available conditions.

G. Pressure testing: Hydrostatically pressure test pressure containing parts in the factory at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher. Submit pressure test reports before shipping.

H. Test measurement and result accuracy:
   1. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
   2. Do not adjust results of tests for instrumentation accuracy. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

I. Field testing:
   1. Submit test plan as specified in Section 01756 and this Section. Indicate test start time and duration, equipment to be tested, other equipment involved or required; temporary facilities required, number and skill or trade of personnel involved; safety issues and planned safety contingencies; anticipated effect on OWNER's existing equipment and other information relevant to the test. Provide locations of all instruments to be used for testing. Provide calibration records for all instrumentation.
   2. Perform general start-up and testing procedures as specified in Section 01756.
   3. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.

J. Reports: Submit reports for source and field-testing. Submit Source Quality Control Test result reports before shipping equipment to the field. Report features:
   1. Report results in a bound document in generally accepted engineering format with title page, written summary of results compared to specified requirements, and appropriate curves or plots of significant variables in English units.
   2. Include appendix with a copy of raw, unmodified test data sheets indicating test value, date and time of reading, and initials of person taking the data.
   3. Include appendix with sample calculations for adjustments to raw test data and for calculated results.
   4. Include appendix with the make, model, and last calibration date of instrumentation used for test measurements.
   5. Include in body of report a drawing or sketch of the test system layout showing location and orientation of the test instruments relative to the tested equipment features.

3.02 EQUIPMENT TESTING, GENERAL

A. Tests for pumps, all levels of testing:
   1. Test in accordance with applicable HI Standards in addition to the requirements in this and other Sections.
   2. Test tolerances: In accordance with appropriate HI Standards, except the following modified tolerances apply:
      a. From 0 to plus 5 percent of head at the specified flows rated design point flow.
      b. From 0 to plus 5 percent of flow at the rated design point head.
      c. No negative tolerance for the efficiency at the specified flows rated design point.
      d. No positive tolerance for vibration limits. Vibration limits and test methods in HI Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

B. Tests for drivers: Test motors as specified in Section 16405. Test other drivers as specified in the driver equipment section.

3.03 REQUIREMENTS FOR VIBRATION TESTING

A. Definitions:
   1. Peak-to-peak displacement: The root mean squared average of the peak-to-peak displacement multiplied by the square root of 2.
   2. Peak velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
   3. Peak acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
   4. High frequency enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency.
      a. Manufacturers: One of the following or equal:
         1) Rockwell Automation, Entek Group, "Spike Energy" analysis.
         2) CSI, "PeakVue."
   5. Low speed equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
   6. High speed equipment: Equipment and equipment components operating at or above 600 revolutions per minute.

B. Vibration instrumentation requirements:
   1. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12 bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, RS232C data output port, circuitry for integration of acceleration data to velocity or double integration to displacement.
      a. Manufacturers: One of the following or equal:
         1) Entek-IRD, Division of Rockwell Automation, Enpac 1200 with applicable data analysis software or Entek Model 838 analyzer with built in printer.
         2) Computational Systems Inc., (CSI) Division of Emerson Electric, Model 2120A, Data Collector/analyzer with applicable analysis software.
   2. Analyzer settings:
      a. Units: English, inches/second, mils, and gravitational forces.
      b. Fast fourier transform lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 revolutions per minute; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
      c. Sample averages: 4 minimum
      d. Maximum frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
      e. Amplitude range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
      f. Fast fourier transform windowing: Hanning Window.
      g. High pass filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.

3. Accelerometers:
    a. For low speed equipment: Low frequency, shear mode accelerometer, 500 millivolts per gravitational force sensitivity, 10 gravitational force range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount.
        1) Manufacturers: One of the following or equal:
            a) Wilcoxon Research, Model 797L.
            b) PCB, Model 393C.
    b. For high speed equipment: General purpose accelerometer, 100 millivolts per gravitational force sensitivity, 50 gravitational force range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder.
        1) Manufacturers: One of the following or equal:
            a) Wilcoxon Research, Model 793.
            b) Entek-IRD Model 943.

C. Accelerometer mounting:
    1. Use magnetic mounting or stud mounting.
    2. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
    3. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.

D. Vibration testing results presentation:
    1. Provide equipment drawing with location and orientation of measurement points indicated.
    2. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.
    3. When Vibration Spectra Data required:
        a. Plot peak vibration velocity versus frequency in cycles per minute.
        b. Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label probable cause of vibration peaks whether in excess of specification limits or not.
        c. Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
        d. Plot motor spectra on a log amplitude scale versus frequency.
    4. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
    5. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.04 TESTING LEVELS

A. Level 1 Quality Control Tests:
    1. Level 1 General Equipment Performance Test:

a. For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
b. Operate at rated design load conditions.
c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

2. Level 1 Pump Performance Test:
   a. Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16405 or the applicable equipment section. Use actual driver for field tests.
   c. Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.
3. Level 1 Vibration Test:
   a. Test requirement:
      1) Measure filtered vibration spectra versus frequency in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component.
      2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
   b. Equipment operating condition: Test at specified maximum speed.
4. Level 1 Noise Test:
   a. Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.

B. Level 2 Quality Control Tests:
1. Level 2 General Performance Test:
   a. For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.
   b. Operate at rated design load conditions.
   c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
2. Level 2 Pump Performance Test:
   a. Test 2 hours minimum for flow and head at the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16405. Use actual driver for field tests.

c. Test for flow and head at 2 additional conditions; 1 at 25 percent below the rated flow and 1 at 10 percent above the rated flow.
d. Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.

3. Level 2 Vibration Test:
   a. Test requirement:
      1) Measure filtered vibration spectra versus frequency and measure vibration phase in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.
      2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
   b. Equipment operating condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.
   c. Natural frequency test of field installed equipment:
      1) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears and supports.
      2) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.
      3) Perform with equipment and attached piping full of intended service or process fluid.
4. Level 2 Noise Test:
   a. Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.

C. Level 3 Quality Control Tests:
1. Level 3 General Equipment Performance Tests:
   a. For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
   b. Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
   c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration or temperatures are observed.
   d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
   e. Bearing temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 3 Pump Performance Test:
    a. Test 4 hours minimum for flow and head at or near the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
    b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16405. Use actual driver for field tests.
    c. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes; for factory testing, test at other speeds may be omitted if test driver at reduced speeds is used for rated condition testing.
    d. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment section) and record observations on noise levels.
3. Level 3 Vibration Test:
    a. Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.
    b. Perform High Frequency Enveloping Analysis for gears and bearings.
        1) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.
        2) Report results in units of acceleration versus frequency in cycles per minute.
    c. Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).
    d. Plot vibration spectra on 3 different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.
4. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at 4 locations approximately 90 degrees apart in plan view; report results for each of 8 octave band mid-points beginning at 63 hertz.

D. Level 4 Quality Control Tests:
1. Level 4 General Equipment Performance Test:
    a. For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.
    b. Operate at rated design load conditions for1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
    c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration or temperatures are observed.

d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
e. Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 4 Pump Performance Test:
   a. Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.
   b. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration and noise data at each test condition.
   c. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment section) and record observations on noise levels.
   d. Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
   e. Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
      1) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
      2) Perform efficiency testing with test fluids at maximum rated speed.
      3) Perform priming time testing with test fluids at maximum rated speed.
3. Level 4 Vibration Test: Same as Level 3 vibration test.
4. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

3.05 SOURCE QUALITY CONTROL

A. Test equipment as specified for each type of test at the test levels specified in equipment sections. Prepare and submit test reports as specified.

B. Inspection and balancing:
   1. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.
   2. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.

C. Critical speed of rotating equipment: Satisfy the following:
   1. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment's maximum operating speed.
   2. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment's lowest operating speed.
   3. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.

3.06 FIELD QUALITY CONTROL

A. Test equipment as specified for each type of test at the test levels specified in equipment sections. Prepare and submit test reports as specified. Comply with latest version of applicable standards.

B. For variable speed equipment, conduct test to establish performance over the entire speed range and at the average operating condition. Establish performance curves for:
   1. The speed corresponding to the rated maximum capacity.
   2. The speed corresponding to the minimum capacity.
   3. The speed corresponding to the average operating conditions.

3.07 VIBRATION ACCEPTANCE CRITERIA

A. Testing of rotating mechanical equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.

B. Vibration displacement limits: Unless otherwise specified, equipment operating at speeds 600 revolutions per minute or less is not to exhibit unfiltered readings in excess of following:

Operating Speed (revolutions per minute)	**Unfiltered (Overall) Peak-to-Peak Amplitude (mils)**
	All Rotating Equipment
0 - 300	6.5
301 - 600	4.5
Note: For all equipment, axial shaft displacements not to exceed 50 percent of the maximum radial shaft displacements shown in the table relative to the casing.	

C. Vibration velocity limits: Unless otherwise specified, equipment operating at speeds greater than 600 revolutions per minute is not to exceed the following peak velocity limits:

Item	Unfiltered Overall Limit (inches per second)	Any Filtered Peak Limit (inches per second)
Non-Clog Solids Handling Centrifugal Pumps	0.35	0.25
Horizontal and Vertical In-Line Centrifugal Pumps (other than Non-Clog type)	0.18 (Input BHP 25 or less)	0.14 (Input BHP 25 or less)
	0.22 (Input BHP more than 25 but less than 100)	0.18 (Input BHP more than 25 but less than 100)
	0.25 (Input BHP 100 or more)	0.20 (Input BHP 100 or more)
Vertical Turbine, Mixed Flow, and Propeller Pumps	0.31 (Input BHP 100 or less)	0.22
	0.35 (Input BHP 125 or more)	0.25
Vertical Turbine, Mixed Flow, and Propeller Short Set Pumps	0.28 (Input BHP 100 or less)	0.21
	0.33 (Input BHP 125 or more)	0.24
Motors	See Applicable Motor Specification	
Gear Reducers, Radial	Not to exceed AGMA 6000-A88 limits	
Other Reducers, Axial	0.10	0.10
Centrifugal Fans and Blowers	0.15	0.10
Other Equipment, Radial	0.16	0.10
Other Equipment, Axial	0.10	0.10

D. Equipment operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.

E. Additional criteria:
   1. No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude component without manufacturer's detailed verification of origin and ultimate effect of such excitation.
   2. The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.
   3. For motors, the following shall be cause for rejection:
      a. Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that are more than 40 percent of the peak at rotational frequency.
      b. Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.

c. Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around 2 times the rotor bar pass frequency.
d. Phasing problems evidenced by 1/3 line frequency side band spectral peaks around the 2 times electrical line frequency peak.

4. The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.

3.08 NOISE REQUIREMENTS AND CONTROL

A. Make measurements in relation to reference pressure of 0.0002 microbar.

B. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.

C. Set sound level meter to slow response.

D. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

3.09 FUNCTIONAL AND OPERATIONAL TESTING OF EQUIPMENT

A. Functional testing as specified in Section 01756 and this Section.

B. General checkout: Prior to operating equipment, inspect, test, and check supporting systems, including but not limited to power systems, control systems, piping systems, lubrication systems, and safety systems.
1. Test and calibrate instrumentation and electrical devices.
2. Test and prepare piping as specified in Sections 15956.
3. As a minimum for control systems associated with the equipment, perform the following:
   a. Individual Loop Tests: Test from field device to intermediate terminations to controller and back to controlled element.
   b. End-to-end test: Simulate input at field device and observe control system response at the final field control element.
4. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.

C. Operation of related existing equipment: OWNER will operate related existing equipment or facilities necessary to accomplish the testing.

D. Acceptable tests: Demonstrate the equipment performance meets the requirements of this Section and the equipment section; when the equipment fails to meet the specified requirements, perform additional more detailed testing to determine the cause, correct, repair, or replace the causative components and repeat the testing that revealed the deficiency.

E. Operational testing: As specified in Section 01756.

END OF SECTION

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.02 DESIGN REQUIREMENTS

A. All electronic boards as part of electrical equipment shall meet the atmospheric conditions of the space the equipment is installed in. All electronic boards which are not installed in a conditioned environment shall be fungus-resistant.

B. All electrical equipment shall be rated for the conditions the equipment is installed in.

1.03 STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Perform all work; furnish and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:
   1. Local Laws and Ordinances.
   2. State and Federal Laws.
   3. National Electrical Code (NEC).
   4. State Fire Marshal.
   5. Underwriters' Laboratories (UL).
   6. National Electrical Safety Code (NESC).
   7. American National Standards Institute (ANSI).
   8. National Electrical Manufacturer's Association (NEMA).
   9. National Electrical CONTRACTOR'S Association (NECA) Standard of Installation.
   10. Institute of Electrical and Electronics Engineers (IEEE).
   11. Insulated Cable Engineers Association (ICEA).
   12. Occupational Safety and Health Act (OSHA).
   13. National Electrical Testing Association (NETA).
   14. American Society for Testing and Materials (ASTM).
   15. Florida Building Code, including Broward County amendments.

B. Conflicts, if any, which may exist between the above items, will be resolved at the discretion of the ENGINEER.

C. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

D. Obtain all permits and pay all fees required by any governmental agency having jurisdiction over the work. Arrange all inspections required by these agencies. On completion of the work, furnish satisfactory evidence to the ENGINEER that the work is acceptable to the regulatory authorities having jurisdiction.

1.04 ELECTRICAL COORDINATION

A. Work Provided Under this Contract:
   1. Provide and install new service entrance rated manual transfer switch, power panel, transformer, lighting panel, VFD (Variable Frequency Drive), etc. as shown on drawings and as described in the specifications for a complete and working system in place.
   2. Provide and install new breaker and modify the existing MCC-HW1 and MCC-HW2 located at the Headworks building as described in the drawings and specifications for a complete working system in place**.**
   3. Provide and install all conduits, junction boxes, conduit supports and wire as described in the drawings complete in place. This includes all instrumentation cables between the instruments and the control panel, and electrical equipment complete in place.
   4. Furnish and install new electrical equipment racks, supports, junction boxes, etc. as described in the drawing and specifications for a complete working system in place.
   5. Provide and install new lighting and convenience power system as shown on drawings and as described in the specifications.
   6. Provide and install all conduits and wires to support instrumentation and control systems complete in place.
   7. Provide and install new grounding systems described in the drawings and specifications complete in place.
   8. Provide and install all yard conduits, manhole/pullbox and spare conduits as described in the drawings and specifications complete in place.
   9. Provide all incidental equipment, labor and material obviously required but not specified in the drawings or specifications to complete the installation as a total working system.
   10. Provide all miscellaneous electrical including terminations, fittings, wiring, conduit, junction boxes, etc. not specified but obviously necessary for a complete working system in place.
   11. Coordinate with Owner provided PLC programmer for termination of the instrumentation signals at the existing PLC control panel at the headworks building and as shown on Instrumentation drawings. Provide and install new Input/Output (I/O) cards as shown on Instrumentation drawings and as describes in specifications. Contractor shall have knowledge or experience with termination and wiring in the PLC control panel or sub-contract to a Instrumentation Contractor/integrator to perform the instrumentation related items. Existing panel system integrator is “Revere Control Systems: phone: 205-824-0004). Make all necessary connections, terminations, etc. for a complete and working system in place. Update the loop drawing in the PLC panel after modification.

B. Temporary Power:
   1. Provide temporary power for all office trailers and for all construction areas. Coordinate with local power and telephone utility for temporary construction power and telephone service during construction.

1.05 SUBMITTALS

A. Quality Control Submittals:
   1. Voltage Field Test Results.
   2. Voltage Balance Report.
   3. Equipment Line Current Report.
   4. Factory test certification and reports for all major electrical equipment.
   5. Site test certification and reports as specified in other Division 16, ELECTRICAL sections.

B. The following information shall be provided for all electrical equipment:
   1. A copy of each specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation.
   2. Electrical equipment submittals shall be made by specification section. Submit one package per specification section and do not group multiple specification sections under one submittal package.
   3. Provide complete conduit and equipment layouts: a scaled plan layout of the electrical room(s) showing spatial relationships of all equipment as well as the overall size of the room. Minimum scale shall be ¼”=1’-0”.
   4. Provide a conduit plan for major power, instrumentation and control conduits, both interior and exterior, showing routing, size and stub up locations for buried or in slab conduits.

1.06 ENVIRONMENTAL CONDITIONS

A. All chemical rooms and areas shall be designated as corrosive.

B. All indoor chemical and process equipment areas shall be considered wet locations.

C. Electrical equipment in rooms designated as Classified by NFPA 70 (national electrical code) as Division 1 or Division 2 shall meet all requirements set forth for that classification as described in NEC article 500.

1.07 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The Electrical Drawings were developed from past record drawings and information supplied by the OWNER. Verify all scaled dimensions prior to submitting bids.

B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and electrical system which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the CONTRACTOR's failure to fulfill this requirement.

C. Carry out any work involving the shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the OWNER. Do such work when directed by the ENGINEER.

D. After award of Contract, locate all existing underground utilities at each area of construction activity. Protect all existing underground utilities during construction. Pay for all required repairs without increase in Contract cost, should damage to underground utilities occur during construction.

1.08 RESPONSIBILITY

A. The CONTRACTOR shall be responsible for:
   1. Complete systems in accordance with the intent of these Contract Documents.
   2. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under Division 16, ELECTRICAL.
   3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

1.09 INTENT OF DRAWINGS

A. Electrical plan Drawings show only general location of equipment, devices, and raceway, unless specifically dimensioned. The CONTRACTOR shall be responsible for the proper routing of raceway, subject to the approval of the ENGINEER.

B. All electrical equipment sizes and characteristics have been based on manufacturer Square D or Eaton. If the CONTRACTOR chooses to and is allowed to substitute, the CONTRACTOR shall be responsible for fitting all the equipment in the available space as shown on the Drawings.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

B. Equipment Finish:
   1. Provide manufacturers' standard finish and color, except where specific color is indicated.
   2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.02 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panel boards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.03 CHECKOUT AND STARTUP

A. Startup:
   1. Demonstrate satisfactory operation of all 480-volt electrical equipment. Participate with other trades in all startup activities.
   2. Assist the Instrumentation and Control (I&C) Contractor in verifying signal integrity of all control and instrumentation signals.

END OF SECTION

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SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American National Standards Institute (ANSI):
      a. C55,1, Standard for Shunt Power Capacitors.
      b. C62.11, Standard for Metal-Oxide Surge Arrestors for AC Circuits.
      c. Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
   2. American Society for Testing and Materials (ASTM):
      a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
      c. A570, Standard Specification for Steel, Sheet, and Strip, Carbon, Hot-Rolled, Structural Quality.
   3. Federal Specifications (FS):
      a. W-C-596, Connector, Receptacle, Electrical.
      b. W-S-896E, Switches, Toggle, Flush Mounted.
   4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
      c. CP I, Shunt Capacitors.
      d. ICS 2, Industrial Control Devices, Controllers, and Assemblies.
      e. KS 1, Enclosed Switches.
      f. LA I, Surge Arrestors.
      g. PB 1, Panelboards.
      h. ST 20, Dry-Type Transformers for General Applications.
      i. WD I, General Requirements for Wiring Devices.
   6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   7. Underwriters Laboratories, Inc. (UL):
      a. 67, Standard for Panelboards.
      b. 98, Standard for Enclosed and Dead-Front Switches.
      c. 198C, Standard for Safety High-Intermpting-Capacity Fuses, Current-Limiting Types.
      d. 198E, Standard for Class Q Fuses.
      e. 486E, Standard for Equipment Wiring Terminals.
      f. 489, Standard for Molded Case Circuit Breakers and Circuit Breaker Enclosures.
      g. 508, Standard for Industrial Control Equipment.
      h. 810, Standard for Capacitors.
      i. 943, Standard for Ground-Fault Circuit Interrupters.

j. 1059, Standard for Terminal Blocks.
k. 1561, Standard for Dry-Type General-Purpose and Power Transformers.

1.02 SUBMITTALS

A. Shop Drawings:
1. Device boxes for use in hazardous areas.
2. Junction and pull boxes used at, or below, grade.
3. Hardware.
4. Terminal junction boxes.
5. Panelboards and circuit breaker data.
6. Fuses.
7. Contactors.
8. Transformers.
9. All other miscellaneous material part of this project.
10. Wire pulling compound.

1.03 QUALITY ASSURANCE

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

1.04 SPARE PARTS

A. Furnish, tag, and box for shipment and storage the following spare parts:
1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

PART 2 PRODUCTS

2.01 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:
1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, cast ferrous metal, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs (Cast Mounting) Manufacturer:
a. Crouse-Hinds; Type FS or FD.
b. Appleton; Type FS or FD.

C. Cast Aluminum:
1. Material:
a. Box: Cast, copper-free aluminum.
b. Cover: Gasketed, weatherproof, cast copper-free aluminum with stainless steel screws.

2. Hubs: Threaded.
3. Lugs: Cast mounting.
4. Manufacturers:
    a. Crouse-Hinds; Type FS-SA or FD-SA.
    b. Appleton; Type FS or FD.

D. PVC-Coated Sheet Steel:
1. Type: One-piece.
2. Material: Zinc- or cadmium-plated.
3. Coating: All surfaces; 40-mil PVC.
4. Manufacturer: Appleton.

E. Nonmetallic:
1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.
3. Manufacturer: Carlon; Type FS or FD, with Type E98 or E96 covers.

2.02 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article OUTLET AND DEVICE BOXES.

B. Large Sheet Steel Box: NEMA 250, Type 1.
1. Box: Code-gauge, galvanized steel.
2. Cover: Full access, screw type.
3. Machine Screws: Corrosion-resistant.

C. Large Stainless Steel Box: NEMA 250, Type 4X.
1. Box: 14-gauge, ASTM A240, Type 316 stainless steel.
2. Cover: Hinged with screws.
3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
4. Manufacturers:
    a. Hoffman Engineering Co.
    b. Robroy Industries.

D. Large Nonmetallic Box, only use where indicated on drawings:
1. NEMA 250, Type 4X.
2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat. Do not use nonmetallic box for direct sunlight application.
3. Cover: Hinged with screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Conduit hubs and mounting lugs.
6. Manufacturers:
    a. Crouse-Hinds; Type NJB.
    b. Carlon; Series N, C, or H.
    c. Robroy Industries.

2.03 WIRING DEVICES

A. Switches:
1. NEMA WD I and FS W-S-896E.

2. Specification grade, totally-enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.
5. Color:
    a. Office Areas: Ivory.
    b. Other Areas: Brown.
6. Switches with Pilot Light: 125-volt, neon light with red jewel, or lighted toggle when switch is ON.
7. Manufacturers:
    a. Bryant.
    b. Leviton.
    c. Hubbell.
    d. Pass and Seymour.
    e. Arrow Hart.

B. Receptacle, Single and Duplex:
1. NEMA WD 1 and FS W-C-596.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Color:
    a. Office Areas: Ivory.
    b. Other Areas: Brown.
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
7. Manufacturers:
    a. Bryant.
    b. Leviton.
    c. Hubbell.
    d. Pass and Seymour.
    e. Sierra.
    f. Arrow Hart.

C. Receptacle, Ground Fault Circuit Interrupter: Duplex, specification grade, tripping at 5 mA.
1. Color: Ivory.
2. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, capable of interrupting 5,000 amps without damage.
3. Size: For 2-inch by 4-inch outlet boxes.
4. Standard Model: NEMA WD 1 with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.
5. Feed-Through Model: NEMA WD 1, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.
6. Manufacturers:
    a. Pass and Seymour.
    b. Bryant.
    c. Leviton.
    d. Hubbell.
    e. Arrow Hart.

2.04 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Plastic:
   1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.
   2. Color: To match associated wiring device.
   3. Mounting Screw: Oval-head metal, color matched to plate.

C. Metal:
   1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
   2. Finish: ASTM A167, Type 302/304, satin.
   3. Mounting Screw: Oval-head, finish matched to plate.

D. Cast Metal:
   1. Material: Malleable ferrous metal, with gaskets.
   2. Screw: Oval-head stainless steel.

E. Engraved:
   1. Character Height: 3/16 inch.
   2. Filler: Black.

F. Weatherproof:
   1. For Receptacles: Gasketed, cast metal or stainless steel, with individual cap over each receptacle opening.
   2. Mounting Screw: Stainless steel.
      a. Cap Spring: Stainless steel.
      b. Manufacturers:
         1) General Electric.
         2) Bryant.
         3) Hubbell.
         4) Sierra.
         5) Pass and Seymour.
         6) Crouse-Hinds; Type WLRD or WLRS.
         7) Bell.
         8) Arrow Hart.
   3. For Switches: Gasketed, cast metal incorporating external operator for internal switch.
      a. Mounting Screw: Stainless steel.
      b. Manufacturers:
         1) Crouse-Hinds; DS-181 or DS-185.
         2) Appleton; FSK-LVTS or FSK-IVS.

G. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

2.05 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB I, NFPA 70, and UL 67, including panelboards installed in motor control equipment.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Rating: If not otherwise shown in plans. Applicable to a system with available short-circuit current of 25,000 amperes rms symmetrical at 208Y/120 or 120/240 volts and 65,000 amperes rms symmetrical at 480Y/277 volts.

E. Where ground fault interrupter circuit breakers are indicated or required by code: 5 mA trip, 10,000 amps interrupting capacity circuit breakers.

F. Cabinet: As shown on plans.

G. Bus Bar:
   1. Material: Copper, full sized throughout length.
   2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
   3. Neutral: Insulated, rated 150 percent of phase bus bars with at least one terminal screw for each branch circuit.
   4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
   5. Lugs and Connection Points:
      a. Suitable for either copper or aluminum conductors.
      b. Solderless main lugs for main, neutral, and ground bus bars.
      c. Subfeed or through-feed lugs as shown.
   6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

H. Circuit Breakers:
   1. NEMA AB 1 and UL 489.
   2. Thermal-magnetic, quick-make, quick-break, molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.
   3. Noninterchangeable, in accordance with NFPA 70.
   4. Locking: Provisions for handle padlocking, unless otherwise shown.
   5. Type: Bolt-on circuit breakers in all panelboards.
   6. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
   7. Do not substitute single-pole circuit breakers with handle ties for multipole breakers.
   8. Do not use tandem or dual circuit breakers in normal single-pole spaces.
   9. Ground Fault Interrupter:
      a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).
      b. Sensor with same rating as circuit breaker and a push-to-test button.

I. Manufacturers:
   1. Square D;
   2. Eaton;

3. Or approved equal.

2.06 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA AB I, UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: As shown or as required.

C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Multipole breakers to automatically open all poles when an overload occurs on one-pole.

G. Enclosure: NEMA 250, Type 12, Industrial Use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multipole circuit breakers are shown.

2.07 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: NEMA 250, Type 12, industrial use, 4X- outdoors, wet locations and corrosive areas, unless otherwise shown.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

2.08 FUSE, 0 TO 600 VOLTS

A. Current-limiting, with 200,000 ampere rms interrupting rating.

B. Provide to fit mountings specified with switches and features to reject Class H fuses.

C. Motor and Transformer Circuits, 0- to 600-Volt:
   1. Amperage: 0 to 600.
   2. UL 198E, Class RK-1, dual element, with time delay.
   3. Manufacturers:

a. Bussmann; Type LPS-RK.
b. Littlefuse; Type LLS-RK.

D. Motor and Transformer Circuits, 0- to 250-Volt:
1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay.
3. Manufacturers:
a. Bussmann; Type LPN-RK.
b. Littlefuse; Type LLN-RK.

E. Feeder and Service Circuits, 0- to 600-Volt:
1. Amperage: 0 to 600.
2. UL 198E, Class RK-I, dual element, with time delay.
3. Manufacturers:
a. Bussmann; Type LPS-RK.
b. Littlefuse; Type LLS-RK.

F. Feeder and Service Circuits, O- to 250-Volt:
1. Amperage: 0 to 600.
2. UL 198E, Class RK-I, dual element, with time delay.
3. Manufacturers:
a. Bussmann; Type LPN-RK.
b. Littleluse; Type LLN-RK.

G. Feeder and Service Circuits, 0- to 600-Volt:
1. Amperage: 601 to 6,000.
2. UL 198C, Class L, double O-rings and silver links.
3. Manufacturers:
a. Bussmann; Type KRP-C.
b. Littlefuse; Type KLPC.

2.09 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. Contact Rating: NEMA ICS 2, Type A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Lights: LED Push-to-test.

D. Pushbutton Color:
1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbuttons and selector switches lockable in the OFF position where indicated.

F. Legend Plate:
1. Material: Aluminum.
2. Engraving: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, indicating specific function.
3. Letter Height: 7/64 inch.

G. Manufacturers:
1. Heavy-Duty Type:

a. General Electric.
b. Square DT.
c. Cutler-Hammer.

2.10 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Terminal Blocks: Provide separate connection point for each conductor entering or leaving box.
   1. Spare Terminal Points: 25 percent.

C. Interior Finish: Paint with white enamel or lacquer.

2.11 TERMINAL BLOCK (0 TO 600 VOLTS)

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of all control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between the compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:
   1. Capable of wire connections without special preparation other than stripping.
   2. Capable of jumper installation with no loss of terminal or rail space.
   3. Individual, rail mounted.

I. Marking system allowing use of preprinted or field-marked tags.

J. Manufacturers:
   1. Weidmuller.
   2. Ideal.
   3. Electrovert.

2.12 MAGNETIC CONTROL RELAY

A. NEMA ICS 2, Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control with field convertible contacts.

B. Time Delay Relay Attachment:
   1. Pneumatic type, timer adjustable from 0.2 to 60 seconds (minimum).
   2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

D. Manufacturers:
   1. Cutler-Hammer; Type M-600.
   2. General Electric; Type CR120B.

2.13 RESET TIMER

A. Drive: Synchronous motor, solenoid operated clutch.

B. Mounting: Semiflush, panel.

C. Contacts: 10-amp, 120-volt.

D. Manufacturers:
   1. Eagle Signal; Bulletin 125.
   2. Automatic Timing and Controls; Bulletin 305.

2.14 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0 to 99,999.9 hours, nonreset type.

C. Mounting: Semiflush, panel.

D. Manufacturers:
   1. General Electric; Type 240, 2-1/2-inch Big Look.
   2. Eagle Signal; Bulletin 705.

2.15 MAGNETIC CONTACTOR

A. NEMA ICS 2, UL 508.

B. Electrically operated, electrically held.

C. Main Contacts:
   1. Power driven in one direction with gravity dropout.
   2. Silver alloy with wiping action and arc quenchers.
   3. Continuous-duty, rated 30 amperes, 600-volt.
   4. Three-pole.

D. Control: Two-wire.

E. One normally open and one normally closed auxiliary contacts rated 10 amperes at 480-volt.

F. Enclosure: NEMA 250, Type 12, unless otherwise shown.

G. Manufacturers:
   1. Westinghouse; Class A211.
   2. General Electric; CR 353.

3. Allen-Bradley; Bulletin 500 Line.

2.16 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Self-cooled, two-winding, UL K-4 rated for nonlinear loads.

C. Insulation Class and Temperature Rise: Manufacturer's standard.

D. Core and Coil:
1. Encapsulated for single-phase units 1/2 to 25 kVA and for three-phase units 3 to 15 kVA.
2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

E. Enclosure:
1. Single-Phase, 3 to 25 kVA: NEMA 250, Type 3R, non-ventilated.
2. Single-Phase, 37-1/2 kVA and Above: NEMA 250, Type 2, ventilated.
3. Three-Phase, 3 to 15 kVA: NEMA 250, Type 2, ventilated.
4. Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.
5. Outdoor Transformers: NEMA 250, Type 3R.

F. Wall Bracket: For single-phase units, 3 to 15 kVA, and for three-phase units, 3-15 kVA.

G. Voltage Taps:
1. Single-Phase, 3 to 10 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
2. Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
3. Three-Phase, 3 to 15 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
4. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

H. Impedance: 4.5 percent minimum on units 75 kVA and larger.

I. Maximum Sound Level: NEMA ST 20:
1. 40 decibels for 0 to 9 kVA.
2. 45 decibels for 10 to 50 kVA.
3. 50 decibels for 51 to 150 kVA.
4. 55 decibels for 151 to 300 kVA.
5. 60 decibels for 301 to 500 kVA.

J. Vibration Isolators:
1. Rated for transformer's weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.

4. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

K. Manufacturers:
1. Square D;
2. Or approved equal.

2.17 ANALOG SURGE PROTECTIVE EQUIPMENT

A. GENERAL:
1. TVSS or SPD protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring.
2. Instruments shall be housed in a suitable case, properly grounded. Ground wires for all TVSS shall be connected to a good earth ground and where practical, each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate NEMA 4X junction box coupled to the enclosure.

B. ANALOG SIGNALS:
1. Protection of analog signal lines originating and terminating not in the same building shall be provided by TVSS. For analog signal lines the TVSS shall be Edco PC-642 or equal. For field mounted two-wire instruments the TVSS shall be encapsulated in stainless steel pipe nipples, and shall be Edco SS64 series.
2. For field mounted four-wire 120VAC instruments, the TVSS shall be in a NEMA 4X polycarbonate enclosure, Edco SLAC series or equal.

2.18 SUPPORT AND FRAMING CHANNELS

A. Material:
1. Dry indoors - galvanized.
2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

B. Finish:
1. Dry indoors - galvanized..
2. All Other Areas: ASTM A167, Type 316 stainless steel or fiber-reinforced epoxy, as required.

C. Inserts: Continuous.

D. Beam Clamps: Gray cast iron.

E. Manufacturers:
1. B-Line.
2. Unistrut.

2.19 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: White, engraved to a black core.

D. Engraving:
   1. Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
   2. Panelboards: Panelboard designation, service voltage, and phases.

E. Letter Height:
   1. Pushbuttons/Selector Switches: 1/8 inch.
   2. Panelboards: 1/4 inch.

2.20 SURGE PROTECTION DEVICE (SPD) FOR POWER DISTRIBUTION

A. This section describes the material and installation requirements for transient voltage surge suppression (TVSS) or Surge Protection devices (SPD) in switchboards, panelboards, and motor control centers for the protection of all AC electrical circuits.

B. SPD shall be listed and component recognized in accordance with UL 1449 and UL 1283.

C. SPD shall be installed and warranted by and shipped from the electrical distribution equipment manufacturer's factory.

D. SPD shall provide surge current diversion paths for all modes of protection; L-L, L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

E. SPD shall be modular in design. Each module shall be fused with a surge rated fuse.

F. A UL approved disconnect switch shall be provided as a means of disconnect in the switchboard device only.

G. SPD shall meet or exceed the following criteria:
   1. Maximum surge current capability (single pulse rated) shall be:
      a. Service entrance switchboard 300kA
      b. Branch panelboards 150kA
      c. Motor control centers 80kA
   2. UL 1449 Listed and Recognized Component Suppression Voltage Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	400V	400V	400V
480Y/277	800V	800V	800V

H. SPD shall have a minimum EMI/RFI filtering of -44dB at 100kHz with an insertion ration of 50:1 using MIL STD. 220A methodology.

I. SPD shall be provided with 1 set of NO/NC dry contacts.

J. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period. Warranty will be the responsibility of the electrical distribution equipment manufacturer.

K. Approve manufactures are:
   1. Cutler Hammer CPS Series
   2. General Electric Tranquell Series
   3. Siemans TPS Series
   4. Square D Company XTE Series

2.21 MANUAL/ NON-AUTOMATIC TRANSFER SWITCH

A. Meet or exceed NEMA Enclosed Switch Standard KS1-1983 and UL Standard Number 1008 and UL 489.

B. For indoor application: NEMA Type 1. For outdoor or non-Air Conditioned area application: NEMA Type 4X stainless steel, if not otherwise shown on drawings.

C. Fuse or no fuse: as shown.

D. Voltage, Ampers, and short circuit rating: as shown.

E. Service Entrance rated molded-case switch with overcurrent trip units for both source 1 and source 2. Blade style transfer switch without overcurrent trip units is not acceptable.

F. LED indication lights for “source 1 is available”, “source 2 is available”, “Source 1 is connected”, and “Source 2 is connected”.

G. Permanently affixed manual operating handle and keyed switch. Transfer switches shall be capable of being operated manually under full rated load conditions.

H. Manual/Non-automatic transfer scheme shall have time delay in the neutral position before transferring to another source.

I. Control power for electrical operation shall be derived from a control power transformer connected to the line side of the source to which the load is being transferred.

J. Transient voltage surge suppression (TVSS) or Surge Protection Device (SPD) with a rating per phase of 80 kA in the manual/non-automatic transfer switch. Transient voltage surge suppression shall be provided with MTS, whether indicated on the drawings for not.

K. Manufacturers:
   1. Square D,
   2. Eaton (Cutler-Hammer),
   3. Or approved equal.

2.22 COMBINATION STARTER - FULL VOLTAVE REVERING NEMA STARTER

A. Rating: Horsepower rated at 600 volts, UL labeled for 100,000 amperes with overload protection.

B. Three-phase, reversing, full voltage with phase failure relay, control transformer, E-stop and other control switches as shown on drawings.

C. LED Pilot Lights: As shown.

D. Disconnect Type: Motor circuit protector.

E. Enclosure: As shown.

F. Dry contact outputs: As shown.

G. Pad-lockable operating handles.

H. Manufacturer: Eaton, Square D, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with NECA 5055.

3.02 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:
   1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
      a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
   2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
   3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:
   1. Drawing locations are approximate.
   2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by ENGINEER.
   3. Light Switch: Install on lock side of doors.
   4. Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.

D. Mounting Height:
   1. General:
      a. Measured to centerline of box.

2. Where specified heights do not suit building construction or finish, mount as directed by ENGINEER.
3. Light Switch: 48 inches above floor.
4. Thermostat: 54 inches above floor.
5. Telephone Outlet: 6 inches above counter tops or 15 inches above floor.
6. Wall Mounted Telephone Outlet: 52 inches above floor.
    a. Convenience Receptacle:
    b. General Interior Areas: 15 inches above floor.
    c. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of splashback, or 6 inches above countertops without splashback.
    d. Industrial Areas, Workshops: 48 inches above floor.
    e. Outdoor, All Areas: 24 inches above finished grade.
7. Special-Purpose Receptacle: 54 inches above floor or as shown.

E. Install plumb and level.

F. Flush Mounted:
1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.

I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

J. Provide plaster rings where necessary.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. Install stainless steel mounting hardware in industrial areas.

M. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

N. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

O. Box Type (Steel Raceway System):
1. Exterior Locations:
    a. Exposed Raceways: Cast metal.
    b. Concealed Raceways: Cast metal.
    c. Concrete Encased Raceways: Cast metal.
    d. Class I, II, or III Hazardous Areas: Cast metal.
2. Interior Dry Locations:

a. Exposed Rigid Conduit: Cast metal.
b. Exposed EMT: Sheet steel.
c. Concealed Raceways: Sheet steel.
d. Concrete Encased Raceways: Cast metal.
e. Lighting Circuits, Ceiling: Sheet steel.
f. Class I, II, or III Hazardous Areas: Cast metal.

3. Interior Wet Locations:
a. Exposed Raceways: Cast metal.
b. Concealed Raceways: Cast metal.
c. Concrete Encased Raceways: Cast metal.
d. Lighting Circuits, Ceiling: Sheet steel.
e. Class I, II, or III Hazardous Areas: Cast metal.

4. Cast-In-Place Concrete Slabs: Sheet steel.

P. Box Type (Rigid Aluminum Raceway System): Cast aluminum.

Q. Box Type (Nonmetallic Raceway System):
1. Corrosive Locations: Nonmetallic.
2. Exposed Raceways: Nonmetallic.
3. Concealed Raceways: Nonmetallic.
4. Concrete Encased Raceways: Nonmetallic.

R. Box Type, Corrosive Locations (PVC-Coated Rigid Galvanized Steel Raceway System): PVC coated cast metal..

3.03 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Installed boxes shall be accessible.

F. Do not install on finished surfaces.

G. Install plumb and level.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.

J. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. At or Below Grade:
   1. Install boxes for below grade conduits flush with finished grade in locations outside of paved areas, roadways, or walkways.
   2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
   3. Obtain ENGINEER's written acceptance prior to installation in paved areas, roadways, or walkways.
   4. Use boxes and covers suitable to support anticipated weights.

M. Flush Mounted:
   1. Install with concealed conduit.
   2. Holes in surrounding surface shall be no larger than required to receive box.
   3. Make edges of boxes flush with final surface.

N. Mounting Hardware:
   1. Noncorrosive Interior Areas: Galvanized.
   2. All Other Areas: Stainless steel.

O. Location/Type:
   1. Finished, Indoor, Dry: NEMA 250, Type 1.
   2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
   3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
   4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.
   5. Unfinished, Indoor and Outdoor, Hazardous: NEMA 250, Type 7 and Type 9, where indicated.
   6. Underground Conduit: Concrete Encased.
   7. Corrosive Locations: Nonmetallic.

3.04 WIRING DEVICES

A. Switches:
   1. Mounting Height: See Paragraph OUTLET AND DEVICE BOXES.
   2. Install with switch operation in vertical position.
   3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:
   1. Install with grounding slot down except where horizontal mounting is shown, in which case install with neutral slot up.
   2. Ground receptacles to boxes with grounding wire only.
   3. Weatherproof Receptacles:
      a. Install in cast metal box.
      b. Install such that hinge for protective cover is above receptacle opening.
   4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for "downstream" conventional receptacles.
   5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

3.05 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to the box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Engrave with designated titles.

F. Types (Unless Otherwise Shown):
   1. Office: Stainless Steel.
   2. Exterior: Weatherproof.
   3. Interior:
      a. Flush Mounted Boxes: Stainless Steel.
      b. Surface Mounted, Cast Metal Boxes: Cast metal.
      c. Surface Mounted, Sheet Steel Boxes: Stainless Steel.
      d. Surface Mounted, Nonmetallic Boxes: Plastic.

3.06 PUSHBU'ITON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Heavy-Duty, oil-tight Type: Locations (Unless Otherwise Shown): Nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   1. Locations (Unless Otherwise Shown): Nonhazardous, outdoor, or normally wet areas.
   2. Mounting: NEMA 250, Type 4X enclosure.

3.07 TERMINAL JUNCTION BOX

A. Install in accordance with Paragraph JUNCTION AND PULL BOXES.

B. Label each block and terminal with permanently attached, nondestructible tag.

C. Do not install on finished outdoor surfaces.

D. Location:
   1. Finished, Indoor, Dry: NEMA 250, Type 1.
   2. Unfinished, Indoor, Dry: NEMA 250, Type 12.
   3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
   4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.08 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

3.09 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moistureproof, flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and three-phase units, 15 to 112 kVA.

3.10 SUPPORT AND FRAMING CHANNEL

A. Furnish zinc-rich primer; paint cut ends prior to installation, where applicable.

B. Install where required for mounting and supporting electrical equipment and raceway systems.

3.11 MOTOR SURGE PROTECTION

A. Ground in accordance with NFPA 70.

B. Low Voltage: Ground terminals to equipment bus.

3.12 TESTING OF MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:
   1. Proper mounting.
   2. Proper conductor size.
   3. Feeder designation according to nameplate and one-line diagram.
   4. Cracked casings.
   5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
   6. Operate breaker to verify smooth operation.
   7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
   8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:
   1. Insulation Resistance Tests:
      a. Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.
      b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.

c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
d. Test values to comply with NETA ATS, Table 10.2.

2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   f. Trip times shall be within limits established by NEMA AB 4, Table 5-3.

D. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4

3.13 THERMOGRAPHIC SURVEY

A. Provide a thermographic survey of connections associated with incoming service conductors, bus work, and branch feeder conductors No. 2 and larger at each:
   1. Low Voltage Motor Control Center (new bucket installation).
   2. Panelboard.

B. Provide a thermographic survey of feeder conductors No. 2 and larger terminating at:
   1. Motors rated 30 horsepower and larger.
   2. Low voltage disconnect switches.
   3. Transfer Switches.

C. Remove necessary enclosure metal panels and covers prior to performing survey.

D. Perform with equipment energized during periods of maximum possible loading.

E. Do not perform survey on equipment operating at less than 20 percent of rated connected operating load.

F. Utilize Thermographic Equipment Capable Of:
   1. Detecting emitted radiation.
   2. Converting detected radiation to visual signal.
   3. Detecting 1 degree C temperature difference between subject area and reference point of 30 degrees C.

G. Temperature Gradients Of:
   1. 3 degrees C to 7 degrees C indicates possible deficiency that warrants investigation.
   2. 7 degrees C to 15 degrees C indicates deficiency that is to be corrected as time permits.

3. 16 degrees C and above indicates deficiency that is to be corrected immediately.

H. Provide Written Report Of:
   1. Areas surveyed and the resultant temperature gradients.
   2. Locations of areas having temperature gradients of 3 degrees C or greater.
   3. Cause of heat rise and actions taken to correct the cause of heat rise.
   4. Detected phase unbalance.

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Association of State Highway and Transportation Officials (AASHTO): Division I, Standard Specifications for Highway Bridges, Fourteenth Edition.
   2. American National Standards Institute (ANSI):
      a. C80.1, Rigid Steel Conduit-Zinc Coated.
      b. C80.3, Electrical Metallic Tubing-Zinc Coated.
      c. CS0.5, Rigid Aluminum Conduit.
      d. C80.6, Intermediate Metal Conduit (IMC)-Zinc Coated.
   3. American Society for Testing and Materials (ASTM):
      a. A123 El, Standard Specification for Zinc-Coated (Galvanized) Coatings on Iron and Steel Products.
      b. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   4. National Electrical Contractor's Association, Inc. (NECA): 5055, Standard of Installation.
   5. National Electrical Manufacturers Association (NEMA):
      a. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
      b. TC 2, Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
      c. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
      d. TC 6, PVC and ABS Plastic Utilities Duct for Underground Installation.
      e. VE 1, Metallic Cable Tray Systems.
   6. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
   7. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Safety Flexible Metal Conduit.
      b. 6, Standard for Safety Rigid Metal Conduit.
      c. 360, Standard for Safety Liquid-Tight Flexible Steel Conduit.
      d. 514B, Standard for Safety Fittings for Conduit and Outlet Boxes.
      e. 514C, Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
      f. 651, Standard for Safety Schedule 40 and 80 PVC Conduit.
      g. 651A, Standard for Safety Type EB and Rigid PVC Conduit and HDPF Conduit.
      h. 797, Standard for Safety Electrical Metallic Tubing.
      i. 870, Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings.
      j. 1242, Standard for Safety Intermediate Metal Conduit.
      k. 1660, Standard for Safety Liquid-Tight Flexible Nonmetallic Conduit.

1.02 SUBMITTALS

A. Shop Drawings:
   1. Manufacturer's Literature for applicable conduit type:
      a. Rigid galvanized steel conduit.
      b. Electric metallic tubing.
      c. Rigid aluminum conduit.
      d. PVC Schedule 40 conduit.
      e. PVC-coated rigid galvanized steel conduit.
      f. Flexible metal, liquid-tight conduit.
      g. Flexible, nonmetallic, liquid-tight conduit.
      h. Conduit fittings.
      i. Wireways.
   2. Precast Manholes and Handholes:
      a. Dimensional drawings and descriptive literature.
      b. Traffic loading calculations.
      c. Accessory information.
   3. Cable Tray Systems:
      a. Dimensional drawings, calculations, and descriptive information.
      b. NEMA load/span designation and how it was selected.
      c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.
      d. Location and magnitude of maximum simple beam deflection of tray for loading specified.
      e. Layout drawings and list of accessories being provided.
   4. Conduit Layout:
      a. Plan and section type, showing arrangement and location of conduit and duct bank required for:
         1) Low and medium voltage feeder and branch circuits.
         2) Instrumentation and control systems.
         3) Communications systems.
         4) Empty conduit for future use.
      b. Reproducible mylar; scale not greater than 1 inch equals 20 feet.
         1) Equipment and machinery proposed for bending metal conduit.
         2) Method for bending PVC conduit less than 30 degrees.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):
   1. Meet requirements of ANSI C80.1 and UL6.
   2. Material: Hot-dip galvanized, with chromated protective layer.

B. Electric Metallic Tubing (EMT):
   1. Meet requirements of ANSI C80.3 and UL 797.
   2. Material: Hot-dip galvanized, with chromated and lacquered protective layer.

C. Rigid Aluminum Conduit:
   1. Meet requirements of ANSI C80.5 and UL 6.
   2. Material: Type 6063, copper-free aluminum alloy.

D. PVC Schedule 40 Conduit:
   1. Meet requirements of NEMA TC 2 and UL 651.
   2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

E. PVC-Coated Rigid Galvanized Steel Conduit:
   1. Meet requirements of NEMA RN 1.
   2. Material:
      a. Conduit: Meet requirements of ANSI C80.1 and UL 6
      b. PVC Coating: 40 mils nominal thickness, bonded to metal.

F. Flexible Metal, Liquid-Tight Conduit:
   1. UL 360 listed for 105 degrees C insulated conductors.
   2. Material: Galvanized steel, with an extruded PVC jacket.

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

2.02 FITTINGS

A. Rigid Galvanized Steel and Intermediate Metal Conduit:
   1. General:
      a. Meet requirements of UL 514B.
      b. Type: Threaded, galvanized. Set screw fittings not permitted.
   2. Bushing:
      a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
      b. Manufacturers:
         1) Thomas & Betts; Type BIM.
         2) O.Z./Gedney; Type HB.
   3. Grounding Bushing:
      a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
      b. Manufacturers:
         1) Appleton; Series GIB.
         2) O.Z. Gedney; Type HBLG.
   4. Conduit Hub:
      a. Material: Malleable iron with insulated throat.
      b. Manufacturers:
         1) O.Z. Gedney; Series CH.
         2) T & B; Series 370.
   5. Conduit Bodies:

a. Material: Malleable iron, sized as required by NFPA 70.
b. Manufacturers (For Normal Conditions):
1) Appleton; Form 35 threaded Unilets.
2) Crouse-Hinds; Form 7 or 8 threaded condulets.
3) Killark; Series O Electrolets.
c. Manufacturers (For Hazardous Locations):
1) Appleton.
2) Crouse-Hinds.
3) Killark.

6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting Manufacturers:
a. Appleton; Type EYF, EYM, or ESU.
b. Crouse-Hinds; Type EYS or EZS.
c. Killark; Type EY or EYS.
8. Drain Seal Manufacturers:
a. Appleton; Type SF.
b. Crouse-Hinds; Type EYD or EZD.
9. Drain/Breather Fitting Manufacturers:
a. Appleton; Type ECDB.
b. Crouse-Hinds; ECD.
10. Expansion Fitting Manufacturers:
a. Deflection/Expansion Movement:
1) Appleton; Type DF.
2) Crouse-Hinds; Type XD.
b. Expansion Movement Only:
1) Appleton; Type XJ.
2) Crouse-Hinds; Type XJ.
11. Cable Sealing Fittings:
a. To form watertight nonslip cord or cable connection to conduit.
b. For Conductors With OD of 1/2 Inch or Less: Neoprene bushing at connector entry.
c. Manufacturers:
1) Crouse-Hinds; CGBS.
2) Appleton; CG-S.

B. Electric Metallic Tubing:
1. Meet requirements of UL 514B.
2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
3. Compression Ring: Stainless steel.
4. Coupling Manufacturers:
a. Appleton; Type 95T.
b. Crouse-Hinds; Type CPR.
5. Connector Manufacturers:
a. Appleton; Type 86T.
b. Crouse-Hinds; Type CPR.

C. Rigid Aluminum Conduit:
1. General:
a. Meet requirements of UL 514B.
b. Type: Threaded, copper-free. Set screw fittings not permitted.
2. Insulated Bushing:

a. Material: Cast aluminum, with integral insulated throat, rated for 150 degrees C.
b. Manufacturer: O.Z. Gedney; Type AB.

3. Grounding Bushing:
   a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.
   b. Manufacturer: O.Z. Gedney; Type ABLG.
4. Conduit Hub:
   a. Material: Cast aluminum, with insulated throat.
   b. Manufacturers:
      1) O.Z. Gedney; Type CHA.
      2) T & B; Series 370AL.
5. Conduit Bodies:
   a. Manufacturers (For Normal Conditions):
      1) Appleton; Form 85 threaded Unilets.
      2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
      3) Killark; Series O Electrolets.
   b. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting Manufacturers:
   a. Appleton; Type EYF-AL or EYM-AL.
   b. Crouse-Hinds; Type EYS-SA or EZS-SA.
   c. Killark; Type EY or EYS.
8. Drain Seal Manufacturers:
   a. Appleton; Type EYDM-A.
   b. Crouse-Hinds; Type EYD-SA or EZD-SA.
9. Drain/Breather Fitting Manufacturers:
   a. Appleton; Type ECDB.
   b. Crouse-Hinds; ECD.
10. Expansion Fitting Manufacturers:
    a. Deflection/Expansion Movement: Steel City; Type DF-A.
    b. Expansion Movement Only: Steel City; Type AF-A.
11. Cable Sealing Fittings: To form watertight nonslip cord or cable connection to conduit.
    a. Bushing: Neoprene at connector entry.
    b. Manufacturer: Appleton CG-S.

D. PVC Conduit and Tubing:
   1. Meet requirements of NEMA TC-3.
   2. Type: PVC, slip-on.

E. PVC-Coated Rigid Galvanized Steel Conduit:
   1. Meet requirements of UL 514B.
   2. Type: Rigid galvanized steel, PVC coated by conduit manufacturer.
   3. Overlapping pressure sealing sleeves.
   4. Conduit Hangers, Attachments, and Accessories: PVC-coated.

F. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Long design type extending outside of box or other device at least 2 inches.
4. Manufacturer: T & B; Series 5300.

G. Flexible, Nonmetallic, Liquid-Tight Conduit: Meet requirements of UL 514B.
1. Type: One-piece fitting body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
2. Manufacturers:
a. Carlon; Type LT.
b. Kellems; Polytuff.
c. T & B; LT Series.

H. Watertight Entrance Seal Device:
1. New Construction:
a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
b. Manufacturer: O.Z./Gedney; Type FSK or WSK, as required.
2. Gored-Hole Application:
a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
b. Manufacturer: O.Z./Gedney; Series CSM.

I. Hazardous Locations: Approved for use in the atmosphere involved.
1. Manufacturer: Crouse-Hinds; Type ECGJH.

J. Corrosive Locations:
1. Material: 40-mil PVC-coated rigid steel.
2. Manufacturers:
a. Robroy Industries.
b. Carlon.
c. Crouse-Hinds.

2.03 WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, with removable, hinged cover.

C. Rating: Outdoor raintight if outdoor, and indoor if indoor.

D. Finish: Gray, baked enamel.

E. Manufacturers:
1. Square D.
2. B-Line Systems, Inc.

2.04 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO Division 1, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6- or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage:
   1. Slope floors toward drain points, leaving no pockets or other non-draining areas.
   2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

E. Raceway Entrances:
   1. Provide on all four sides.
   2. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.
   3. At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:
   1. Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
   2. Location:
      a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
      b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:
   1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
   2. Wall Attachment:
      a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
      b. Insert Spacing: Maximum 3-foot on center entire inside perimeter of manhole.
      c. Arrange so that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:
   1. Material: Machined cast iron.
   2. Cover Type: Indented, solid top design, with two drop handles each.
   3. Cover Loading: AASHTO Division I, H-20.
   4. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
      a. Above 600 Volts: ELECTRIC HV.
      b. 600 Volts and Below: ELECTRIC LV.
      c. TELEPHONE.

I. Handhole Frames and Covers:
   1. Material: Steel, hot-dipped galvanized.
   2. Cover Type: Solid, bolt-on, of checkered design.
   3. Cover Loading: H-20.
   4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:

a. 600 Volts and Below: ELECTRIC LV.
b. TELEPHONE.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:
1. U.S. Precast.
2. Brooks Products, Inc.
3. Penn-Cast Products, Inc.
4. Concrete Conduit Co.
5. Associated Concrete Products, Inc.
6. Utility Vault Co.
7. Pipe,Inc.

2.05 ACCESSORIES

A. Duct Bank Spacers:
1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturer: Underground Device, Inc.; Type WUNPEECE.

B. Identification Devices:
1. Raceway Tags:
a. Material: Permanent, nylon.
b. Shape: Round.
c. Raceway Designation: Pressure stamped, embossed, or engraved.
d. Tags relying on adhesives or taped-on markers not permitted.
2. Warning Tape:
a. Material: Polyethylene, 4-mil gauge.
b. Color: Red.
c. Width: Minimum 6-inch.
d. Designation: Warning on tape that electric circuit is located below tape.
e. Manufacturers:
1) Blackburn, Type RT.
2) Griffolyn Co.
3. Buried Raceway Marker:
a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
b. Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES. in letters 1/4-inch high.
c. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

C. Raceway Coating:
1. Material: Bitumastic or plastic tape coating.
2. Manufacturers:
a. Koppers bitumastic; No. 505.
b. Scotchwrap; No. 51, plastic tape.

D. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Manufacturer: Raychem; Type TWDB.

PART 3 EXECUTION

3.01 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors. Reference Section 16120, CONDUCTORS, concerning conduit sizing for aluminum conductors.

B. All installed Work shall comply with NECA 5055.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Aluminum Conduit: Do not install in direct contact with concrete. Use unistrut or back and strap (clamp back strap) for installation on concrete wall or surface.

G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

M. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

N. Install watertight fittings in outdoor, underground, or wet locations.

O. Paint threads, before assembly of fittings, of galvanized conduit or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

P. All metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

Q. Do not install raceways in concrete equipment pads, foundations, or beams.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

T. Use long radius elbow for conduit with fiber optic cable, indicated or not on the drawings.

3.02 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum cover 1-1/2 inches.

B. Provide support during placement of concrete to ensure raceways remain in position.

C. Floor Slabs:
   1. Outside diameter of conduit not to exceed one-third of the slab thickness.
   2. Separate conduit by minimum six times conduit outside diameter, except at crossings.

3.03 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed:
   1. Rigid Aluminum.

C. Interior, Exposed:
   1. Rigid Aluminum.
   2. Electric metallic tubing for ceiling portion of lighting circuits in a conditioned environment.

D. Interior, Concealed (Not Embedded in Concrete):
   1. Rigid Aluminum.
   2. PVC Schedule 40.

E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: PVC Schedule 40.

F. Concrete Slab on Top: PVC Schedule 40.

G. Under Slabs-On-Grade: PVC Schedule 40.

H. Corrosive Areas: PVC Schedule 40.

I. Lightning Protection: PVC Schedule 40.

J. Class 1 Division 2 Area: Rigid Aluminum.

3.04 CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:
   1. Conduit Size 4 Inches or Less: Flexible metal, liquid-tight conduit.
   2. Conduit Size Over 4 Inches: Nonflexible.
   3. Corrosive Areas: Flexible, nonmetallic, liquid or PVC-coated metallic, liquid-tight.
   4. Length: 18-inch minimum, 60-inch maximum, of sufficient length to allow movement or adjustment of equipment.

B. Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Transition From Underground or Concrete Embedded to Exposed: PVC Coated Rigid galvanized steel conduit.

E. Under Equipment Mounting Pads: Rigid galvanized steel conduit.

F. Exterior Light Pole Foundations: Rigid galvanized steel conduit.

3.05 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit in contact with concrete floor slabs to a point 2 inches above concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:
   1. General: Seal raceway at the first box or outlet with minimum 2 inches thick expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
   2. Concrete Roof or Membrane Waterproofed Wall or Floor:
      a. Provide a watertight seal.
      b. Without Concrete Encasement: Install watertight entrance seal device on each side.
      c. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
      d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.

e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

3. Heating, Ventilating, and Air Conditioning Equipment:
   a. Penetrate equipment in area established by manufacturer.
   b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
   c. Seal penetration with fire stop silicone type sealant, Dow Corning or equal.
4. Corrosive-Sensitive Areas:
   a. Seal all conduit passing through chlorine and ammonia room walls.
   b. Seal all conduit entering equipment panel boards and field panels containing electronic equipment.
   c. Seal penetration with fire stop silicone type sealant, Dow Corning or equal..
5. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.
6. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
   a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
   b. Fill space between raceway and sleeve with an expandable plastic compound on each side.
7. Manholes and Handholes:
   a. Metallic Raceways: Provide insulated grounding bushings.
   b. Nonmetallic Raceways: Provide bell ends flush with wall.
   c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.06 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 40 percent extra space for future conduit.

C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
   1. Wood: Wood screws.
   2. Hollow Masonry Units: Toggle bolts.
   3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
   4. Steelwork: Machine screws.

D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.07 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:
   1. Bends 30-Degree and Larger: Provide factory-made elbows.
   2. 90-Degree Bends: Provide rigid steel elbows.
   3. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.08 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.09 PVC CONDUIT

A. Solvent Welding:
   1. Provide manufacturer recommended solvent; apply to all joints.
   2. Install such that joint is watertight.

B. Adapters:
   1. PVC to Metallic Fittings: PVC terminal type.
   2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belied-End Conduit: Bevel the unbelled end of the joint prior to joining.

3.10 PVC-COATED RIGID STEEL CONDUIT

A. nstall in accordance with manufacturer's instructions.

B. Provide PVC boot to cover all exposed threading.

3.11 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

3.12 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Sheet Metal Boxes, Cabinets, and Enclosures:
   1. Rigid Galvanized Conduit:
      a. Provide one lock nut each on inside and outside of enclosure.
      b. Install grounding bushing.
      c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
      d. Install insulated bushing on ends of conduit where grounding is not required.
      e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   2. Electric Metallic Tubing: Provide gland compression, insulated connectors.
   3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
   4. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
   5. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
   6. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.

C. Motor Control Center, Switchboard, Switchgear, and Free-Standing Enclosures: Terminate conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.13 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:
   1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.

2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Installation with Other Piping Systems:
1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

I. Metallic Raceway Coating: At couplings and joints and along entire length, apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

J. Concrete Encasement: As specified in Section 03300, CAST-IN-PLACE CONCRETE.
1. Concrete Color: Gray, dust top of concrete ductbank with powdered red concrete dye before concrete sets and trowel dry onto top of ductbank.

K. Backfill:
1. As specified in Section 01045, CUTTING AND PATCHING
2. Do not backfill until inspected by ENGINEER.

3.14 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade back to original state.

B. Do not install until final raceway grading has been determined.

C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

D. Grounding: As specified in Section 16450, GROUNDING.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be i-inch minimum height.

3.15 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Paragraph IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.16 IDENTIFICATION DEVICES

A. Raceway Tags:
1. Identify origin and destination.

2. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.
3. Provide nylon strap for attachment.

B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

C. Buried Raceway Markers:
1. Install at grade to indicate direction of underground raceways.
2. Install at all bends and at intervals not exceeding 100 feet in straight runs.
3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.17 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up damage to coating on PVC-coated conduit with patching compound approved by manufacturer.

END OF SECTION

SECTION 16120

CONDUCTORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American National Standards Institute (ANSI): 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   2. American Society for Testing and Materials (ASTM):
      a. A167, Standard Specification for Stainless and Heat Resisting Chromium-Nickel-P1ated Steel Plate, Sheet, and Strip.
      b. B3, Standard Specification for Soft or Annealed Copper Wire.
      c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
      d. B263, Standard Test Method for Determination of Cross- Sectional Area of Stranded Conductors.
   3. Association of Edison Illuminating Companies (AEIC):
      a. CS 5, Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 35 kV.
      b. CS 6, Ethylene- Propylene-Rubber-Insulated Shielded Power Cables Rated 5 Through 69 kV.
   4. Insulated Cable Engineer's Association, Inc. (ICEA): T-29-250, Procedure for Conducting Vertical Cable Tray Flame Test With a Theoretical Heat Input of 210,000 Btu/hour.
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 48, Standard Test Procedures and Requirements or High-Voltage Alternating Current Cable Terminations.
      b. 404, Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V through 46,000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V through 500,000V.
   6. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.
   7. National Electrical Manufacturers' Association (NEMA):
      a. CC 1, Electric Power Connectors for Substations.
      b. WC 3, Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      c. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      d. WC 7, Crosslinked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      e. WC 8, Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
      f. WC 55, Instrumentation Cables and Thermocouple Wire.
   8. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   9. Underwriters Laboratories, Inc. (UL):
      a. 13, Standard for Safety Power-Limited Circuit Cables.

b. 44, Standard for Safety Rubber-Insulated Wires and Cables.
c. 62, Standard for Safety Flexible Cord and Fixture Wire.
d. 486A, Standard for Safety Wire Connector and Soldering Lugs for Use with Copper Conductors.
e. 486B, Standard for Safety Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.
f. 510, Standard for Safety Insulating Tape.
g. 854, Standard for Safety Service-Entrance Cables.
h. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces.
i. 1072, Standard for Safety Medium-Voltage Power Cables.
j. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
k. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Shop Drawings:
1. Wire and cable descriptive product information.
2. Wire and cable accessories descriptive product information.
3. Cable fault detection system descriptive product information.
4. Manufactured wiring systems descriptive product information.
5. Manufactured wire systems rating information.
6. Manufactured wire systems dimensional drawings.
7. Manufactured wire systems special fittings.
8. Busway descriptive product information.
9. Busway rating information.
10. Busway dimensional drawings.
11. Busway special fitting information.
12. Busway-equipment interface information for equipment to be connected to busways.

B. Quality Control Submittals:
1. Certified Factory Test Report for conductors 600 volts and below.
2. Certified Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:
1. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Stranded copper.

2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Stranded copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW insulation.

D. Direct Burial and Aerial Conductors and Cables:
1. Type USE/RHH/RHW insulation, UL t(54 listed, Type RHW-2/USE-2.
2. Conform to physical and minimum thickness requirements of NEMA WC 3.

E. Flexible Cords and Cables:
1. Type SOW-A50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 8.

F. Cable Tray Conductors and Cables: Type TC.

2.02 600-VOLT RATED CABLE

A. General:
1. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Wire and Connectors:
1. Cable shall be rated for 600 volts and shall meet the requirements below:
2. Conductors shall be stranded
3. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.
4. Type of wire shall be XHHW or THHN, rated 75 degrees C suitable for wet locations except where required otherwise by the drawings.
5. No wire smaller than No. 12 gauge shall be used unless specifically indicated.
6. Conductor metal shall be copper.
7. All conductors shall be megger tested after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance.

C. Type l-Multiconductor Control Cable:
1. Conductors:
a. No. 14 AWG, seven-strand copper.
b. Insulation: 15-mil PVC with 4-mil nylon.
c. UL 1581 listed as Type THHN/THWN rated VW-l.
d. Conductor group bound with spiral wrap of barrier tape.
e. Color Code: In accordance with NEMA WC 5, Method 1, Sequence K-2.
2. Cable: Passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (inches)	Jacket Thickness (mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	00.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. Rome Cable.

D. Type 2-Multiconductor Power Cable:
1. Conductors:
   a. Class B stranded, coated copper.
   b. Insulation: Chemically crosslinked ethylene-propylene with Hypalon jacket.
   c. UL 1581 listed as Type EPR, rated VW-1.
   d. Color Code: Conductors, size No. 8 AWG and smaller, colored conductors, NEMA WC5 Method 1, color 5 per Article POWER CONDUCTOR COLOR CODING. Conductors, size No. 6 AWG and larger, NEMA WC5, Method 4.
2. Cable pass the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
3. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. of Conductors	Max.Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2 3 4	0.42 0.45 0.49	45 45 45
10	10	2 3 4	0.54 0.58 0.63	60 60 60
8	10	3 4	0.66 0.72	60
6	8	3 4	0.74 0.81	60
4	6	3 4	0.88 0.97	60 80
2	6	3 4	1.01 1.11	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.46	80
4/0	4	3 4	1.56 1.78	80

4. Manufacturers:
    a. Okonite Co.
    b. Pome Cable.

E. Type B-No. 16 AWG, Twisted, Shielded Pair (TSP), Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
    1. Outer Jacket: 45-mil nominal thickness.
    2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
    3. Dimension: 0.31-inch nominal OD.
    4. Conductors:
        a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8
        b. 20 AWG, seven-strand tinned copper drain wire.
        c. Insulation: 15-mil nominal PVC.
        d. Jacket: 4-mil nominal nylon.
        e. Color Code: Pair conductors black and red.
    5. Manufacturers:
        a. Okonite Co.
        b. Alpha Wire Corp.
    6. The following test shall be performed on instrumentation and control system cables. All tests shall be end-to-end test of installed cables with the ends supported in free air, not adjacent to any ground object. All test data shall be recorded on forms acceptable to the Engineer. Complete records of all tests shall be made and delivered to the Engineer.
        a. Continuity tests shall be performed by measuring wire/shield loop resistances of signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall carry by more than $\pm$2 ohms from the calculated average loop resistance valve.
        b. Insulation resistance tests shall be performed by using a 500 volt megohmeter to measure the insulation resistance between each channel wire and channel shield, between individual channel shields in a multi-channel cable, between each individual channel and the overall cable shield in multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 10 megohms shall be unacceptable.

F. Type B1-No. 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
    1. Outer Jacket: 45-mil nominal.
    2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
    3. Dimension: 0.32-inch nominal OD.
    4. Conductors:
        a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
        b. 20 AWG, seven-strand, tinned copper drain wire.
        c. Insulation: 15-mil nominal PVC.
        d. Jacket: 4-mil nylon.
        e. Color Code: Triad conductors black, red, and white.

5. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.

G. Type B2-No. 18 AWG, Multi-Twisted, Shielded Pairs with a Common, Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 55 requirements.
1. Conductors:
    a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8
    b. Tinned copper drain wires.
    c. Pair drain wire size AWG 20, group drain wire size AWG 18.
    d. Insulation: 15-mil PVC.
    e. Jacket: 4-mil nylon.
    f. Color Code: Pair conductors black and red with red conductor numerically printed for group identification.
    g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
3. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.50	45
8	0.68	60
12	0.82	60
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

4. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.

H. Type B3-No. 18 AWG, Multi-twisted Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 55.
1. Conductors:
    a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
    b. Tinned copper drain wire size 18 AWG
    c. Insulation: 15-mil nominal PVC.
    d. Jacket: 4-mil nylon.
    e. Color Code: Pair conductors black and red, with red conductor numerically printed for group identification.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
3. Cable Sizes:

Number Of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.46	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.06	80
36	1.21	80
50	1.42	80

4. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.

I. Ethernet Cat. 6e UTP Cable (Copper):
1. Section applies to all Ethernet Cable (Copper) except for Fiber Optic cable.
2. Conductor Physical Characteristics: 4 twisted pairs (8 conductors), 23 AWG solid bare Copper with Polyolefin Insulation. Overall Nominal Diameter: 0.235 inch. Operating Temperature Range: -20'C to +75'C. Model Number – 7881A, Belden Inc.
3. NEC/UL specification CMR, UL444, UL verified category 6.
4. Manufacturer:
   a. Belden Inc.

2.03 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.04 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:
1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arcs and Fireproofing:
   a. 30-mil, elastomer
   b. Manufacturers and Products:
      1) Scotch; Brand 77, with Scotch Brand 69 glass cloth tape binder.
      2) Plytnount; Plyarc 30, with Plymount Plyglas glass cloth tape binder.

B. Identification Devices:
1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:
   1. Nylon, Self-Insulated Crimp Connectors:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) Burndy; Insulink.
         3) ILSCO.
   2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) Burndy; Insulink.
         3) ILSCO.

D. Cable Lugs:
   1. In accordance with NEMA CC I.
   2. Rated 600 volts of same material as conductor metal.
   3. Insulated, Locking-Fork, Compression Lugs:
      a. Manufacturers and Products:
         1) Thomas & Betts; Sta-Kon.
         2) ILSCO; ILSCONS.
   4. Un-insulated Crimp Connectors and Terminators:
      a. Manufacturers and Products:
         1) Square D; Versitide.
         2) Thomas & Betts; Color-Keyed.
         3) ILSCO.
   5. Un-insulated, Bolted, Two-Way Connectors and Terminators:
      a. Manufacturers and Products:
         1) Thomas & Betts; Locktite.
         2) Burndy; Quiklug.
         3) ILSCO.

E. Cable Ties: Nylon, adjustable, self-locking, and reusable.
   1. Manufacturers and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyofin.
   1. Manufacturers and Product: Thomas & Betts; SHRINK-KON.

2.05 PULLING COMPOUND

A. Nontoxic, non-corrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:
   1. Ideal Co.; Yellow 77.
   2. Polywater, Inc.
   3. Cable Grip Co.

2.06 WARNING TAPE

A. As specified in Section 16110, RACEWAYS.

2.07 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and Below: Test in accordance with UL 44 and 854 Standards.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation to be in accordance with NECA 5055.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

F. Bundling: Where single conductors and cables in manholes, hand holes, vaults, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

I. Cable Tray Installation:
   1. Install wire and cable parallel and straight in tray.
   2. Bundle, in groups, all wire and cable of same voltage having a common routing and destination; use cable ties, at maximum intervals of 8 feet.
   3. Clamp cable bundles prior to making end termination connections.
   4. Separate cables of different voltage rating in same cable tray with barriers.
   5. Fasten wires, cables, and bundles to tray with nylon cable straps at the following maximum intervals:
      a. Horizontal Runs: 20 feet.
      b. Vertical Runs: 5 feet.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:
   1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
   2. No. 8 AWG and Smaller: Provide colored conductors.
   3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation. Coordinate with AHJ and local codes and adjust the color accordingly.		

   4. Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, hand holes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:
   1. Assign circuit name based on device or equipment at load end of circuit.
   2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:
   1. Conductors No. 3 AWG and Smaller: Identify with sleeves.
   2. Cables, and Conductors No. 2 AWG and Larger:
      a. Identify with marker plates.
      b. Attach marker plates with nylon tie cord.
   3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by ENGINEER.

C. Connections and Terminations:
   1. Install wire nuts only on solid conductors.
   2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.
   3. Install un-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
   4. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.
   5. Install un-insulated bolted, two-way connectors for motor circuit conductors No. 12 and larger.
   6. Tape insulates all un-insulated connections.
   7. Place no more than one conductor in any single-barrel pressure connection.
   8. Install crimp connectors with tools approved by connector manufacturer.
   9. Install terminals and connectors acceptable for type of material used.
   10. Compression Lugs
      a. Attach with a tool specifically designed for purpose.
      b. Tool shall provide complete controlled crimp and shall not release until crimp is complete.
      c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:
   1. Indoors: Use general purpose, flame retardant tape.
   2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

F. Cap spare conductors and conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:
   1. Remove surplus wire, bridle and secure.
   2. Where conductors pass through openings or over edges in sheet metal, remove bums, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:
   1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
   2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
   3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.

4. Where connections of cables installed under this section are to be made under PROCESS INSTRUMENTATION AND CONTROL SYSTEMS, leave pigtails of adequate length for bundled connections.
5. Cable Protection:
    a. Under Infinite Access Floors: May be installed without bundling.
    b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2-inch in diameter.
    c. Maintain integrity of shielding of instrumentation cables.
    d. Ensure grounds do not occur because of damage to jacket over the shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.05 FIELD QUALTTY CONTROL - LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:
1. Inspect Each Individual Exposed Power Cable No. 6 and Larger For:
    a. Physical damage.
    b. Proper connections in accordance with single-line diagram.
    c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
    d. Color coding conformance with specifications.
    e. Proper circuit identification.
2. Mechanical Connections For:
    a. Proper lug type for conductor material.
    b. Proper lug installation.
    c. Bolt torque level in accordance with NETA ATS, Table 10. 1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
    a. Proper shield grounding.
    b. Proper terminations.
    c. Proper circuit identification.
4. Control Cables For:
    a. Proper termination.
    b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:
1. Insulation Resistance Tests:
    a. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
    b. Evaluate ohmic values by comparison with conductors of same length and type.
    c. Investigate values less than 50 megohms.
    d. Utilize 1,000V dc megohmmeter for 600V insulated conductors.
2. Continuity test by ohmmeter method to ensure proper cable connections.

END OF SECTION

SECTION 16262

VARIABLE FREQUENCY DRIVES BELOW 75 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Complete, solid-state variable frequency drive (VFD) unit(s) and VFD system(s) including design, fabrication, software, technical data, spare parts, testing, installation and support requirements for speed control of 3-phase squirrel cage rotor, induction motors, for control of the RAS pumps.

B. Related Sections:
   1. Division 16 - Electrical

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. Standard 250 - Enclosures for Electrical Equipment (1,000 volts maximum).
   2. NEMA MGI, Part 31 - Motors with higher peak voltage capability.
   3. NEMA ICS7 – Industrial Controls and Adjustable Speed Drives.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. Standard 519 - 1992 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

C. Underwriters' Laboratories, Inc. (UL):
   1. UL label is required on VFD unit
   2. UL 508 – Industrial Control Equipment
   3. UL 508 label is required on VFD equipment and enclosure assembly
   4. UL 50 – Enclosures for Electrical Equipment

1.03 SYSTEM DESCRIPTION

A. The CONTRACTOR and variable frequency drive system Supplier are cautioned regarding the review and compliance with the total Contract Documents. Typical required auxiliary devices may include circuit breakers, motor circuit protectors, relays, timers, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment. These auxiliary items may be provided by separate supplier; however, they shall be integrated as complete VFD working system.

B. See Division 11 for data of the motors and driven equipment including full load current, torque, speed, and performance requirements and provide all supplementary equipment and services to accomplish the necessary operation.

1.04 SUBMITTALS

A. Shop Drawings:

1. General non-specific "catalog data" are not acceptable.
2. Layout drawings of each VFD in control cabinet or separate enclosure dimensions, access details, weights, arrangement, color, and nameplates, door mounted devices and conduit stub-ups.
3. Internal VFD schematic and interconnection wiring diagrams among internal devices, external devices including terminal blocks, and wire numbering.
4. Specific equipment names, relay and timer coil, respective contact identification numbers shall be consistent with the design Drawings.
5. Complete single line diagrams including, but not limited to, electrical ratings, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system.
6. Complete Bills of Material and catalog data sheets for all equipment and devices.
7. Complete drawings to provide the OWNER with operations and maintenance capabilities.

B. Product Data:
1. Functional diagrams that identify major system functional blocks and interfaces.
2. Special requirements or restrictions of the motor-load combination that may result from operation on the VFD.

C. Test Reports:
1. Submit certified copies of field test reports verifying adequate performance.
2. Submit factory standard bench-test data verifying that the manufacturer's proposed equipment has been tested after product assembly.

D. Operation, Maintenance and Installation Instructions.

E. Guides and Manuals: If the variable frequency drive systems require settings or configuration, provide copies of all settings.

F. Record Drawings:
1. Drawings of each VFD type representing the as-built condition of the equipment and respective settings. Final or corrected as-built drawing shall be delivered 4 weeks after field system acceptance.

G. Warranty documents.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Variable frequency drive manufacturer shall maintain, as part of a national network, engineering service facilities within 150 miles of the equipment installation to provide quick responsive start-up service, training of customer personnel, periodic maintenance service contracts, and emergency troubleshooting and repair service.
2. The manufacturer shall have produced the specified type of VFDs for a minimum period of five (5) years.

1.06 WARRANTY

A. Contractor and manufacturer shall warrant that the material and workmanship of all components, and the operation of the VFD system shall be free of any limitations and deficiencies. Also, the warranty shall include:
   1. Replace components found to be faulty and make changes in equipment, substitution arrangement, include system rewiring, rebuilt or additional equipment required, or adjustments necessary during trial operation or subsequent operation of the unit during the warranty period, to meet the equipment or functional requirements of this Specification.

1.07 MAINTENANCE

A. Spare Parts: As a minimum, provide the following spare parts:
   1. One complete main control key pad for each type and rated size of VFD.
   2. Any special dedicated tool for emergency service and troubleshooting.

B. Field Services: Manufacturer shall describe the field service system available to support the proposed variable frequency drive system. As a minimum describe:
   1. Type of technical support available (e.g. system engineering and technician).
   2. Location of field service personnel.
   3. Field service daily rates in dollars per hour and dollars per day.
   4. Guaranteed response times to service requests.

C. Local Service Representative:
   1. Provide cell phone number and office phone numbers of local service and parts contacts for emergency repairs and callouts.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Yaskawa, to match existing controllers for RAS pumps. No approved equal.

2.02 GENERAL REQUIREMENTS

A. VFD system shall be rated for the following:
   1. Supply the amperage demand and speed control of motor size(s) scheduled or indicated on the Drawings.
   2. Maintain output frequency (setpoint) with a steady state accuracy of 0.5 percent of rated frequency of 60 hertz for a 24 hour period.
   3. Provide smooth, stepless changes in motor speed, acceleration and deceleration over the entire operating speed (revolutions per minute) range.
   4. Automatic current limit feature during startup and provide a "soft start" torque profile for the motor-load combination. Also, it shall limit current due to motor winding or motor lead phase-to-phase short circuit or phase-to-ground short circuit. The current limit protection setting shall be field adjustable and it shall withstand available short circuit currents of the operating environment.
   5. Operate the motor load continuously within the range of 10 percent to 105 percent of rated speed. The minimum and maximum continuous operating speeds shall each be field adjustable setpoints within this speed range.

Provide 2 field-adjustable speed setpoints for the variable frequency drive to skip equipment resonant frequencies.

6. VFD shall have linear acceleration capability to ramp up the speed, in revolutions per minute, of the selected minimum to maximum operating speed range in a maximum of 30 seconds. Provide controlled linear deceleration capability. The acceleration and deceleration time limits shall be field adjustable to values up to 120 seconds.
7. VFD shall be capable of supplying indefinitely 110 percent of the motor nameplate full load current. Also, the unit shall have a one (1) minute overload current rating of 150 percent of the motor nameplate full load current.

B. The VFD unit overall efficiency shall be a minimum of 95 percent at rated voltage, frequency, and current. This efficiency shall be calculated as follows:

$$Efficiency\ (\%) = \frac{Power\ (Load)}{Power\ (Supply)}\ x\ 100$$

Power (Load) is the total 3-phase power measured at the output terminals of the drive system, including VFD, output filters or transformers. Power (Supply) is the total power measured at the input terminals of the VFD including input filters, line reactors, isolation transformers, harmonic distortion attenuation equipment and auxiliary equipment (e.g., controls, fans) for complete system operation.

C. The VFD and/or protective relay system shall continuously monitor the output voltages and generate an alarm condition when the unbalance exceeds 1 percent. The system shall detect and generate a separate alarm for loss of any output phase voltage (single phasing). Phase unbalance shall be as defined by NEMA Standard MG-1.

D. VFD shall operate continuously without interruption of service or damage to equipment during transient input voltage variations of minus 40 percent for a duration of 15 cycles. Unacceptable voltage fluctuations on the supply bus shall cause under or over-voltage protection to trip and remove supply voltage from the drive system.

2.03 SYSTEM FEATURES AND CHARACTERISTICS

A. VFD system shall have microprocessor based controls it shall include the following:
   1. Input section rectifier shall consist of a 6-pulse full wave diode system and direct current link with 3% input line reactor.
   2. The inverter shall use insulated gate bipolar transistors (IGBTs) with space vector pulse width modulation (PWM) technology. The inverter shall invert the direct current voltage into an alternating current voltage at a frequency which shall be proportional to the desired speed. This alternating current voltage and frequency shall both vary simultaneously at a constant "Volts-Per-Hertz" ratio to operate the induction motor at the desired speed.

B. VFD output voltage regulation shall be plus or minus 2 percent and carrier frequency shall be field-adjustable.

C. Controls and indicators to accomplish operation functions shall be located on the VFD. As a minimum, the required controls and indicators shall consist of the following features via the keypad or auxiliary devices:
   1. Digital Output Speed Indicator: Revolutions per minute.
   2. Input Voltage
   3. Output Voltage
   4. Output Current
   5. Output Frequency
   6. Drive Ready Indicator
   7. Running time meter.
   8. Control Mode Selector Switches: As required
   9. Manual speed control and HAND-OFF-AUTO, VFD-OFF-BYPASS selector switch
   10. Alarm Read-Out: Display on keypad
   11. Alarm reset button.
   12. Alarm, Auxiliary Contacts and Other Devices: as indicated on the Drawings.
   13. Molded case circuit breaker disconnect with lockout mechanism
   14. Refer to electrical drawings for VFD control schematic for space heater and motor thermal switch wiring requirements.

D. VFD system shall provide a 4 to 20 milliamperes direct current output signal that is proportional to the drive output frequency for use as speed feedback or control and remote speed indication.

E. VFD system shall accept a 4 to 20 milliamperes direct current input command signal to control the output frequency in the automatic and/or manual control modes. The controls shall accept the input increase/decrease command with a resolution that permits incremental changes in speed, revolutions per minute, equal to or less than 0.1 percent of rated speed.

F. When operating in the automatic mode, the VFD system shall shut down during a power outage. Upon restoration of normal power and after an adjustable time delay (0 to 2 minutes; motor has coasted to zero speed and there is no backspin), the VFD system shall automatically restart and then ramp up to speed as required by the control system. The process operator shall not be required to reset the system manually after a shutdown caused by a power outage.

G. Furnish door mounted selector switch or keypad pilot device for selection of local/remote speed reference signal (e.g., analog output from a programmable logic controller) supplied to the VFD.

H. Include in each variable frequency drive system an automatic trip feature which will remove the drive output from the motor and allow it to decelerate safely. This automatic system shall trip and indicate the fault only upon the following conditions:
   1. Motor overload.
   2. Motor stator winding fault (phase-to-ground, phase-to-phase).
   3. Loss of input power to the variable frequency drive or unacceptable voltage variation.
   4. High variable frequency drive equipment temperature.

I. Provide each VFD system with transmitted and received radio interference protection. In addition, provide protection against starting a rotating motor, both

directions (coasting to zero speed and backspin). In the event that a motor automatic restart feature (catch the motor "on-the-fly) is provided in the drive controller as standard, this feature shall be capable of being disabled.

J. VFD shall include on-line diagnostics with an automatic self-check feature, that will detect a failure which in turn affects motor operation and generates an alarm output, contact rated for 125 volts-direct current.
   1. Diagnostics shall operate a visual and audible alarm indicator(s) on the VFD cabinets without opening cabinet doors.
   2. Diagnostics shall provide an easily readable output that will indicate a failure.

K. VFD shall have thermostat with enclosure fan (size as required by the heat load of the VFD drive).

L. VFD shall have mechanically interlocked contactors for VFD mode and Bypass mode operation.

M. Minimum Starting Speed: When called to operate, the VFD shall immediately ramp to a minimum speed. The minimum speed shall be adjustable but initially set at 60% of maximum speed. The 4-20 mA speed signal from the PLC and keypad on the front of the drive shall modulate the signal between the minimum speed setpoint and the maximum output speed of the drive; i.e., at the 4 mA signal, the VFD shall run at the minimum speed. At the 20 mA signal, the VFD shall run at full speed.

2.04 OPERATING CONDITIONS

A. The following operating conditions are applicable for all VFD equipment.
   1. Utility Power Supply: 480 volts, 3-phase, fixed frequency of 60 hertz.
   2. Suitable to operate, at times, on a limited power source with waveform distortion engine-generator set.
   3. Short Circuit Fault Withstand: 35,000 amperes symmetrical at rated voltage.

2.05 ENCLOSURES

A. Unless otherwise specified or indicated on the Drawings, each VFD system enclosure shall be in NEMA 4, with stainless steel painted white enclosure, gasketed force ventilated dead front with front accessibility, and maximum dimensions per equipment layout on drawings. Design enclosures for bottom entry of power supply cables and top exit of motor cables. Design VFD system so that rear cabinet access is not required for operations, maintenance, and repair tasks.
   1. Treat metal surfaces and structural parts by phosphatizing, or equal, prior to painting.
   2. Apply a gun-metal gray undercoat to enclosures which is equal to zinc chromate.
   3. Finish exterior of the enclosures in ANSI-Ivory color enamel.
   4. Brace each door to prevent sag when fully open.

B. Main disconnecting means shall have external operating handle interlocked with the door so that it cannot be opened unless the disconnect is in the OFF position. Power supply to the motor from the VFD shall be capable of being positively locked out in the OFF position. The disconnect shall be interlocked so that equipment cannot be energized when the door is open.

C. Electrical ground bus shall be tin-plated copper. Power and control wiring shall be copper, and identified in accordance with Section 16120.

D. Equipment to be of modular construction allowing normal maintenance and repair to be done with ordinary hand tools. Design and install device assemblies so that a single failed item can be individually removed and replaced.

2.06 SOURCE QUALITY CONTROL

A. Factory Wiring Labels:
   1. Provide all VFD internal wiring with identification numbers or labels and connected to terminal blocks:

B. Factory Testing:
   1. Factory test each VFD system in accordance with IEEE and NEMA standards for operational integrity.
   2. VFD system components, including power transistors, GTOs, SCRs, and diodes shall be 100 percent inspected, including temperature cycling and ambient high temperature of 65 degrees Celsius load testing. All integrated circuits shall be inspected, pass/fail tested, temperature cycled and ambient high temperature tested. Small components, including small signal semiconductors, resistors, capacitors, diodes, etc. shall be lot sampled and tested for functionality.
   3. Auxiliaries, including fans, that are required for rated load operation at maximum ambient temperature, shall be 100 percent redundant. A new and unused spare replacement fan(s), shipped in original carton, may be acceptable.
   4. VFD system shall not be shipped from the manufacturing and assembly facility until the acceptance tests are completed and the results approved by the test representative.
   5. Acceptance of a shop test does not relieve CONTRACTOR from requirements to meet field installation tests under specified operating conditions, nor does the inspection relieve the CONTRACTOR of responsibilities.

PART 3 EXECUTION

3.01 GENERAL

A. Variable frequency drives rated below 75 hp shall be installed in NEMA 4 gasketed enclosure - control panels, to match existing control equipment for RAS pumps and in accordance with drawings.

3.02 FIELD QUALITY CONTROL

A. The CONTRACTOR shall successfully complete Acceptance Test Procedures on the assembled drive system. The test plan shall be submitted for acceptance at least 30 days prior to the planned test date.

B. Provide the services of an experienced, factory trained technician or service engineer of the variable frequency drive manufacturer, for minimum of 2 days for VFD unit test and startup, beginning at a date mutually agreeable to the CONTRACTOR and the OWNER. The technician shall be on duty at the site for at least 6 hours per each required day of each VFD normal test and startup; and he

shall be available 24 hours per day when required to advise concerning special problems with equipment and systems.

C. Include in the bid the training of personnel in the operation and maintenance of each furnished variable frequency drive pump control system. Training shall include 2 separate days - 4 hour sessions for 5 designated plant operators, plus 2 separate days - 4 hour sessions for 5 designated plant maintenance staff.

END OF SECTION

SECTION 16405

ELECTRIC MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Anti-Friction Bearing Manufacturers' Association (AFBMA):
      a. 9, Load Ratings and Fatigue Life for Ball Bearings.
      b. 11, Load Rating and Fatigue Life for Roller Bearings.
   2. American National Standards Institute (ANSI): C50.41, Polyphase Induction Motors for Power Generating Stations.
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 85, Test Procedure for Airborne Sound Measurements on Rotating Machines.
      b. 112, Standard Test Procedures for Polyphase Induction Motors and Generators.
      c. 114, Standard Test Procedures for Single-Phase Induction Motors.
      d. 620, Guide for Construction and Interpretation of Thermal Limit Curves for Squirrel-Cage Motors Over 500 Horsepower.
      e. 841, Recommended Practice for Chemical Industry Severe-Duty Squirrel-Cage Induction Motors, 600V and Below.
   4. National Electrical Manufacturers Association (NEMA):
      a. MG 1, Motors and Generators.
      b. MG 13, Frame Assignments for Alternating Current Integral Horsepower Induction Motors.
      c. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   5. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)
   6. Underwriters Laboratories (UL):
      a. 547, Thermal Protectors for Electric Motors.
      b. 674, Electric Motors and Generators Used in Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. CISD-TEFC: Chemical industry, severe-duty enclosure.

B. DIP: Dust-ignition-proof enclosure.

C. EXP: Explosion-proof enclosure.

D. ODP: Open drip-proof enclosure.

E. TEFC: Totally enclosed, fan cooled enclosure.

F. TENV: Totally enclosed, non-ventilated enclosure.

G. WPI: Open weather protected enclosure, Type I.

H. WPII: Open weather protected enclosure, Type II.

I. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Descriptive information.
   2. Nameplate data in accordance with NEMA MG 1.
   3. Additional Rating Information:
      a. Service factor.
      b. Locked rotor current.
      c. No load current.
      d. Safe stall time for motors 200 horsepower and larger.
      e. Multispeed load classification (e.g., variable torque).
      f. Adjustable frequency drive motor load classification (e.g., variable torque) and minimum allowable motor speed for that load classification.
   4. Enclosure type and mounting (e.g. horizontal, vertical).
   5. Dimensions and total weight.
   6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
   7. Bearing type.
   8. Bearing lubrication.
   9. Bearing life.
   10. Space heater voltage and watts.
   11. Description and rating of motor thermal protection.
   12. Motor sound power level in accordance with NEMA MG 1.
   13. Maximum brake horsepower required by the equipment driven by the motor.
   14. Description and rating of submersible motor moisture-sensing system.

B. Quality Control Submittals:
   1. Factory test reports, certified.
   2. Manufacturer's Certificate of Proper Installation, 100 horsepower and larger.
   3. Operation and Maintenance Manual.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. General Electric.

B. Reliance.

C. Magnetek.

D. Siemens.

E. U.S.Motors.

F. Westinghouse.

G. Toshiba.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, use a single supplier to provide a drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. Frame assignments in accordance with NEMA MG 13.

E. Provide motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

F. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

G. Lifting lugs on all motors weighing 100 pounds or more.

H. Operating Conditions:
   1. Maximum ambient temperature not greater than 50 degrees C.
   2. Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.
   3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specifications.

B. Constant Speed Applications: Brake horsepower of the driven equipment at any head capacity point on the pump curve not to exceed motor nameplate horsepower rating, excluding any service factor.

C. Adjustable Frequency, Adjustable Speed Applications: Driven equipment brake horsepower at any head capacity point on the pump curve not to exceed motor nameplate horsepower rating, excluding any service factor.

2.04 SERVICE FACTOR

A. 1.15 minimum at rated ambient temperature, unless otherwise indicated.

2.05 **VOLTAGE** AND FREQUENCY RATING

A. System Frequency: 60-Hz.

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specifications:

Size	Voltage	Phases
1/2 hp and smaller	115	1
3/4 hp through 400 hp	460	3
450 hp and larger	4,000	3

C. Suitable for full voltage starting.

D. One hundred horsepower and larger also suitable for reduced voltage starting with 65 or 80 percent voltage tap settings on reduced inrush motor starters.

E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 horsepower, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:
   1. Efficiency:
      a. Tested in accordance with NEMA MG 1, paragraph 12.54.1. Tested efficiency shall meet or exceed listed in NEMA MG 1 Table 12-10.
      b. Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.
   2. Power Factor: Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code F or lower if motor horsepower not covered by NEMA MG 1 tables.

B. Safe stall time 15 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

B. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.

C. Three-Phase and Integral Horsepower Motors, Unless Otherwise Indicated in Motor-Driven Equipment Specifications: Class F with Class B rise at nameplate horsepower and designated operating conditions, except EXP and DIP motors which must be Class B with Class B rise. Insulation shall be chemical and humidity resistant.

2.09 ENCLOSURES

A. All enclosures to conform to NEMA MG 1.

B. Unless otherwise noted, all motors shall be TEFC and shall be furnished with a drain hole with porous drain/weather plug.

C. Explosion-Proof (EXP):
   1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class 1, Division 1, Group C and D hazardous locations.
   2. Drain holes with drain and breather fittings.
   3. Integral thermostat opening on excessive motor temperature in accordance with UL 547 and NFPA 70.
   4. Thermostat leads to terminate in a terminal box separate from main terminal box.

D. Dust-Ignition-Proof (DIP):
   1. TEFC listed to met UL 674 and NFPA 70 requirements for Class II, Division 1, Group E, F, G.
   2. Integral thermostat opening on excessive motor temperature in accordance with UL 547 and NFPA 70.
   3. Thermostat leads to terminate in a terminal box separate from main terminal box.

E. Submersible: In accordance with Paragraph SPECIAL MOTORS.

F. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Paragraph SPECIAL MOTORS.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for all motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1-11.06 and 20.62 and NFPA 70, Article 430:

Voltage	Horsepower	Percentage
Below 600	15 thru 125	500
Below 600	150 thru 300	275
Below 600	350 thru 600	225
Above 600	All Sizes	200

E. Terminal for connection of equipment grounding wire in each terminal box.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:
   1. 3/4 horsepower and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
   2. 1 Through 400 horsepower: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
   3. Above 400 horsepower: Regreasable antifriction bearings in labyrinth sealed end bells with removable grease relief plugs.
   4. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in AFBMA 9 and 11.

B. Vertical Motors:
   1. Thrust Bearings:
      a. Antifriction bearing.
      b. Manufacturer's standard lubrication 100 horsepower and smaller.
      c. Oil lubricated 125 horsepower and larger.
      d. Minimum 100,000 hours L-10 bearing life.
   2. Guide Bearings:
      a. Manufacturer's standard bearing type.
      b. Manufacturer's standard lubrication 100 horsepower and smaller.
      c. Oil lubricated 125 horsepower and larger.
      d. Minimum 100,000 hours L-1O bearing life.

C. Regreasable Antifriction Bearings:
   1. Readily accessible, grease injection fittings.
   2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:
   1. Oil reservoirs with sight level gauge.
   2. Oil fill and drain openings with opening plugs.
   3. Provisions for necessary oil circulation and cooling.

2.12 NOISE

A. Measured in accordance with IEEE 85 and NEMA MG 1 and be less than levels in 12.53.3 at no load.

B. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1-12.06 and 1-12.07.

2.14 EQUIPMENT FINISH

A. External Finish: Prime and finish coat manufacturer's standard. Field painting in accordance with Section 09960.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen over Air Openings: Stainless steel on motors with ODP, WPI, and WPII enclosures meeting requirements for Guarded Machine in NEMA MG 1.

B. Winding Thermal Protection, if shown on drawings:
   1. Thermostats:
      a. Motors for constant speed and adjustable speed application 50 and larger.
      b. Bi-metal disk or rod type thermostats embedded in stater windings (normally closed contact).
      c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature.

2.16 FACTORY TESTING

A. Tests:
   1. In accordance with IEEE 112 for polyphase motors and IEEE 114 for single-phase motors.
   2. Routine (production) tests on all motors in accordance with NEMA MG 1, plus no load power at rated voltage and polyphase, rated voltage measurement of locked rotor current. Test multispeed motors at all speeds.
   3. For energy efficient motors, test efficiency at 50, 75, and 100 percent of rated horsepower:
      a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, paragraphs 12.54 and 12.57.
      b. For motors 500 horsepower and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
   4. Power factor:
      a. Speed.
      b. Current at rated horsepower.
      c. kW input at rated horsepower.
      d. On motors of 100 horsepower and smaller, furnish a certified copy of a motor efficiency test report on an identical motor.

B. Test Report Forms
   1. Routine Tests: IEEE 112, Form A-1.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts. Provide anchor bolts meeting manufacturer's recommendations and of sufficient size and number for the specified seismic conditions.

3.02 FIELD QUALITY CONTROL

A. General: Inspection and testing limited to motors rated 5 horsepower and larger.

B. Visual and Mechanical Inspection:
   1. Proper electrical and grounding connections.
   2. Shaft alignment.
   3. Blockage of ventilating air passageways.
   4. Operate Motor and Check For:
      a. Excessive mechanical and electrical noise.
      b. Overheating.
      c. Correct rotation.
      d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
      e. Excessive vibration.
   5. Check operation of space heaters.

C. Electrical Tests:
   1. Insulation Resistance Tests:
      a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
         1) Motors above 200 horsepower for l0-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
         2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
      b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
   2. Calculate polarization index ratios for motors above 200 horsepower. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
   3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
   4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.
   5. Overpotential Tests:
      a. Applied dc voltage in accordance with IEEE 95.
      b. Limited to 4,000-volt motors rated 1,000 horsepower and greater.
      c. Test results evaluated on pass/fail basis.

3.03 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative at site for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 75 horsepower.

B. Manufacturer's Certificate of Proper Installation.

3.04 SUPPLEMENTS

A. Table supplements, following "END OF SECTION," are a part of this Specification.

END OF SECTION

TABLE 1 MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
1	1800	80.0	81.5			Mfr.'s Std.	Mfr.'s Std.		
	1200	78.5	79.3			Mfr.'s Std.	Mfr.'s Std.		
1.5	3600	79.3	81.5			Mfr.'s Std.	Mfr.'s Std.		
	1800	79.3	82.0			Mfr.'s Std.	Mfr.'s Std.		
	1200	82.5	84.0		82.0	Mfr.'s Std.	Mfr.'s Std.		Mfr.'s Std.
2	3600	82.0	84.0			Mfr.'s Std.	Mfr.'s Std.		
	1800	81.5	83.7			Mfr.'s Std.	Mfr.'s Std.		
	1200	85.5	85.5	83.7	83.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	82.9	82.5	82.9	81.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
3	3600	82.0	84.0	82.0	82.0	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	84.8	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	87.5	88.1	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	84.1	82.9	84.1	82.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
5	3600	84.8	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	86.5	86.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	87.5	88.1	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	86.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
7.5	3600	86.5	88.1	84.8	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	88.5	88.5	88.4	87.5	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	86.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
10	3600	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	89.3	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	89.5	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
15	3600	88.5	89.8	88.4	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	91.0	91.0	90.9	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	90.2	90.2	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
20	3600	91.0	90.6	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.

TABLE 1 MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
	1800	91.7	91.7	91.7	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.0	90.6	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
25	3600	91.7	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.7	91.0	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
30	3600	91.7	91.4	89.5	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1200	91.7	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	91.7	91.7	90.9	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
40	3600	91.7	91.7	90.2	89.3	86.6	86.1	87.0	89.0
	1800	93.6	93.0	92.8	91.7	78.2	78.2	83.0	84.5
	1200	92.4	92.4	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.0	90.9	90.2	70.0	70.5	70.0	70.5
50	3600	92.0	92.0	90.2	89.3	85.1	86.7	89.0	89.0
	1800	93.6	93.0	92.8	91.7	79.5	79.4	82.5	82.5
	1200	92.4	92.4	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.7	90.9	90.9	78.5	72.9	78.5	80.0
60	3600	92.7	93.0	91.7	90.9	85.8	88.3	87.5	89.0
	1800	93.6	94.1	93.5	92.8	80.5	79.9	80.5	80.5
	1200	93.0	93.0	92.8	91.7	81.5	81.5	81.5	81.5
	900	92.4	91.7	91.7	90.9	79.5	73.2	79.5	79.5
70	3600	93.6	93.6	91.7	91.7	87.1	88.5	88.5	88.5
	1800	94.5	94.5	93.5	93.5	81.0	81.5	81.0	81.5
	1200	93.6	93.5	93.5	92.8	82.0	82.0	82.0	82.0
	900	92.8	92.4	92.8	91.7	80.5	74.5	80.5	81.0
100	3600	93.6	93.3	91.7	90.7	87.0	88.2	87.0	88.5
	1800	95.1	94.5	94.0	93.5	81.0	81.0	81.0	81.0
	1200	93.6	93.6	92.8	92.8	82.1	81.7	85.5	85.5
	900	93.5	92.4	92.8	91.7	77.0	77.3	77.0	80.0

TABLE 1 MOTOR PERFORMANCE REQUIREMENTS									
		% Guar. Min. Full Load Efficiency				%Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
125	3600	93.6	93.7	91.7	91.7	86.4	89.1	87.0	90.5
	1800	94.5	94.7	93.5	92.8	85.4	85.5	87.5	86.0
	1200	93.6	94.1	93.5	92.8	82.7	82.3	85.5	85.5
	900	93.5	93.0	92.8	92.4	78.5	78.5	78.5	78.5
150	3600	93.6	93.7	92.4	91.7	86.5	90.0	86.5	90.5
	1800	95.0	95.2	94.5	94.0	82.5	85.0	84.5	85.0
	1200	94.5	94.5	93.5	94.0	81.5	81.5	81.5	81.5
	900	93.5	93.0	92.8	92.4	78.0	78.5	78.0	78.5
200	3600	94.3	94.3	92.4	93.0	87.8	89.4	91.0	91.0
	1800	95.0	95.2	94.0	94.0	85.2	86.5	87.0	87.0
	1200	94.5	94.5	93.5	93.5	79.0	82.5	79.0	82.5
250	3600	94.3	94.7	91.7	92.4	85.0	86.5	85.0	96.5
	1800	85.4	95.4	94.5	94.5	79.0	79.0	79.0	79.0
	1200	95.0	94.5	94.5	93.5	82.0	82.0	82.0	82.0
300	3600	93.7	94.3			89.8	89.9		
	1800	95.4	95.2	94.5	94.0	80.0	80.0	800	80.0
	1200	93.7	93.7			84.5	90.1		
350	3600	94.3	94.7			89.4	85.9		
	1800	94.7	94.7			85.9	85.9		
400	3600	94.3				88.4			
	1800	9437				86.8			
450	3600	94.7				89.1			
500	3600	94.7				88.3			

SECTION 16450

GROUNDING

PART 1 PART 1 GENERAL

1.01 SCOPE

A. Provide and install grounding system as shown on drawings and as specifies herein complete in place.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section:
   1. American National Standards Institute (ANSI): C2, National Electrical Safety Code (NESC).
   2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

B. Submittals
   1. Shop Drawings:
      a. Product Data:
         1) Exothermic weld connectors.
         2) Mechanical connectors.
         3) Compression connectors.

C. UL Compliance
   1. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.01 GROUND ROD

A. Material: Copper clad.

B. Diameter: Minimum 5/8 inch.

C. Length: 20 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 16120, CONDUCTORS.

2.03 CONNECTORS

A. Exothermic Weld Type:
   1. Outdoor Weld: Suitable for exposure to elements or direct burial.
   2. Indoor Weld: Use low-smoke, low-emission process.
   3. Manufacturers:

a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
b. Thermoweld.

B. Compression Type:
1. Compress deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels pre-filled with oxide inhibiting and anti-seizing compound and sealed.
5. Manufacturers:
a. Burndy Corp.
b. Thomas and Betts Co.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.
1. Manufacturers:
a. Burndy Corp.
b. Thomas and Betts Co.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers:
1. Christy Co.; No. G5.
2. Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 EXECUTION

3.01 GENERAL

A. Grounding shall comply with NFPA 70 and ANSI C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

F. Shielded Control Cables:
1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum I inch at termination to field instrument and apply heat shrink tube.
3. Do not ground control cable shield at more than one point.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to non-current carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to non-current carrying grounding bus.

C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

3.05 GROUNDING WELLS

A. Install inside buildings, asphalt, and paved areas.

B. Install riser ring and cover flush with surface.

C. Place 9 inches crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:
   1. Above grade Connections: Use exothermic weld, mechanical, or compression-type connectors.
   2. Below grade Connections: Install exothermic weld type connectors.
   3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
   4. Notify Engineer before backfilling ground connections.

B. Exothermic Weld Type:
   1. Wire brush or file contact point to bare metal surface.
   2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
   3. Avoid using badly worn molds.
   4. Mold to be completely filled with metal when making welds.
   5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:
   1. Install in accordance with connector manufacturer's recommendations.
   2. Install connectors of proper size for grounding conductors and ground rods specified.
   3. Install using connector manufacturer's compression tool having proper sized dies and proof of calibration within the last 12 months.

D. Mechanical Type:
   1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
   2. Install in accordance with connector manufacturer's recommendations.
   3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each.

B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all non-current carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of substation transformers to substation grounding grid and system grounding network.

C. Bond neutrals of pad-mounted transformers to four locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

3.11 INSTRUMENT GROUND - SURGE SUPPRESSION

A. Connect all instrument surge protection with #6 insulated copper groundwire (in conduit where above grade) to closest plant ground system

3.12 BONDING

A. Bond to Main Conductor System:

B. All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.

C. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.

D. Provide air terminals as required.

E. Bond steel columns or major framing members to grounding system per National Electrical Code.

F. Bond each main down conductor to grounding system.

G. All conduits terminations in panels shall be grounded using appropriate ground bushing and conductor to nearest ground point.

3.13 GROUNDING SYSTEM

A. Grounding Conductor:

B. Completely encircle building structure.

C. Bury minimum 30 inches below finished grade.

D. Minimum 2 feet distance from foundation walls.

E. Interconnect ground rods by direct-buried copper cables.

F. Connections:
   1. Install ground cables continuous between connections.
   2. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and non-accessible connections.
   3. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
   4. Use bolded offset parapet bases or through-roof concealed base assemblies for air terminal connections.
   5. Provide interconnections with electrical and telephone systems and all underground water and metal pipes.
   6. Provide electric service arrestor ground wire to building water main.

3.14 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection:
   1. Equipment and circuit grounds in motor control centers, panelboards, switchboards, and switchgear assemblies for proper connection and tightness.
   2. Ground bus connections in motor control centers, panelboards, switchboards, and switchgear assemblies for proper termination and tightness,
   3. Effective transformer core and equipment grounding.
   4. Accessible connections to grounding electrodes for proper fit and tightness.
   5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:
   1. Fall-Of-Potential Test:
      a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
      b. Main ground electrode system resistance to ground to be no greater than 5 ohms.
   2. Two-Point Direct Method Test:
      a. In accordance with IEEE 81, Section 8.2. 1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
      b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

END OF SECTION

SECTION 16480

LOW VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American National Standard Institute (ANSI):
      a. C2, National Electrical Safety Code (NESC).
      b. C57.12.28, Switchgear and Transformers - Pad-Mounted Equipment-Enclosure Integrity.
      c. Z55, Gray Finishes for Industrial Apparatus and Equipment.
   2. National Electrical Manufacturers Association (NEMA):
      a. AB 1 Molded Case Circuit Breakers.
      b. ICS 1, General Standards for Industrial Control and Systems.
      c. ICS 2, Standards for Industrial Control Devices, Controllers, and Assemblies.
      d. ICS 2.3, Instructions for Handling, Installation, Operation, and Maintenance of Motor Control Centers
      e. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
      f. 250-1997, Enclosures for Electrical Equipment (1,000 volts maximum).
   3. National Fire Protection Association (NFPA): 70-90, National Electrical Code. (NEC) Latest Edition.
   4. Underwriters Laboratories, Inc. (UL):
      a. 98, Standard for Safety Enclosed and Dead-Front Switches, Eleventh Edition.
      b. 489, Standard for Safety Molded Case Circuit Breakers and Circuit Breaker Enclosures, Seventh Edition.
      c. 845, Standard for Safety Motor Control Centers, Third Edition.
      d. 508A Industrial Control Equipment.
   5. Uniform Building Code (UBC): Section 2312, Earthquake Requirements.
   6. InterNational Electrical Testing Association (NETA) Acceptance Testing Specifications, latest edition.
   7. Institute of Electrical and Electronics Engineers (IEEE):
      a. 112, latest revision, Standard Test Procedure for Polyphase Induction Motors and Generators
      b. 43, latest edition, Recommended Practice for Testing Insulation Resistance of Rotating Machinery

1.02 SUBMITTALS

A. Shop Drawings:
   1. Itemized bill of material.
   2. Descriptive information.
   3. Dimensional drawings.
   4. Conduit entrance locations/provisions.
   5. Bus data including horizontal and vertical bus capacities, voltage rating and interrupting capacity. Include materials of construction

6. Protective Devices: Copies of time-current characteristics.
7. Anchoring instructions and details.
8. Typed tabulation:
    a. Motor name; tag (equipment) numbers as shown on Drawings.
    b. Motor horsepower.
    c. Nameplate full load current.
    d. Measured load current and voltage.
    e. Heater catalog number.
    f. Protective device trip settings.
9. Attach above typed, tabulated data to a copy of starter manufacturer's overload heater selection tables for the starters provided.
10. Control Diagrams:
    a. NEMA ICS 2, Section 322.08 Type I.
    b. Wiring Type B.
    c. In addition to standard NEMA control diagrams, provide the following:
        1) Remote control devices.
        2) Remote indication and/or pilot lights.
        3) Interconnections and interlocking circuits between starter and remote equipment.
        4) Remote sensors.
        5) Tag numbers associated with all control devices and equipment.
        6) Clearly identify items provided by others.
11. One-line diagrams.
12. Schematic (elementary) diagrams. Custom schematics shall be furnished. Diagrams shall include all remote devices. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the CONTRACTOR stamped "REJECTED-RESUBMIT".
13. Outline diagrams.
14. Interconnection diagrams.
15. Enclosure NEMA rating and color.
16. Ground bus size and material of construction.
17. Main incoming line entry provision (top or bottom).
18. Control unit nameplate schedule.
19. All circuit breaker types, frames and settings.
20. All starter NEMA sizes, auxiliary contact provisions, coil voltage Relays, timers, pilot devices, control transformer VA and fuse sizes.
21. Short circuit rating of the complete assembly.
22. Replacement parts lists and operation and maintenance procedures.
23. Plan and elevation dimensional views of each MCC section.

B. Quality Control Submittals:
    1. Manufacturer's installation instructions.
    2. Operation and Maintenance Manual.
    3. Factory test reports, certified.

1.03 UL COMPLIANCE

A. Products manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL Listing Mark. Where shown or required motor control centers shall be suitable for service entrance.

1.04 PACKING AND SHIPPING

A. Shipping Splits: Established by CONTRACTOR to facilitate ingress of equipment to final installation location within the building.

1.05 RESPONSIBILTIES:

A. The information provided on the drawings is for guidance only and does not limit the equipment size. When motors furnished differ from the expected rating indicated the CONTRACTOR shall make the necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate the motors actually installed.

1.06 INSPECTION COORDINATION:

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. A. Cutler-Hammer.

B. B. Square D.

C. C. General Electric

D. D. Or approved equal.

2.02 MOTOR CONTROL

A. General:
   1. Provide each motor with a suitable controller and devices that will function as specified for the respective motors and meeting NEMA ICS 2, (class A), the NEC, and UL.
   2. Like Items of Equipment: Same manufacturer as low voltage switchboard and panelboards for standardization. Devices of the same type shall be products of the same manufacturer. This requirement applies to all control devices, and insofar as practical, to equipment manufactured on a production basis. It also applies without exception to equipment custom fabricated for this project.
   3. Make adjustments as necessary to wiring, conduit; disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.
   4. Overload Protection:
      a. Each motor shall have a direct current sensing solid-state overload protection in all ungrounded phases. This protection shall have current overload relays sensitive to motor current, and mounted within the motor controller. Reset of the protection shall be manually activated with

externally operated reset button. All overload protection devices shall be the inverse time limit type and match the motor characteristic.

5. Control Transformer:
   a. Two winding, 120-volt secondary, primary voltage to suit.
   b. Two current-limiting fuses for primary circuit.
   c. One fuse in secondary circuit.
   d. Mount within starter unit.
6. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
7. Lifting lugs on all equipment and devices weighing over 100 pounds.
8. Anchor Bolts: Galvanized, sized by equipment manufacturer.
9. Operating Conditions:
   a. Ambient Temperature: Maximum 40 degrees C.
   b. Equipment to be fully rated without any derating for operating conditions listed above.
10. Enclosures: In accordance with NEMA 250 and ANSI C57.12.28.
11. Equipment Finish:
   a. Electro-coating process applied over a rust-inhibiting phosphated base coating.
   b. Exterior Color: Manufacturer's standard.
12. All manual starters and combination motor starters shall be lockable in the off position.

B. Manually Operated Starter, Fractional Horsepower:
1. Rating: 16 amperes continuous at 277 volts maximum.
2. Single-phase, non-reversing, full voltage with overload protection.
3. Toggle operated, keyed where shown.
4. Enclosure: NEMA 250, Type 4, unless shown otherwise.
5. Neon Light: Red.
6. Handle guard/lock-off attachment.

C. Manually Operated Starter, Integral Horsepower:
1. Rating: Horsepower rated to maximum of 10 horsepower at 600 volts with overload protection.
2. Single or three-phase, non-reversing, full voltage.
3. Control: Toggle or pushbutton.
4. Enclosure: NEMA 250, Type 4, unless shown otherwise.
5. Red pilot light in series with an auxiliary contact.
6. Locking in OFF position.
7. Two spare auxiliary, field-convertible contacts.

D. Combination Full-Voltage, Magnetic Starter:
1. Rating: Horsepower rated at 600 volts, UL labeled for 100,000 amperes with overload protection.
2. Three-phase, non-reversing, full voltage.
3. Control: As shown.
4. Disconnect Type: Motor circuit protector.
5. Enclosure: As shown.
6. Pilot Lights: As shown.
7. Pad-lockable operating handles.

2.03 MOTOR CONTROL CENTERS

A. General:
   1. In accordance with NEMA ICS 2 and UL 845.
   2. The motor control centers shall be 600-volt class suitable for operation on a three-phase, 60-Hz system. The system operating voltage and number of wires shall be as indicated, on project drawings.
   3. MCC designated as service entrance rated shall include provision for termination of an incoming neutral conductor in conformance to NEC requirements.
   4. Short Circuit Rating: Amperes rms symmetrical as shown on Drawings for entire motor control center as a complete assembly.
   5. All controllers, main and branch circuit breakers, wire connections, and other devices to be front mounted and accessible unless otherwise noted.
   6. NEMA ICS 2, Section 322.08.
      a. Class: IIS.
      b. Type: B. Diagrams and wiring.
      c. Provide blank spaces on interconnection diagrams to add control conductor code designations during installation of equipment.
   7. Size and Arrangement
      a. Motor control centers shall be of mechanical groupings of control center units, assembled into a lineup of control center sections. Each control section shall be nominally 90-inches tall by minimum 20-inches deep.
      b. MCC's shall be designed to not exceed the space requirements as indicated on the Contract Drawings, including spaces, spares, and future compartments. MCC's shall be subject to rejection for exceeding the lengths indicated where allotted space is critical.
      c. Equipment within the MCC may be rearranged at the discretion of the manufacturer, providing the MCC provides the spares, space, and future provisions indicated.
      d. All switches and circuit breakers used as switches shall be located so that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, will not be more than 6-feet 7-in.

B. Enclosure:
   1. Type: NEMA 250, Type 1, gasketed.
   2. Construction:
      a. Sheet steel reinforced with channel or angle irons.
      b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
      c. Removable top cover plates and bottom cover plates.
      d. Removable plates on end panels for future bus extension.
      e. Structural members shall be fabricated of not less than 12 gauge steel and side and top panels and doors shall be not less than 14 gauge steel.
   3. Section Mounting: Removable formed-steel channel sills and lifting angles.
   4. Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.
   5. Vertical Wiring Compartment: Full height, isolated from unit starters with separate door.
   6. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.

7. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.
8. Door Interlocking: Interlock starter and feeder doors mechanically so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access at any time.
9. External disconnect handles, pad-lockable in OFF position.
10. Cable Entrance: Main leads enter as shown on the Drawings. Control and feeder circuits enter from top and bottom.
11. Spaces designated as "SPACE" or "BLANK" shall include blank hinged doors and vertical bus bars.
12. Control units inside compartments shall be clearly identified with tags or stencil markings.
13. Each control unit including spares, spaces and blanks, lights, and devices shall be identified by an engraved nameplate. Identification shall include circuit number as indicated.
14. Each motor control center shall be fitted with the manufacturer's nameplate which shall include the NEMA Standard electric rating and other pertinent data, including manufacturer, sales order number, date of manufacture, and place of manufacture.
15. Where "L" or "U" shaped MCC layouts are indicated, corner compartments shall have similar current and short circuit ratings as functional compartments.
16. Fans, heat exchangers, transformers, capacitors, junction boxes, or other devices may not be mounted on the outside of the motor control center enclosure.
17. Finish for motor control center shall be light grey, ANSI 61. The panels shall be given 2 coats of primer inside and out and 2 coats of enamel finish. External colors other than ANSI 61 will not be acceptable.
18. Each section shall be dead-front and dead-back construction. Rear access shall not be necessary for inspection and maintenance. The structure arrangement shall be for front only mounting of units.
19. Power cables to the motor control center shall be either top or bottom feed as indicated on the project drawings. Provide all necessary lugs, clamps, and supports to terminate incoming power cables.

C. Bus:
1. Horizontal Power Bus:
    a. Three-phase tin-plated, copper, entire width of control center, rated as indicated.
    b. Silver-plated at joints.
    c. Construct to allow future extension of additional sections.
    d. Pressure type solderless lugs for each incoming line cable.
    e. Isolated from top horizontal wireway.
    f. Provide Belleville washers on bus connection bolts.
2. Vertical Power Bus:
    a. Three-phase tin-plated, copper, full height of section, rated as required by the load but not less than 300 amperes, minimum.
    b. Silver-plated at joints.
    c. Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.
    d. Insulated and isolated barrier complete with shutters.
    e. Provide Belleville washers on bus connection bolts.
3. Neutral Bus: None.

4. Ground Bus:
    a. Copper, tin-plated, 33 percent minimum of phase bus ampacity, entire width of control center.
    b. Provide Belleville washers on bus connection bolts.
5. Bus Bracing: 65,000 amperes rms symmetrical.

D. Motor Controller Unit:
1. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.
2. Each motor starter unit shall consist of a combination magnetic contactor and short circuit protective device. Short circuit protective device shall be an instantaneous, magnetic only circuit breaker or thermal magnetic circuit breaker as defined in the project one line diagrams. All circuit breakers provided as part of a motor starter unit shall be capable of being padlocked in the open position. Reset of thermal overload elements shall be possible with unit door closed. Three phase overload trip units shall be furnished to suit the full load current of the equipment installed. Overload relays shall be solid state type capable of detecting phase loss and ground faults and shall meet NEMA class 20 tripping characteristics.
3. Magnetic starters shall have auxiliary contacts as required by electrical motor control diagrams, including N-O and N-C contacts as indicated, plus one each spare N-O and N-C contact. As a minimum, provide one normally open and one normally closed auxiliary contact.
4. Each starter unit shall have its own control power transformer. It shall have a 115-volt grounded secondary. One secondary fuse and 2 primary fuses shall be provided. Control power transformers shall be sized to accommodate the control devices indicated. Minimum transformer size is 50 VA. Local control devices shall be mounted independently of the cover door. All starters shall have a local "running" lamp and a "off" light to indicate the presence of control power when the motor is not running. Indicating lights shall be push-to-test type. Starters shall be provided with elapsed time meters, hand/off/auto selector switches, and other devices as indicated. All cubicle control wires shall be terminated at a pull apart disconnecting terminal block at the cubicle.
5. The motor control center manufacturer shall be responsible for identifying each control wire within each motor starter unit with wrap-around permanent plastic markers. Each control wire shall be identified at both ends. Markers shall be produced from a device specifically made to produce tags, such as manufactured by Brady Corporation or Thomas & Betts. Hand lettered markers are not acceptable.
6. Motor starters shall be designed to NEMA ratings. Starters designed to IEC ratings or with dual IEC/NEMA ratings will not be acceptable, either as part of any MCC, as remote starters, or as part of any equipment package.
7. Construction:
    a. Draw out combination type with stab connections for starters NEMA ICS, Size 4 and smaller. The fixed-type unit assembly shall be constructed so that it can be easily removed from its panel after disconnecting the wires to the terminal block and withdrawing from the primary bus. Removal of a unit assembly shall be possible without rear access and without disturbing any other unit in the motor control center.

b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 5 and larger.
c. Readily interchangeable with starters of similar size.
d. Pull-apart unit control wiring terminal boards on all units.

E. Starters:
1. NEMA ICS 2, Section 322.08 standard rating, except none smaller than NEMA ICS, Size 1.
2. Rating: Horsepower rated at 600 volt, UL labeled for 65,000 amperes with overload protection.
3. Three-phase, non-reversing, unless otherwise shown.
4. Disconnect Type: Motor circuit protector.
5. Combination Full Voltage, Magnetic Starter:
   a. Control: As shown.
   b. Pilot Lights: Red-ON and Green-OFF.
6. Combination Reduced Voltage Auto-Transformer Starters:
   a. Reduced voltage auto-transformer starters shall consist of a molded-case motor circuit protector in combination with a closed transition type auto-transformer starter with 50 percent, 65 percent, and 80 percent taps, and shall be set on the 65 percent tap.
   b. The starter shall have three phase solid state overload relays capable of sensing phase loss and ground fault with manual reset.
   c. The auto-transformer shall include a thermal switch wired to protect itself from overheating.
   d. Timing of the starting period shall be controlled by an adjustable accelerating relay. Requirements set forth in paragraph 2.03 for enclosures and devices apply herein.
7. Solid State Reduced Voltage Starters:
   a. Solid state reduced voltage starters shall meet the requirements of UL 508 and shall consist of an incoming power circuit breaker, a power section; logic board, isolation contactor, and paralleling full load bypass contactor.
   b. Soft Starters shall conform to the following:
      1) The SCR-based power section shall consist of 6 back-to-back SCRs, two SCRs per phase, and shall be rated for a minimum peak inverse voltage rating of 2.5 times line voltage, 1200 PIV for 480 volts. Units using triacs or SCR/diode combinations shall not be acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt characteristics of the electrical system.
      2) Starters shall include the following logic and control functions:
         a) Adjustable maximum starting current from 200 percent to 500 percent
         b) Ramp time adjustment from 1 to 40 seconds
         c) Adjustable linear voltage deceleration
         d) Kick start
         e) Phase loss protection
         f) Adjustable Undervoltage/ overvoltage protection
         g) Current unbalance protection
         h) Instantaneous overcurrent detection.
         i) Phase rotation protection (prevents starting)
         j) Shorted SCR detection.

k) Selectable Class 10, 20, 30 electronic overload protection. Heat sink overtemperature protection shall be provided.
l) Dry contacts for remote indication of RUN and TRIP status
m) Battery “back up” of set starter parameters.
n) Event recorder.
o) Elapsed time meter.
p) LCD status display.

3) The paralleling bypass contactor shall energize when the motor reaches full speed. The contactor shall be fully rated for across-the-line starting duty. The effect of the bypass contactor during normal operation is the elimination of heat buildup resulting from the voltage drop across the SCR’s. The bypass contactor may also be used as a means of starting the motor should problems be encountered with the soft starter. A door mounted selector switch shall be furnished such that the starting means can be selected as being either via the soft starter or via the bypass contactor as across-the-line.
4) An isolation contactor shall be supplied. The isolation contactor shall remove three phase power from the input side of the solid state controller when the bypass contactor is selected for across-the-line starting
5) The starter shall be housed in an appropriate NEMA rated enclosure as directed by project drawings. Heaters and cooling fans shall be provided if required to maintain the equipment within the manufacturer’s environmental guidelines.
6) The enclosure shall be of two-door compartment type construction. The left hand compartment shall contain the starter power section and any equipment rated at line voltage. The right hand compartment shall include only that equipment rated at 120 VAC or less including the starter’s CPU PC card and LCD display. The enclosure shall include a partition dividing the two compartments. Each compartment shall be designed to provide a barrier between the equipment at line voltage and the equipment at 120 VAC or less
7) The starter shall be provided with a control power transformer sized to accommodate all controls indicated on the Contract Drawings. An input power circuit breaker shall be provided. Lug termination of the incoming power conductors shall not be permitted. The starter and circuit breaker shall be rated for 65 KAIC RMS at 480V.
8) The starter shall have door mounted indication of run, phase rotation, phase loss, undervoltage, current unbalance, and current trip.
9) Door mounted LCD / keyboard display assembly designed to:
   a) Set or examine operating parameters.
   b) Provide starter status information.
   c) Provide real-time information about line current, voltage, and frequency.
   d) Provide a means to start and stop the starter

c. Pad-lockable operating handle when de-energized.
d. Unit door interlocked to prevent opening when disconnect is in closed position.
e. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.

f. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

8. Two Speed Starters:
   a. Two Speed Starters shall be of the two-winding type unless otherwise indicated.
   b. Requirements set forth in paragraph 2.03 for enclosures and devices apply herein.
9. Disconnecting Device:
   a. In each starter, control circuit disconnect to de-energize circuits in unit which are not de-energized by starter power disconnect device.
   b. Pad-lockable in OPEN position.
10. Circuit Breaker:
   a. Meeting the requirements of NEMA AB1 and UL 489.
   b. Molded case with manufacturer's recommended trip setting for maximum motor protection.
   c. Magnetic trip only.
   d. Tripping indicated by operating-handle position.
   e. Interrupting capacity required for connection to system with short circuit capacity indicated.
11. Fused Switch:
   a. Heavy-duty, motor rated load-break, quick-make, quick-break type meeting the requirements of UL 98 and NEMA KS 1.
   b. Current-limiting fuses, with rejection clips.
12. Load Detector Relay:
   a. Manual reset with adjustable differential.
   b. Manufacturer:
      1) Cutler-Hammer; Type D60LA.
      2) Allen-Bradley; Bulletin 2100.
13. Motor Overload Protection:
   a. Direct current sensing solid-state overload protection in all ungrounded phases.
   b. Manual-reset overload relays.
14. Motor Thermal Protector Interface: Manual-reset interposing relay for connection to motor-mounted thermal protector system.
15. Ground Fault Protection: Where indicated and as specified in paragraph Feeder Units and Main Protective Device, except provide instantaneous operation device.
16. Capacitor Connection: Terminals to allow easy connection of power factor correction capacitors on source side of starter overload relays on starters where capacitor connection is shown.

F. Control Unit:
1. Disconnecting Device: Capable of de-energizing external source control circuits in unit.
2. Control Devices: As indicated and as specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.
3. Control Wiring:
   a. Minimum wire size 14 AWG copper.
   b. Permanent sleeve type markers with wire numbers applied to each end of wires.
   c. Terminate wires using insulated locking fork or ring type crimp terminals.
   d. Terminate current transformer leads on shorting type terminal blocks.

G. Incoming Line Terminal:
   1. Construction: As specified in Paragraph Motor Controller Unit.
   2. Incoming Service Feeder: Cable entering section as shown.
   3. Maximum short-circuit rating of 65,000 amperes.
   4. Mechanical type CU-/AL lugs for 75 degrees C cable.

H. Feeder Unit and Main Protective Device:
   1. Construction: As specified in Paragraph Motor Controller Unit.
   2. Incoming Service Feeder: Cable entering section as shown.
   3. Molded Case Circuit Breaker:
      a. In accordance with NEMA AB 1 and UL 489.
      b. Main and feeder protective device.
      c. UL labeled as suitable for service entrance.
      d. Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.
      e. Indicate tripping by operating-handle position.
      f. Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.
      g. Circuit breakers having a frame size of 150 amperes or less shall be molded-case type with thermal magnetic non-interchangeable, trip-free, sealed trip units.
      h. Circuit breakers with a frame size of 225 amperes to 1,200 amperes shall be molded case with interchangeable thermal and adjustable magnetic trip or RMS sensing electronic trip elements.
      i. The interrupting capacity of all main, and feeder branch circuit breakers shall be a minimum of 65,000 RMS symmetrical amperes. Service disconnects rated 1000A or more shall provide ground fault protection of equipment.
   4. Ground Fault Protection:
      a. Suitable for 480-volt, three-phase, three-wire, solidly grounded wye system.
      b. Ground sensors to encircle all phase conductors and neutral conductor where used and connected to ground relays with adjustable pickup settings and time-current characteristics indicated.
      c. Circuit breaker shunt trip and relay operating from fused 120-volt ac control source within control center.
      d. Manufacturers:
         1) Ground Fault System ITE; Ground Shield.
         2) General Electric; Ground Break.
   5. Phase Monitoring Relay:
      a. Three-phase monitoring relay to protect against low voltage, voltage unbalance, and phase reversal.
      b. Manufacturer: Furnas; Class 47.

I. Instruments:
   1. Provide solid state type metering where indicated. Include CT's and PT's of ratios as indicated.
      a. Solid state “metering” shall include but not be limited to the following functions:
         1) Metering: Device shall monitor Voltage (VLL/VLN), Current (Amps per phase), Real Power (W), Reactive Power (VAR) and Apparent

Power (VA). Device shall have data gathering ability for analysis. The device(s) shall conform to the requirements of UL 508.

2) Alarms:Device shall utilize assignable output relays to trigger alarms for specific applications. Alarm messages shall be displayed on the front panel of the device. Alarm outputs via dry contacts shall alarm Over/Under Current, Over/Under Voltage, Current Unbalance/Neutral Current, Phase Sequence, Over/Under Frequency, Power Factor and Switch Inputs.

3) Communications: Device shall be able to communicate with current and future process control systems using standard protocols such as Devicenet, Ethernet, Modbus, Profibus, or as called for on project drawings. Front and rear panel communications ports shall be available for information access. Display of monitored values shall be available both locally and remotely.

J. Pushbuttons, selector switches, and pilot lights shall be the heavy-duty, oil-tight type, sized to 30 mm. Miniature style devices are not acceptable. All devices shall conform to the requirements of UL 508.
   1. Lens colors for “run”, “stop”, “on”, “off”, “open”, and “closed” shall be coordinated with the District’s requirements.
   2. Pilot lights shall be LED, push-to-test type.
   3. Provide hazardous location type pilot devices in classified locations per the NEC.

K. Elapsed Time Meters: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

L. Time Delay Relays: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

M. Relays shall be 3 PDT with 10 amp contacts, plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips.

N. Reset Timers: As specified in Section 16050, BASIC ELECTRICAL MATERIALS AND METHODS.

O. Nameplates:
   1. Laminated plastic; white, engraved to black core.
   2. Provide for each motor control center and each unit.
   3. Engrave with inscription shown on single-line diagram.
   4. Provide blank nameplates on spaces for future units.
   5. Attach with stainless steel pan head screws on face of control center.

P. Factory Testing: NEMA ICS 1, Section 109.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with NEMA ICS 2.3, Submittal Drawings, and Manufacturer's Instructions and Recommendations.

B. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Install equipment plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

E. Grout mounting channels into floor or mounting pads.

F. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.

G. Motor control centers shall be installed on 3-1/2-inch concrete pads. After leveling and shimming, the CONTRACTOR shall anchor motor control centers to concrete pads, and shall grout so that no space exists between the pad and support beams.

H. The CONTRACTOR shall:
   a. Torque all bus bar bolts to manufacturer's recommendations. Tighten all sheet metal and structure assembly bolts.
   b. Adjust all Motor Circuit Protector (MCP) devices to the instantaneous trip setting position recommended for the actual horsepower and full load amps of the motor. Verify that overload devices are proper for equipment installed; make necessary changes in overload devices as required for motors having power factor correcting capacitors.
   c. After equipment is installed, touch up scratches and verify that nameplate, and other identification is accurate.
   d. Provide high voltage switchboard matting in front of the MCC. The mat shall be 1/4-inch thick and 36-inches wide.

3.02 TESTING

A. A. Factory Test: All motor control centers, micro processor based soft starters and their components shall be given manufacturer's standard electrical and mechanical production tests and inspections. The tests shall include electrical continuity check, dielectric tests for each circuit, and inspection for proper functioning of all components including controls, protective devices, metering, and alarm devices.

B. Field Test MCC:
   1. Visual and mechanical inspection after installation
      a. Inspect for physical damage, proper anchorage, and grounding
      b. Verify that the ratings of the solid state overload relays match the motor full-load current nameplate data.
      c. Check tightness of bolted connections.

C. Electrical Tests

   1. Insulation tests
      a. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute. Test voltage and minimum acceptable resistance shall be in accordance with manufacturer's recommendations.
      b. Measure insulation resistance of each starter section phase to phase and phase to ground with the starter contacts closed and the protective device

open. Test voltage and minimum acceptable resistance shall be in accordance with the manufacturer's recommendations.

c. Measure insulation resistance of each control circuit with respect to ground

2. Verify proper operation of control logic in all modes of control.

3.03 CIRCUIT BREAKERS

A. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.

B. Adjust to approximately Il times motor rated current.

C. Determine motor rated current from motor nameplate following installation.

3.04 OVERLOAD RELAY

A. Adjust overload relays after the actual nameplate full-load current rating of motor has been determined.

3.05 MOTOR DATA

A. Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
   1. Motor served by tag number and equipment name.
   2. Nameplate horsepower.
   3. Motor code letter.
   4. Full load amperes.
   5. Service factor.
   6. Installed overload relay heater catalog number.

3.06 MANUFACTURERS' SERVICES

A. Furnish manufacturer's representative in accordance for the following services at jobsite or classroom as designated by OWNER, for minimum person-days listed below, travel time excluded:
   1. 1 person-day for installation assistance, and inspection of installation.
   2. 1 person-day for functional and performance testing.
   3. 1 person-day for plant startup.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install lighting fixtures, and accessories for all lighting systems, complete and operable, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Electrical General Provisions.

1.03 REFERENCES

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section:
   1. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
   4. 595, Standard for Safety Marine-Type Electric Lighting Fixtures.
   5. 844, Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
   6. 924, Standard for Safety Emergency Lighting and Power Equipment.
   7. ANSI C82.1-1977 Specifications for Fluorescent Lamp Ballasts
   8. ANSI C84.4-1978 Specifications for High Intensity Discharge Lamp Ballast (Multiple Supply Type)
   9. Standards of the Certified Ballast Manufacturers Association

1.04 SUBMITTALS

A. The Contractor shall submit the following in accordance with the requirements of the Section entitled "Submittals."
   1. Shop drawings and catalog data:
      a. Interior Luminaires:
         1) Catalog data sheets and pictures.
         2) Luminaire finish and metal gauge.
         3) Lens material, pattern, and thickness.
         4) Candle power distribution curves in two or more planes.
         5) Candle power chart 0 to 90 degrees.
         6) Lumen output chart.
         7) Average maximum brightness data in foot-lamberts.
         8) Coefficients of utilization for zonal cavity calculations.
         9) Mounting or suspension details.

10) Heat exchange and air handling data.

b. Exterior Luminaires:
   1) Catalog data sheets and pictures.
   2) Luminaire finish and metal gauge.
   3) Lens material, pattern, and thickness.
   4) IES lighting classification and isolux diagram.
   5) Fastening details to wall or pole.
   6) Ballast type, location, and method of fastening.
   7) For light poles, submit wind loading, complete dimensions, and finish.

c. Lamps:
   1) Voltages.
   2) Colors.
   3) Approximate life (in hours).
   4) Approximate initial lumens.
   5) Lumen maintenance curve.
   6) Lamp type and base.
   7) Copy of lamp order, including individual quantities, for Project.

d. Ballasts:
   1) Type.
   2) Wiring diagram.
   3) Nominal watts and input watts.
   4) Input voltage and power factor.
   5) Starting current, line current, and re-strike current values.
   6) Sound rating.
   7) Temperature rating.
   8) Efficiency ratings.
   9) Low temperature characteristics.
   10) Emergency ballasts rating and capacity data.

e. Photo-Time Control:
   1) Wiring diagram.
   2) Contact ratings.

f. Photocells:
   1) Voltage, and power consumption.
   2) Capacity.
   3) Contacts and time delay.
   4) Operating levels.
   5) Enclosure type and dimensions.
   6) Temperature range.

2. Complete literature for each fixture substitution. Photoelectric data shall include coefficients of utilization, average brightness, candle power distribution curves, and lumen output chart. Substitutions for specified fixtures shall be based upon quality of construction, light distribution, appearance, and maintenance. Other makes of fixtures than those specified will be approved by the Engineer provided they are judged equal in all respects to the type specified

3. For exterior pole mounted applications, submit calculations signed and sealed by a professional structural engineer registered in the State of Florida, certifying that the outdoor pole and fixture installation, including pole, fixture, base and installation method will meet the appropriate wind loading criteria given by the Florida Building Code for the wind zone in which the assembly will be installed.

1.05 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.06 QUALITY ASSURANCE

A. Exterior lighting system operation shall be demonstrated during the hours of darkness to indicate that fixtures are properly focused, photo-cell operation is correct, and that fixture switching functions as intended. Similar requirements shall apply to interior lighting. Through demonstration, the Contractor shall also verify that panel schedules properly indicate the lighting outlets connected to each circuit.

B. Lighting demonstration shall occur within 2 weeks prior to project acceptance.

C. Lighting fixtures shall be stored in their original cartons from the manufacturers until the time of installation. Fixtures poles shall be stored on blocks above grade until the time of installation.

1.07 CLEANUP

A. Fixture lenses, diffusers and reflects shall be cleaned just prior to the time specified for the system demonstrations.

B. Contractor shall re-lamp all lighting fixtures with new lamps 30 days prior to acceptance.

C. Fixture trim, including poles and support brackets, where finish has been damaged, shall be refinished.

PART 2 PRODUCTS

2.01 FIXTURES - GENERAL

A. All fixtures shall be pre-wired with leads for connection to building circuits.

B. All fluorescent and HID fixtures shall be provided with internal fuses, whether indicated on the lighting fixture schedule or not.

2.02 EXTERIOR FIXTURES

A. Exterior fixtures and pole assemblies, in combination with their method of installation, shall be capable of meeting the wind loading criteria for the wind zone of installation as defined in the Florida Building Code. The wind loading requirement shall apply to the entire assembly including foundation (or base) and earthen materials used to secure the foundation or base. The calculation required under section 1.04.A.3 shall include this analysis.

B. Exterior fixtures shall have corrosion-resistant hardware and hinged doors or lens retainer. Fixtures specified to be furnished with integral photo-electrical control shall be of the fixture manufacturer's standard design.

2.03 INTERIOR FIXTURES

A. Interior fluorescent fixtures without diffusers shall be furnished with end plates. Where diffusers are required, they shall be of high molecular strength acrylic. Minimum thickness of the acrylic shall be 0.125 inches for all diffusers, except that those on 4 foot square fixtures

2.04 LUMINAIRES

A. Specific requirements relative to execution of Work of this section are located in the Luminaire Schedule on Drawings.

B. Feed-through type or separate junction box.

C. Ballasts: Two-lamp when possible.

D. Tandem wired for three-lamp, fluorescent fixtures.

E. Wire Leads: Minimum 18 AWG.

F. Component Access: Accessible and replaceable without removing luminaire from ceiling.

G. Soffit Installations:
   1. UL Labeled: SUITABLE FOR DAMP LOCATIONS.
   2. Ballast: Removable, pre-wired.

H. Exterior Installations:
   1. UL Labeled: SUITABLE FOR WET LOCATIONS.
   2. Ballast: Removable, pre-wired.
   3. When factory-installed photocells are provided, entire assembly shall have UL label.

I. Emergency Lighting:
   1. Power Pack: Self-contained, 120-volt transformer, inverter/charger, sealed nickel cadmium battery, and indicator switch in accordance with UL 924.
   2. Lighted push-to-test indicator.
   3. Capable of providing full illumination for 1-1/2 hours in emergency mode.
   4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
   5. Capable of protecting against excess charging and discharging.

J. Lamps
   1. Fluorescent:
      a. Type Efficiency: Energy.
      b. Color: Cool white.
   2. High Intensity Discharge:
      a. Type: Metal Halide.
      b. Color: Color corrected.
   3. Manufacturers:
      a. General Electric.
      b. Sylvania.
      c. North American Phillips.

K. Ballasts
   1. General:
   2. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
   3. Certified by electrical testing laboratories to conform to Certified Ballast Manufacturer's specifications.
   4. Fluorescent:
      a. Type: High power factor, energy efficient, rapid-start and instant-start type ballast, compatible with lamps specified.
      b. Sound Rating: Minimum A, maximum allowable noise level of 30 decibels measured 2 feet from installed fixture.
      c. Class: P.
      d. Automatic resetting, thermo-protector to prevent case temperature from exceeding 110 degrees C in the event of a short circuit.
   5. High Pressure Sodium:
      a. High power factor, normal ambient, 180 degrees C insulation class, with capacitor and igniter.
      b. Type:
         1) Autotransformer for 50-watt lamps.
      c. Constant wattage autotransformer for lamps 70 watts and above.
      d. Manufacturers:
         1) Magnetek Jefferson.
         2) Advance Transformer.
         3) Universal.
   6. Metal Halide:
      a. The Metal Halide Electronic Ballast shall not have more than +/- 0.5% variation in output power with a +/- 10% variation in input line voltage and shall not have more than +/- 3% variation in output power within all ranges of accepted ANSI lamp voltages.
      b. Electronic Ballast shall have a 'square wave' output whose frequency does not exceed 200 Hz and be equipped with a safety shutdown feature to prevent excessive pulsing of failed lamps.
      c. Electronic Ballast shall comply with FCC Part 18C, Class A. Furthermore, the manufacturer must show documentation showing that the ballast meets or exceeds the non-consumer limits for EMI & RFI.
      d. Electronic Ballast shall:
         1) Have a Total Harmonic Distortion (THD) of less than 10%.
         2) Have a Lamp Crest Factor of less than 1.3.
         3) Have a Power Factor of 95% or greater.
         4) Be sound rated "A".
         5) Be thermally protected to shut off when Temperatures reach unacceptable levels.
      e. The Electronic Ballast shall be UL Listed and shall carry a Five (5) Year Warranty.
      f. For down light fixtures, the Metal Halide Electronic Ballast shall be marked "Suitable for recessed use".
      g. The specified lamps shall be approved or warranted by the lamp manufacturer for use on the designated Metal Halide Electronic Ballast.
      h. The minimum rating of the Power Supply Electrolytic Capacitor(s) shall be 5000 hours at 105 degrees Celsius.

L. Lighting Control

1. Photocell:
    a. Automatic ON/OFF switching photo control.
    b. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
    c. Setting: ON at dusk and OFF at dawn.
    d. Time delay feature to prevent false switching.
    e. Field adjustable to control operating levels.
    f. Manufacturers:
        1) Tork.
        2) Paragon.

M. Poles
1. Rating (with Luminaire): Shall meet Florida Building Code and ASCE 7-98 requirements for wind zone of installation.
2. Material: Extruded aluminum or concrete.

PART 3 EXECUTION

3.01 LIGHTING FIXTURES

A. Lighting fixtures shall be furnished complete with lamps at each outlet in accordance with the Fixture Schedule.

B. Lighting fixtures shall be installed plumb and square with building and wall intersections. Pendant-mounted fixtures which are mounted from sloping ceilings shall be suspended by ball hangers. Fixtures installed in machinery rooms shall be located after machines have been installed. In all cases, fixture locations shall be coordinated with work of other trades to prevent obstruction of light from the fixtures. Fixtures shall be installed in accordance with the architectural reflected ceiling drawings. Unless otherwise indicated, fixtures shall be centered on ceiling tiles. All fixtures and outlets shall be rigidly supported from the building structure or rigid conduit.

C. Recessed fixtures shall be installed light-tight to the ceiling and shall be provided with auxiliary safety supports attached directly to the building structure. Said safety supports shall consist of #10 AWG soft drawn galvanized wires.

3.02 LUMINAIRES

A. General:
1. Install in accordance with manufacturer's recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount.
4. Install plumb and level.
5. Mounting heights shown for wall mounted or pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
6. Install each luminaire outlet box with galvanized stud.

B. Pendant Mounted:
   1. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
   2. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
   3. Provide twin-stem hangers on single luminaires.

C. Pole Mounted:
   1. Provide precast concrete base or pre-cast concrete pole as described in the drawings.
   2. Provide branch circuit in-line fuses in pole base handhole.

D. Swinging Type:
   1. Provide, at each support, safety cable capable of supporting four times the vertical load from the structure to the luminaire.

E. Finished Areas:
   1. Install symmetrically with tile pattern.
   2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
   3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.
   4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
   5. Junction Boxes:
      a. Flush and Recessed Luminaires: Locate minimum 1 foot from luminaire.
      b. In concealed locations, install junction boxes to be accessible by removing luminaire.
      c. Wiring and Conduit:
      d. Provide wiring of temperature rating required by luminaire.
      e. Provide flexible steel conduit.
      f. Provide plaster frames when required by ceiling construction.
   6. Independent Supports:
      a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
      b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
      c. Fasten chain or wire to each end of luminaire.

F. Unfinished Areas: Locate luminaires to avoid either conflict with other building systems or blockage of luminaire light output.
   1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.
   2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

G. Lamps
   1. Provide in each fixture, the number and type for which the fixture is designed, unless otherwise noted.

H. Ballasts
   1. Install in accordance with manufacturer's recommendations.
   2. Utilize all ballast mounting holes to fasten securely within luminaire.
   3. Replace noisy or defective ballasts.

I. Lighting Control
   1. Outdoor Luminaires: Photocells with time clocks will switch lights ON at dusk and OFF at a set time.

J. Cleaning Following Construction
   1. Remove all labels and other markings, except UL listing mark.
   2. Wipe luminaires inside and out to remove construction dust.
   3. Clean luminaire plastic lenses with anti-static cleaners only.
   4. Touch up all painted surfaces of luminaires and poles with matching paint ordered from manufacturer.
   5. Replace all defective lamps at time of Substantial Completion.

3.03 COORDINATION

A. The Contractor shall coordinate lighting fixture locations with all other disciplines. In case light fixtures are covered by pipe or other equipment, fixtures shall be moved with no cost to the Owner to provide for lighting level on the floor as indicated.

END OF SECTION