



**INVITATION FOR BID
IFB # 16-1006CD
SOUTHWEST WATER RECLAMATION FACILITY RECHARGE WELL
SYSTEM INFRASTRUCTURE**

Manatee County, a political subdivision of the State of Florida, (hereinafter "Owner") 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 ensure all prospective bidders have sufficient information and understanding of Owner's needs, an Information Conference will be held at: **9:00 AM on March 11, 2016** at the **Southwest Water Reclamation Facility Conference Room, 5101 65th Street West, Bradenton, FL 34210**. A site inspection shall take place immediately following the information conference. Attendance is not mandatory, but is highly encouraged.

DEADLINE FOR CLARIFICATION REQUESTS: **5:00 PM on March 22, 2016**
Reference Bid Article A.06

BID OPENING TIME AND DATE DUE: **3:00 PM on April 4, 2016**

FOR INFORMATION CONTACT:

Chris Daley, CPPO, CPPB, Contract Specialist
(941) 749-3048

chris.daley@mymanatee.org

Manatee County Financial Management Department
Purchasing Division

AUTHORIZED FOR RELEASE: DWW

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Technical Specifications (dated <u>March 2016</u>)	633 pages
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SECTION A **INFORMATION TO BIDDERS**

A.01 OPENING LOCATION

Sealed bids will be **publicly opened** at the **Manatee County Purchasing Division, 1112 Manatee Avenue West, Suite 803, Bradenton, Florida 34205** in the presence of Owner officials at the time and date stated, or soon thereafter. All bidders or their representatives are invited to attend the sealed bid opening.

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. Bidder shall be solely and strictly responsible for its timely delivery to the Purchasing Division. Bids delayed by mail, courier, or bids delayed for any other reason, shall not be considered, shall not be opened at the public opening, and arrangements shall be made for their return at the bidder's request and expense.

A.02 SEALED & MARKED

Bids shall be submitted in **duplicate, one original (marked Original) and one copy/copies (marked Copy)** of your **signed bid** shall be submitted in one **sealed** package, clearly marked on the outside **"Sealed Bid #16-1006CD- Southwest Water Reclamation Facility Recharge Well System Infrastructure"** along with your company name.

For your convenience, a mailing label is provided with this Invitation for Bid (IFB) package. Or, you may address the package as follows:

Manatee County Purchasing Division
1112 Manatee Avenue West, Suite 803
Bradenton, Florida 34205
Sealed Bid #16-1006CD- Southwest Water Reclamation Facility
Recharge Well System Infrastructure

All blank spaces on the bid form 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 thereupon. 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 the requirements of this IFB.

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.

A.03 SECURING BID DOCUMENTS

IFB's and related documents are available on <http://www.mymanatee.org/purchasing> for download in a portable document format (.PDF) file by clicking on "Bids and Proposals" from the Purchasing Division's web page. You may view and print these files using Adobe Reader software. If necessary, you may download a free copy of Adobe Reader from the link provided on the "Bids and Proposals" page.

Additionally, Manatee County collaborates with the Manatee Chamber of Commerce by announcing solicitation opportunities to the Chamber which are then passed to its members.

Manatee County may also use DemandStar to distribute bids. On the DemandStar website, <http://www.DemandStar.com>, click on the tab titled "My DemandStar" for more information regarding this service. Participation in the DemandStar system is not a requirement for doing business with Manatee County.

Complete copies of the IFB and all related documents are available for public inspection at the Manatee County Purchasing Division, 1112 Manatee Avenue West, Suite 803, Bradenton, FL 34205, or by calling (941) 749-3014. Appointments are encouraged. Documents are available between the hours of 9:00 AM and 4:00 PM Monday through Friday, with the exception of holidays. A complete set of the IFB documents must be used in preparing bids. Owner assumes no responsibility for errors and misinterpretations resulting from the use of incomplete sets of bid documents.

A.04 EXAMINATION OF BID DOCUMENTS AND SITE(S)

It is the responsibility of each bidder before submitting a bid, to (a) examine the IFB documents thoroughly; (b) visit the Project Site(s) 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 IFB documents; and (e) notify Owner of all conflicts, errors, or discrepancies in the IFB documents.

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 Project Site(s) 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 IFB documents. Owner will provide each bidder access to the site(s) to conduct such explorations and tests.

Bidder shall fill all holes, clean up and restore the Project Site(s) 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 successful bidder in performing the Work are identified in the IFB documents.

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

Inspection of the Project Site(s) is **a requirement** to be considered for award of this bid. Prior to submitting a bid, each bidder shall examine the Project Site(s) and all conditions thereon fully familiarizing themselves with the full scope of the Work. Failure to become familiar with Project 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 Project Plans and Specifications. Bidder shall acknowledge inspection of the Project Site(s) on his/her signed, submitted Bid Form.

A.05 MODIFICATION OF BID DOCUMENTS

If a bidder wishes to recommend changes to the IFB documents, the bidder shall furnish, in writing, data and information necessary to aid Owner in evaluating the request to modify the IFB documents. Owner is not obligated to make any changes to the IFB documents. Unless an addendum is issued, the IFB documents shall remain unaltered. **Bidders must fully comply with the IFB documents in their entirety.**

A.06 CLARIFICATION & ADDENDA

Each bidder shall examine all IFB documents and shall judge all matters relating to their adequacy and accuracy. Any inquiries, suggestions or requests concerning interpretation, clarification or additional information pertaining to this IFB shall be made through the Manatee County Purchasing Division. Owner shall not be responsible for oral interpretations given by any Owner employee, representative, or others.

5:00 PM on March 22, 2016 shall be the deadline to submit to the Purchasing Division, in writing, all inquiries, suggestions, or requests concerning interpretation, clarification or additional information pertaining to this IFB.

This deadline has been established to maintain fair treatment of all potential bidders, while maintaining progression of the Work.

If any addenda are issued to this IFB, Owner will post the documents on the Purchasing Division's web page at <http://www.mymanatee.org/purchasing>, and then by clicking on "Bids and Proposals". If the original solicitation was broadcast via DemandStar, the addenda will also be broadcast on the DemandStar distribution system to "Planholders" on this web service.

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

It shall be the **responsibility of each bidder, prior to submitting a bid**, to contact the Purchasing Division (see contact information on the cover page) to **determine if any addenda were issued** and to make such addenda a part of their bid.

A.07 LOBBYING

After the issuance of any IFB, prospective bidders or their agents, representatives or persons acting at the request of such bidder shall not contact, communicate with or discuss any matter relating to the IFB with any officer, agent or employee of Manatee County other than the Purchasing Official or the contact identified in this IFB, pursuant to the Manatee County Code of Laws. This prohibition includes copying such persons on all written communication, including email correspondence. This requirement begins with the issuance of an IFB and ends upon execution of the final Agreement or when the IFB has been cancelled. Violators of this prohibition shall be subject to sanctions as provided in the Manatee County Code of Laws.

A.08 UNBALANCED BIDDING PROHIBITED

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

- a. Bids showing omissions, alterations of form, additions not specified, or required conditional or unauthorized alternate bids.
- b. 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.
- c. Bids where the unit costs offered are in excess of or below reasonable cost analysis values.

In the event Owner 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 its bid. Owner reserves the right to reject as nonresponsive any presumptive unbalanced bids where the bidder is unable to demonstrate the validity and/or necessity of the unbalanced unit costs.

A.09 FRONT LOADING OF BID PRICING PROHIBITED

Prices offered for performance and/or acquisition activities which 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 loaded. Front loaded bids could reasonably appear to be an attempt to obtain unjustified early payments creating a risk of insufficient incentive for the bidder to complete the Work or otherwise creating an appearance of an undercapitalized bidder.

In the event Owner determines that a bid is presumed to be front 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. Owner reserves the right to reject as nonresponsive any presumptive front loaded bids where the bidder is unable to demonstrate the validity and/or necessity of the front loaded costs.

A.10 WITHDRAWAL OF BIDS

Bidders may withdraw bids as follows:

- a. Mistakes discovered before the public bid opening may be withdrawn by written notice from the bidder submitting the bid. This request must be received in the Purchasing Division prior to the time set for delivery and opening of the bids. A copy of the request shall be retained and the unopened bid returned to the bidder; or
- b. After the bids are opened or a selection has been determined, but before an Agreement is signed, a bidder alleging a material mistake of fact may be permitted to withdraw their bid if:
 1. The mistake is clearly evident in the solicitation document; or
 2. Bidder submits evidence which clearly and convincingly demonstrates that a mistake was made. Request to withdraw a bid must be in writing and approved by the Purchasing Official.

A.11 IRREVOCABLE OFFER

Any bid may be withdrawn up until the time and date 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 IFB until one or more of the bids have been duly accepted by Owner.

A.12 BID EXPENSES

All expenses for making bids to Owner are to be borne by the bidder.

A.13 RESERVED RIGHTS

Owner reserves the right to accept or reject any and/or all bids, to waive irregularities and technicalities, and to request resubmission. Also, Owner 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 Owner. Any sole response received by the first submission date may or may not be rejected by Owner depending on available competition and current needs of Owner. 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 IFB documents or otherwise required by Owner.

To be responsive, a bidder shall submit a bid which conforms in all material respects to the requirements set forth in the IFB.

To be a responsible bidder, the bidder shall have the capability in all respects to perform fully the bid requirements, and the tenacity, perseverance, experience, integrity, reliability, capacity, facilities, equipment, and credit which will assure good faith performance.

Also, Owner reserves the right to make such investigation as it deems necessary to determine the ability of any bidder to furnish the service requested. Information Owner 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.14 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 the Manatee County Purchasing Division shall be in accordance with the Manatee County Purchasing Ordinance as amended.

A.15 COLLUSION

By submitting a bid to this IFB, bidder certifies that it has not divulged, discussed or compared its bid with any 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. 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 resulting Agreement to be entered into; and
- e. no person or agency has been employed or retained to solicit or secure the resulting Agreement upon an agreement or understanding or a commission, percentage, brokerage, or contingent fee except bona fide employees or established commercial agencies maintained by bidder for purpose of doing business.

A.16 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 Chapter 112, Part III, Code of Ethics for Public Officers and Employees, Florida Statutes, such bidder will be disqualified from eligibility to perform the Work described in this IFB, 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 Owner that all statements made and materials submitted are truthful, with no relevant facts withheld. If a bidder is determined to have been untruthful in their bid or any related presentation, such bidder will be disqualified from eligibility to perform the Work described in this IFB, 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.17 PUBLIC CONTRACTING AND ENVIRONMENTAL CRIMES

A person or affiliate who has been placed on the convicted vendor list following a conviction for a public entity crime, as that term is defined in Section 287.133, Florida Statutes, may not submit a bid to provide any goods or services to a public entity; may not submit a bid with a public entity for the construction or repair of a public building or public work; may not submit bids on leases of real property to a public entity; may not be awarded or perform Work as a contractor, supplier, Subcontractor, or consultant under an agreement with any public entity; and may not transact business with any public entity in excess of the threshold amount provided in Section 287.017, Florida Statutes, 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 bid 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 ensure compliance with the foregoing, the Code requires all persons or entities desiring to do business with Owner 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 Owner. 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 herein for this purpose.

A.18 BID FORMS

Bids must be submitted on the provided 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 bid and bind the company. Bidders must fully comply with all requirements of this IFB in its entirety.** Failure to comply shall result in bidder being deemed nonresponsive.

A.19 AGREEMENT FORMS

The Agreement resulting from the Acceptance of a bid shall be in the form of the Agreement stated in this IFB, which is attached herein.

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 Owner. (Note: Agreement must be approved in accordance with Chapter 2-26 of the Manatee County Code of Laws and the Administrative Standards and Procedures Manual approved by the County Administrator).

A.20 LEGAL NAME

Bids shall clearly indicate the legal name, address and telephone number of the bidder on the Bid Form. Bid Forms 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.

When bidder is a partnership, the Bid Form shall be signed in the name of the firm and by all partners required under the terms of the partnership agreement. When a corporation is a bidder, the authorized corporate officers shall sign.

Bidders who are corporations or limited partnerships shall provide a certified copy of their permit to transact business in the State of Florida, preferably along with the Bid Form, or within forty-eight (48) hours after request by Owner.

When submitting a bid as a joint venture, it must have filed paper documents with the Division of Profession's Construction Industry Licensing Board prior to submitting a bid.

A.21 DISCOUNTS

Any and all discounts must be incorporated in the prices contained in the bid and not shown separately. The prices indicated on the Bid Form shall be the prices used in determining award.

A.22 TAXES

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

The Contractor shall be responsible for the payment of taxes of any kind and character, including, but not limited to sales, consumer, use, and other similar taxes payable on account of the work performed and materials furnished under the award in accordance with the laws and Regulations of the place of the project which are applicable during the performance of the work. Nothing herein shall affect the bidder's normal tax liability.

A.23 DESCRIPTIVE INFORMATION

Unless otherwise specifically provided in the IFB documents, all equipment, materials and articles provided shall be new and of the most suitable grade for the purpose intended. Unless otherwise specifically provided in the IFB documents, 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 AUTHORIZED PRODUCT REPRESENTATION

The bidder, 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 Owner's sole discretion, be deemed a material breach of the resulting Agreement, and shall constitute grounds for Owner's immediate termination of the resulting Agreement.

A.25 ROYALTIES AND PATENTS

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

A.26 AMERICANS WITH DISABILITIES ACT

Owner does not discriminate upon the basis of any individual's disability status. This non-discrimination policy involves every aspect of Owner'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 cover page of this IFB document at least twenty-four (24) hours in advance of either activity.

A.27 EQUAL EMPLOYMENT OPPORTUNITY

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, Owner hereby notifies all bidders 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 bid award.

A.28 MBE/DBE

The State of Florida Office of Supplier Diversity provides the certification process and the database for identifying certified MBE/DBE 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.29 MATHEMATICAL ERRORS

Bid Forms without mathematical formulas:

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. In the event the dollar amount for contract contingency is omitted, it will be added to the total price of the bid.

Bid Forms with mathematical formulas:

Interactive Bid Forms that contain mathematical formulas may be used for automating lengthy and complex bid forms. In the event these forms are used and a multiplication/extension error(s) is discovered, the unit price entered by the vendor shall prevail. The vendor shall assume the responsibility and accuracy of the information input in the bid form and therefore shall verify that the calculations are correct before submitting their bid.

Regardless of which type of bid form is used, all bids shall be reviewed mathematically and corrected, if necessary, using these standards, prior to additional evaluation.

A.30 SUBCONTRACTORS

The successful bidder will obtain prior written approval from the County for any subcontractor(s) and the work they will perform. A subcontractor is defined as any entity performing work within the scope of the project who is not an employee of the successful bidder.

Bidders subcontracting any portion of the work shall include a list of subcontractors along with their bid. The list shall include: name and address of subcontractor, type of work to be performed and the percent of the contract amount to be subcontracted.

Prior to the employment of any person under this contract, the successful bidder shall utilize the U.S. Department of Homeland Security's E-Verify system to verify the employment eligibility of (a) all persons employed during the contract term by the successful bidder to perform employment duties within Florida and (b) all persons, including subcontractors, assigned by the successful bidder to perform work pursuant

to the contract with Manatee County. For more information on this process, please refer to United States Citizenship and Immigration Service site at: <http://www.uscis.gov/>.

Only those individuals determined eligible to work within the United States shall be employed under this contract.

By submission of a bid in response to this IFB, the successful bidder commits that all employees and subcontractors will undergo e-verification before placement on this contract.

If County has reasonable objection to any subcontractor, the County may request the successful bidder to submit an acceptable substitute without an increase in contract sum or contract time.

If successful bidder declines to make any such substitution, the County may award the resulting agreement to the next lowest qualified bidder that proposes to use acceptable subcontractors, who County does not make written objection to. In the event the successful bidder declines to make any such substitution post award, the County may exercise its right to terminate the agreement.

The successful bidder shall maintain sole responsibility for the actions of its employees and subcontractors. New employees brought in after contract award shall follow the same requirement stated above for the life of the contract.

A.31 DISCLOSURE

Upon receipt, all inquiries and responses to inquiries related to this IFB become "Public Records", and shall be subject to public disclosure consistent with Florida Statutes, Chapter 119.

Bids become subject to disclosure thirty (30) days after the opening or if a notice of intent to award decision is made earlier than this time as provided by Florida Statutes § 119.071(1)(b). No announcement or review of the bid shall be conducted at the public bid opening.

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

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

Pursuant to Section 119.0701, Florida Statutes, in any Agreement entered into by

Owner wherein the successful bidder is acting on behalf of Owner, successful bidder must:

- a. Keep and maintain public records that ordinarily and necessarily would be required by Owner in order to perform the service.
- b. Provide the public with access to public records on the same terms and conditions that Owner would provide and at a cost that does not exceed the cost provided in Florida Statutes, Chapter 119, or as otherwise provided by law.
- c. Ensure that public records that are exempt or confidential and exempt from public records disclosure requirements are not disclosed except as authorized by law.
- d. Meet all requirements for retaining public records and transfer, at no cost, to Owner all public records in possession of successful bidder upon termination of the awarded Agreement and/or PO and destroy any duplicate public records that are exempt or confidential from public records disclosure requirements. All records stored electronically must be provided to Owner in a format that is compatible with Owner's information technology systems.

A.32 LOCAL PREFERENCE

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.

Local preference shall not apply to the following categories of Agreements:

1. Purchases or Agreements 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.
2. 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.

To qualify for local preference under this section, **a local business must certify to Owner** by completing an “**Affidavit as to Local Business Form**”, which is available for download at www.mymanatee.org/vendor. Click on “Affidavit for Local Business” to access and print the form. Complete, notarize, and mail the notarized original to the following address: Manatee County Purchasing Division, 1112 Manatee Avenue West, Suite 803, Bradenton, FL 34205.

It is the responsibility of the bidder to ensure accuracy of the Affidavit as to Local Business and notify Owner of any changes affecting same.

A.33 VENDOR REGISTRATION

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.

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/purchasing

A link to Vendor Registration is listed on the Purchasing Division's web page under "Register as a Vendor". Click on "Vendor Registration Form" for on-line input.

Registration is not mandatory; however, by taking the time to register, you are helping Owner to provide timely notification of quotation, bid and proposal opportunities to your business.

A.34 ENVIRONMENTAL SUSTAINABILITY

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.

Bidders shall acknowledge whether or not their organization has an environmental sustainability initiative by checking the appropriate box on the bid form. In addition, the bidder shall submit a summary of their environmental sustainability initiative along with their bid. This information will be used as a determining factor in the award decision when all other evaluative factors, including local preference policies are otherwise equal.

A.35 ePAYABLES

Manatee County and Clerk of the Circuit Court have partnered to offer the ePayables program, which allows payments to be made to vendors via credit cards. The Clerk will issue a unique credit card number to each vendor; the card has a zero balance until payments have been authorized.

After goods are delivered or services rendered, vendors submit invoices to the remit to address on the purchase order according to the current process. When payments are authorized, an email notification is sent to the vendor. The email notification includes the invoice number(s), invoice date(s), and amount of payment. There is no cost for

vendors to participate in this program; however, there may be a charge by the company that processes your credit card transactions.

If you are interested in participating in this program, please complete the ePayables Application attached herein and return the completed form via email to Ms. Lori Bryan, Supervisor at lori.bryan@manateeclerk.com.

NOTE: ANY OR ALL STATEMENTS CONTAINED IN THE FOLLOWING SECTIONS: SCOPE OF WORK, BID SUMMARY, CONSTRUCTION AGREEMENT FOR STIPULATED SUM, AND GENERAL CONDITIONS OF THE CONSTRUCTION AGREEMENT, WHICH VARY FROM THE INFORMATION TO BIDDERS, SHALL HAVE PRECEDENCE.

END OF SECTION A

SECTION B **SCOPE OF WORK**

B.01 SCOPE OF WORK

The Work included in this Bid consists of furnishing all labor, materials, equipment and incidentals required to provide interconnection improvements for the recharge well system at the Manatee County Southwest Water Reclamation Facility as required by the specifications and plans included with this Invitation for Bids.

The construction of the recharge well system interconnections consist of, but are not limited to, the following:

- Recharge well head with material and equipment for operation of system
- 24-inch pipe between effluent pump station discharge header and the recharge well head
- Two (2) monitoring well heads; discharge piping with materials and equipment for a complete system
- An ammonium sulfate solution bulk storage tank with metering pumps, chemical piping, and injection system
- All civil, structural, electrical, instrumentation and control systems for complete operating systems,
- Project coordination with other ongoing projects at the facility.

The successful Bidder shall furnish all Shop Drawings, working drawings, labor, materials, equipment, tools, services and incidentals necessary to complete all Work required by the Invitation for Bids documents.

The successful Bidder 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 County.

The successful Bidder 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.

B.02 INSPECTION OF SITE

Inspection of the site(s) is **a requirement** to be considered for Award of this Bid. Prior to submitting a Bid, each Bidder shall examine the site(s) 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. Bidder shall acknowledge inspection of the Project site(s) on his/her signed, submitted Bid Form.

A site inspection will be conducted immediately following the informational conference. Bidders who are unable to inspect the site following the informational conference shall contact Tom Birk at (941)-792-8811 ext 5179 or Jeff Blosser at (941)-792-8811 ext 5184, between the hours of 8:00 AM and 2:00 PM Monday thru Friday, for coordination of the site visit.

B.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 **460 calendar days. Only one Award shall be made.**

B.04 LIQUIDATED DAMAGES

If the successful bidder fails to achieve Substantial Completion of the Work within the Contract Time and as otherwise required by the Contract Documents, the Owner shall be entitled to retain or recover from the successful bidder, as liquidated damages and not as a penalty, the sum of **\$1,742.00** per calendar day, commencing upon the first day following expiration of the Contract Time and continuing until the actual date of Substantial Completion. Such liquidated damages are hereby agreed to be a reasonable estimate of damages the Owner will incur as a result of delayed completion of the Work. The Owner may deduct liquidated damages as described in this paragraph from any unpaid amounts then or thereafter due the successful bidder under this Agreement. Any liquidated damages not so deducted from any unpaid amounts due the successful bidder shall be payable to the Owner at the demand of the Owner, together with interest from the date of the demand at the maximum allowable rate.

B.05 CONTRACT CONTINGENCY WORK

Contract contingency is a monetary allowance used solely at Owner's discretion to handle unexpected conditions as required to satisfactorily complete the Work in accordance with the IFB documents. A Field Directive must be issued by an authorized Owner representative to authorize use of contract contingency funds.

The percentage for contract contingency is listed on the Bid Form. Bidder shall enter the dollar amount for contract contingency based on the percentage of the total base bid. The total contract award will include contract contingency.

Appropriate uses of contract contingency include increases to existing bid item quantities that do not change the initial scope of Work, which may be directed by staff; modification items not originally bid which were unforeseen yet necessary during the Work to provide a safe, complete Project and that do not change the initial scope of Work; and unanticipated conflicts and/or design changes required during construction which are necessary to provide a safe, complete Project and that do not change the initial scope of Work.

Inappropriate uses of contract contingency include anything that changes the initial scope of Work, including the Contract Sum and Contract Time, and adding bid items not previously contemplated that change the initial scope of Work.

END OF SECTION B

SECTION C

BID SUMMARY

C.01 MINIMUM QUALIFICATIONS OF BIDDERS

No person who is not certified or registered as a General Contractor pursuant to Chapter 489, Florida Statutes, 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 Work. In the event that a bidder is a business organization, including a partnership, corporation, business trust or other legal entity as set forth in Section 489.119(2), Florida Statutes, then the bidder shall only be qualified to bid on this Work 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 Section 489.119, Florida Statutes, 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.

The Bidding Contractor (company supplying the Bid) shall have a minimum of three (3) years' experience in the construction of recharge and monitoring well heads, which is the subject of this Invitation for Bid, to be considered for award.

C.02 BASIS OF AWARD

Award shall be to the lowest, responsive, responsible Bidder having the lowest total offer 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 Bid Documents to 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, Owner 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. Owner 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 are equal with respect to price, and all other evaluative factors are otherwise equal, including local preference policies, if the company provides documented environmentally preferable "green" products, materials, or supplies, they 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, and neither of these bids provides documented “green” products, 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.

END OF SECTION C

SECTION D

INSURANCE AND BONDING REQUIREMENTS

The successful bidder will not commence Work under the resulting Agreement until all insurance under this section, and such insurance coverage as might be required by Owner, has been obtained. The successful bidder shall obtain, and submit to the Purchasing Division within ten (10) calendar days from the date of notice of intent to award, at his expense, the following minimum amounts of insurance (inclusive of any amounts provided by an umbrella or excess policy):

Insurance / Bond Type	Required Limits
1. <input checked="" type="checkbox"/> Automobile Liability:	Bodily Injury and Property Damage, Owned/Non-Owned/Hired; Automobile included \$ <u>1,000,000</u> each occurrence/ \$ <u>2,000,000</u> aggregate <i>This policy shall contain severability of interests' provisions.</i>
2. <input checked="" type="checkbox"/> Commercial General Liability: (Occurrence Form - patterned after the current ISO form)	Bodily Injury and Property Damage \$ <u>1,000,000</u> single limit per occurrence; \$ <u>2,000,000</u> aggregate This shall include Premises and Operations; Independent Contractors; Products and Completed Operations and Contractual Liability. <i>This policy shall contain severability of interests' provisions.</i>
3. <input checked="" type="checkbox"/> Employer's Liability:	\$ <u>100,000</u> single limit per occurrence
4. <input checked="" type="checkbox"/> Worker's Compensation:	Statutory Limits of Chapter 440, Florida Statutes, and all Federal Government Statutory Limits & Requirements
5. <input type="checkbox"/> Other Insurance, as noted:	<p>a. <input type="checkbox"/> Aircraft Liability \$ _____ per occurrence Coverage shall be carried in limits of not less than \$5,000,000 each occurrence if applicable to the completion of the services under this Agreement.</p> <p>b. <input type="checkbox"/> Installation Floater \$ _____ If the resulting Agreement does not include construction of or additions to above ground building or structures, but does involve the installation of machinery or equipment, successful bidder 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).</p> <p>c. <input type="checkbox"/> Maritime Coverage (Jones Act) \$ _____ per occurrence Coverage shall be maintained where applicable to the completion of the Work.</p>

Insurance / Bond Type	Required Limits
	<p>d. <input type="checkbox"/> Pollution \$ _____ per occurrence</p> <p>e. <input type="checkbox"/> Professional Liability \$ _____ per claim and in the aggregate</p> <ul style="list-style-type: none"> • \$1,000,000 per claim and in the aggregate • \$2,000,000 per claim and in the aggregate <p>f. <input type="checkbox"/> Project Professional Liability \$ _____ per occurrence</p> <p>g. <input type="checkbox"/> Property Insurance \$ _____</p> <p>If the resulting Agreement includes construction of or additions to above ground buildings or structures, bidder 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).</p> <p><i>To the extent that property damage is covered by commercial insurance, Owner and successful bidder agree to waive all subrogation rights against each other, except such rights as they may have to the proceeds of such insurance. Successful bidder shall require a similar waiver of subrogation from each of its bidder personnel and sub-consultants, to include Special Consultants; successful bidder shall provide satisfactory written confirmation to Owner of these additional waivers.</i></p> <p>h. <input type="checkbox"/> U.S. Longshoreman’s and Harborworker’s Act Coverage shall be maintained where applicable to the completion of the Work.</p> <p>i. <input type="checkbox"/> Valuable Papers Insurance \$ _____ per occurrence</p> <p>j. <input type="checkbox"/> Watercraft \$ _____ per occurrence</p>
6. <input checked="" type="checkbox"/> Bid Bond:	Bid bond shall be submitted by bidder for 5% of the total amount of the bid.
7. <input checked="" type="checkbox"/> Payment and Performance Bond:	Payment and Performance Bond shall be submitted by bidder for 100% of the award amount.

Reviewed by Risk: _____

INSURANCE REQUIREMENTS

The amounts and types of insurance coverage shall conform to the minimum requirements set forth in this Exhibit, with the use of Insurance Services Office (ISO) forms and endorsements or their equivalents. If successful bidder has any self-insured retentions or deductibles under any of the listed minimum required coverage, successful bidder must identify on the certificate of insurance the nature and amount of such self-insured retentions or deductibles and provide satisfactory evidence of financial responsibility for such obligations. All self-insured retentions or deductibles will be successful bidder's sole responsibility.

Nothing herein shall in any manner create any liability of Owner in connection with any claim against the successful bidder for labor, services, or materials, or of Subcontractors; and nothing herein shall limit the liability of the successful bidder or successful bidder's sureties to Owner or to any workers, suppliers, material men or employees in relation to the resulting Agreement.

Builder's Risk Coverage. The successful bidder shall procure and maintain during the entire course of the Work a builder's risk policy, completed value form, insured to provide coverage on an all risk basis, including coverage for off-site stored materials and including coverage for theft. This coverage shall not be lapsed or cancelled because of partial Acceptance by the Owner prior to final Acceptance of the Project. Successful bidder shall recommend to Owner any additions to the Project Costs resulting from any casualty described in Article XII General Conditions of the Construction Agreement, including those costs, expenses and other charges (including normal and ordinary compensation to the successful bidder) necessary for reconstruction of the Project substantially in accordance with the Project Plans and Specifications. The nature, level and type of builder's risk coverage (including completed value or replacement cost coverage) shall be determined by Owner through insurers selected by successful bidder and approved by Owner.

Excess Policy or Umbrella. An excess policy or umbrella may be used to cover limits over and above Commercial General Liability.

Subcontractor's Public Liability and Property Damage Insurance. The successful bidder shall require each Subcontractor to procure and maintain during the term of the subcontract, insurance of the type specified above, or insure the activities of Subcontractors in its policy, as approved by Owner prior to performance of any services. The levels of coverage as set forth in the table above may be adjusted to require a reduced level of coverage consistent with the scope of Work to be provided by that particular Subcontractor. Any reduction in the levels of insurance coverage required by the successful bidder's standard form of subcontract shall be approved by the Owner.

Waiver of Subrogation. Owner and successful bidder waive against each other and the Owner's separate Vendors, Contractors, Design Consultants, Subcontractors agents and employees of each and all of them, all damages covered by property insurance provided herein, except such rights as they may have to the proceeds of such insurance. The successful bidder and Owner shall, where appropriate, require similar waivers of subrogation from the Owner's separate Vendors, Design Consultants and Subcontractors and shall require each of them to include similar waivers in their contracts.

Worker's Compensation Insurance. The successful bidder shall procure and maintain during the term of the Contract Documents, workers' compensation insurance for all its employees connected with the Work and shall require all Subcontractors similarly to provide workers' compensation insurance for all their employees unless such employees are covered by the protection afforded by successful bidder. Such insurance shall comply with the Florida Workers' Compensation Law. The successful bidder shall provide adequate insurance, satisfactory to Owner, for the protection of employees not otherwise protected.

By way of its submission of a bid hereto, bidder:

- a. Represents that bidder maintains, and will maintain during the term of any Agreement arising from this solicitation, all insurance coverage required herein from responsible companies duly authorized to do business under the laws of the State of Florida that hold a rating of "A-" or better by Best's Key Guide, latest edition, and are deemed acceptable to Owner as set forth in this solicitation.
- b. Agrees that insurance, as specified herein, shall remain in force and effect without interruption from the date of commencement of the Work throughout the duration of the Project, and shall remain in effect for at least two (2) years after the termination of the Contract Documents.
- c. Agrees that if the initial or any subsequently issued certificate of insurance expires prior to completion of the Work, successful bidder shall furnish to Owner renewal or replacement certificate(s) of insurance no later than ten (10) calendar days after the expiration date on the certificate. Failure of successful bidder to provide Owner with such renewal certificate(s) shall be considered justification for Owner to terminate any and all Agreements.
- d. Agrees that bidder and/or its insurance carrier shall provide thirty (30) days written notice to Owner of policy cancellation or non-renewal on the part of the insurance carrier or the successful bidder. Successful bidder shall also notify Owner, in a like manner, within twenty-four (24) hours after receipt, of any notices of expiration, cancellation, non-renewal or material change in coverage or limits received by successful bidder from its insurer and nothing contained herein shall relieve successful bidder of this requirement to provide notice. In the event of a reduction in the aggregate limit of any policy to be provided by successful bidder hereunder, successful bidder shall immediately take steps to have the aggregate limit reinstated to the full extent permitted under such policy.
- e. Agrees that failure of successful bidder to obtain and maintain proper amounts of insurance at all times as called for herein shall constitute a material breach of the resulting Agreement, which may result in immediate termination.
- f. Agrees that, should at any time the successful bidder not maintain the insurance coverage(s) required herein, Owner may terminate the Agreement or at its sole discretion shall be authorized to purchase such coverage(s) and charge successful bidder for such coverage(s) purchased. If successful bidder fails to reimburse Owner for such costs within thirty (30) days after demand, Owner has the right to offset these costs from any amount due successful bidder under this Agreement or any other agreement between Owner and successful bidder. Owner shall be under no obligation to purchase such insurance, nor shall it be responsible for the coverage(s) purchased or the insurance companies used. The decision of Owner to purchase such insurance coverage(s) shall in no way be construed to be a waiver of any of its rights under the Contract Documents.
- g. Agrees to provide, upon request, the entire and complete insurance policies required herein.

- h. The payment of deductibles for insurance required of the successful bidder by the Contract Documents shall be the sole responsibility of the successful bidder.

Certificate of Insurance Requirements:

- a. Certificates of insurance in duplicate evidencing the insurance coverage specified herein shall be filed with the Purchasing Division 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, and must read: For any and all work performed on behalf of Manatee County.
- b. **Additional Insured:** The Automobile Liability and Commercial General Liability policies provided by the successful bidder to meet the requirements of this IFB shall name Manatee County, Board of County Commissioners, as an additional insured as to the operations of the successful bidder under this IFB and shall contain severability of interests provisions.
- c. 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 County Commissioners
Bradenton, FL
IFB# 16-1006CD, Southwest Water Reclamation Facility Recharge Well
Infrastructure
For any and all work performed on behalf of Manatee County.**
 2. Certificate shall be mailed to:
**Manatee County Purchasing Division
1112 Manatee Avenue West, Suite 803
Bradenton, FL 34205
Attn: Chris Daley, CPPO, CPPB, Contract Specialist**

BONDING REQUIREMENTS

Bid Bond/Certified Check. By submitting a bid to this IFB, the bidder agrees should the bidder's bid be accepted, **to execute the form of Agreement 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 Agreement **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 an Agreement, as prescribed by Manatee County, the bid bond/certified check accompanying the bid shall be forfeited to Manatee County as agreed liquidated damages. If Owner enters into an Agreement with a bidder, or if Owner rejects any and/or all bids, accompanying bond will be promptly returned.

Payment and Performance Bonds. Prior to commencing Work, the successful bidder shall obtain, for the benefit of and directed to Owner, a Payment and Performance Bond satisfying the requirements of Section 255.05, Florida Statutes, covering the faithful performance by the successful bidder of its obligation under the Contract Documents, including but not limited to the construction of the Project on the Project Site and the payment and obligations arising thereunder, including all payments to Subcontractors, laborers, and materialmen. The surety selected by the successful bidder to provide the Payment and Performance Bond shall be approved by Owner prior to issuance of such Bond, which approval shall not be unreasonably withheld or delayed provided that surety is rated A- or better by Best's Key Guide, latest edition.

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 Section 255.05, Florida Statutes, and must not contain notice, demand or other terms and conditions, including informal pre-claim meetings, not provided for in Section 255.05, Florida Statutes.

Surety of such bonds shall be in an amount equal to 100% of the Contract Price issued by a duly authorized and nationally recognized surety company, authorized to do business in the State of Florida, satisfactory to Owner. Surety shall be rated as "A-" or better by Best's Key Guide, latest edition. The attorney-in-fact who signs the bonds must file with the bonds, a certificate and effective dated copy of power-of-attorney. Payment and Performance Bonds shall be issued to Manatee County, a political subdivision of the State of Florida, **within ten (10) calendar days after notice of intent to award.**

In addition, pursuant to Section 255.05(1)(b), Florida Statutes, prior to commencing Work, the successful bidder shall be responsible and bear all costs associated to record the Payment and Performance 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 Section 255.05(1)(b), Florida Statutes, Owner will make no payment to the successful bidder until the successful bidder has complied with this paragraph.

Furnishing Payment and Performance Bonds shall be requisite to execution of an Agreement with Owner. Said Payment and Performance Bonds will remain in force for the duration of the Agreement with the premiums paid by the successful bidder. Failure of the successful bidder to execute such Agreement and to supply the required bonds shall be just cause for cancellation of the award. Owner may then contract with the next lowest, responsive and responsible bidder or re-advertise this IFB. 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 Owner at any time to require performance by the successful bidder of any provisions set out in the resulting Agreement will in no way affect the right of Owner, thereafter, to enforce those provisions.

BIDDER'S INSURANCE STATEMENT

THE UNDERSIGNED hereto have read and understand the aforementioned insurance requirements of this IFB and note that the evidence of insurability shall be required within ten (10) days from the date of notice of intent to award.

Bidder Name: _____ Date: _____

Bidder's Signature: _____

Print Name: _____

Insurance Agency: _____

Agent Name: _____ Agent Phone: _____

Please return this completed and signed statement with your bid.

BID FORM
(Submit in duplicate)

**For: 16-1006CD- Southwest Water Reclamation Facility Recharge Well System
Infrastructure**

Total Offer: _____
Based on a completion time of <u>460</u> calendar days

We, the undersigned, hereby declare that we have carefully reviewed the IFB Documents in their entirety and with full knowledge and understanding of the aforementioned herewith submit this bid, completely meeting each and every specification, term, and condition contained therein.

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

As bidder, we understand that the IFB documents, in its entirety, shall be made a part of any resulting Agreement between Manatee County and the successful bidder. Failure to enter into an Agreement shall result in default, whereupon, the defaulting successful bidder shall be required to pay for any and all re-procurement costs, damages, and attorney fees as incurred by County, and agrees to forfeit his/her bid bond.

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

Bidder's Name: _____

Mailing Address: _____

Telephone: () _____ Fax: () _____

Email Address: _____

I, _____ on [date(s)] _____ 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): _____

Date: _____

BID FORM

(Submit in Duplicate)

SOUTHWEST WATER RECLAMATION FACILITY RECHARGE WELL SYSTEM INFRASTRUCTURE**Bid Based on Completion Time of 460 Calendar Days**

ITEM NO.	ITEM DESCRIPTION	EST. QTY.	U/M	UNIT PRICE	EXTENDED PRICE
1	MOBILIZATION	1	LS	\$	\$
2	FURNISH AND INSTALL RECHARGE WELL HEAD	1	LS	\$	\$
3	FURNISH AND INSTALL 24 INCH PIPE BEWTEEN EFFLUENT PUMP STATION DISCHARGE HEADER AND THE RECHARGE WELL HEAD	1	LS	\$	\$
4	FURNISH AND INSTALL TWO (2) MONITORING WELLS AND DISCHARGE PIPING	1	LS	\$	\$
5	FURNISH AND INSTALL AMMONIUM SULFATE SOLUTION STORAGE TANK WITH METERING PUMPS, CHEMICAL PIPING AND INJECTION SYSTEM	1	LS	\$	\$
6	CLEANUP AND DEMOBILIZATION	1	LS	\$	\$
	TOTAL BASE BID - Based on Completion Time of <u>460</u> Calendar Days				\$
7	CONTRACT CONTINGENCY WORK (USED ONLY WITH COUNTY APPROVAL)		10% OF TOTAL BASE BID		\$
	TOTAL OFFER FOR BID with Contract Contingency - Based on Completion Time of <u>460</u> Calendar Days				\$

Bidder Name: _____

Authorized Signature: _____

ATTACHMENT A
BIDDER'S QUESTIONNAIRE
(Submit in Duplicate)

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. Contact Information:

FEIN #: _____
License #: _____
License Issued to: _____
Date License Issued (MM/DD/YR): _____
Company Name: _____
Physical Address: _____
City: _____ State of Incorporation: _____ Zip Code: _____
Phone 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. Bidder is authorized to do business in the State of Florida: ☐ Yes ☐ No

For how many years? _____

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

Is this firm in bankruptcy? _____

6. Attach a list of projects where this specific type of Work was performed.

BIDDER: _____

7. Is this firm currently contemplating or in litigation? Provide summary details.

8. 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.

9. Have you ever failed to complete Work awarded to you? Or failed to complete projects within contract time? If so, state when, where (contact name, address, phone number) and why.

10. Have you ever been debarred or prohibited from providing a bid to a governmental entity? If yes, name the entity and describe the circumstances.

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

BIDDER: _____

12. If any, list MBE/DBE (with Agreement amount) 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)

15. List the following in connection with the surety which is providing the bond(s):

Surety's Name: _____

Address: _____

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

Agent's Name: _____

Address: _____

Phone: _____

Email: _____

BIDDER: _____

ATTACHMENT B
PUBLIC CONTRACTING AND ENVIRONMENTAL CRIMES CERTIFICATION

SWORN STATEMENT PURSUANT TO ARTICLE V,
MANATEE COUNTY PROCUREMENT CODE

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 an Owner's Agreement for public improvements, procurement of goods or services (including professional services) or an Owner's lease, franchise, concession or management agreement, or shall receive a grant of Owner's monies unless such person or entity has submitted a written certification to Owner 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 Owner'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.

ATTACHMENT B

PUBLIC CONTRACTING AND ENVIRONMENTAL CRIMES CERTIFICATION

(Continued)

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 Owner's Purchasing Official. Upon presentation of such satisfactory proof, the person or entity shall be allowed to contract with Owner.

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 AGREEMENT OR BUSINESS TRANSACTION SHALL PROVIDE FOR SUSPENSION OF PAYMENTS, OR TERMINATION, OR BOTH, IF THE CONTRACTING OFFICER OR 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]

Notary Public Signature

My commission expires _____

[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.

ATTACHMENT C
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. 16-1006CD**
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 Owner 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: _____



Angelina M. Colonnese

CLERK OF THE CIRCUIT COURT AND COMPTROLLER OF MANATEE COUNTY

1115 Manatee Avenue West, Bradenton, Florida 34205 - Phone (941) 749-1800 – Fax (941) 741-4082
P.O. Box 25400, Bradenton, Florida 34206 - www.manateeclerk.com

ATTACHMENT D: E PAYABLES APPLICATION

Company name_____

Contact person_____

Phone number_____

Email Address_____

FINANCE USE ONLY

Open orders: YES or NO

PEID _____

CREATE DATE _____

CONFIRMED WITH _____

Name and phone number

IFAS _____

BANK _____

INITIALS _____

Return completed form to:

Via email to: lori.bryan@manateeclerk.com

Via fax to: (941) 741-4011

Via mail:

PO Box 1000

Bradenton, FL 34206

Revised: September 30, 2015

“Pride in Service with a Vision to the Future”

Clerk of the Circuit Court – Clerk of Board of County Commissioners – County Comptroller – Auditor and Recorder

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

BIDDER: _____

SEALED BID NO: 16-1006CD

BID TITLE: Southwest Water Reclamation Facility Recharge Well
System Infrastructure

DUE DATE/TIME: _____ @ _____

CONTRACT DOCUMENTS
FOR THE CONSTRUCTION OF

SWWRF
RECHARGE WELL SYSTEM



PREPARED FOR:

MANATEE COUNTY UTILITIES
MANATEE COUNTY, FL

VOLUME 1 OF 2
SPECIFICATIONS

For Information regarding
this project contact:

NIEL POSTLETHWAIT, P.E.
4350 West Cypress Street
Suite #600
Tampa, FL 33607-4178
(813) 281-7749

CH2MHILL

CH2M HILL
Project No. 659297

MARCH 2016

BID DOCUMENTS

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MANATEE COUNTY, FLORIDA**

SWWRF RECHARGE WELL SYSTEM

TECHNICAL SPECIFICATIONS

Tao Fu, P.E. No. 63138

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(the following section only)

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DIVISION 10—SPECIALTIES

10 14 00

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43 40 01

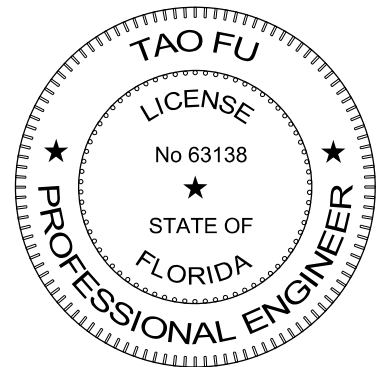
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**MANATEE COUNTY UTILITIES
MANATEE COUNTY, FLORIDA**

SWWRF RECHARGE WELL SYSTEM

TECHNICAL SPECIFICATIONS

Rocco Devilliers Koekemoer P.E. No. 76468

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(the following sections only)

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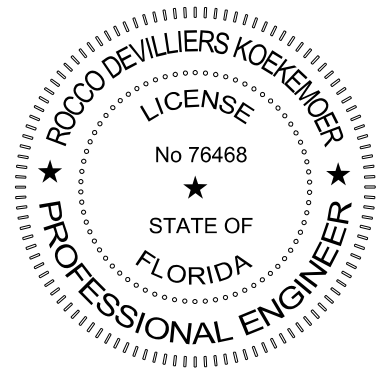
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MANATEE COUNTY, FLORIDA**

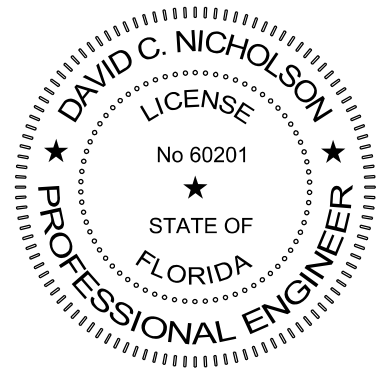
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David C. Nicholson, P. E. No 60201

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SWWRF RECHARGE WELL SYSTEM

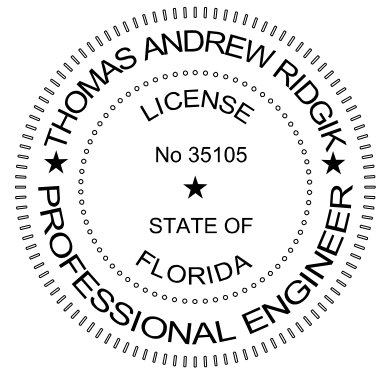
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Thomas Andrew Ridgik, P. E. No 35105

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MANATEE COUNTY, FLORIDA**

SWWRF RECHARGE WELL SYSTEM

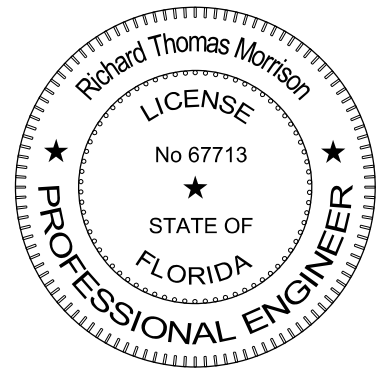
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Richard Thomas Morrison, P. E. No 67713

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CLIENT SPECIFICATIONS

SECTION 01005 GENERAL REQUIREMENTS**PART 1 GENERAL****1.01 SCOPE AND INTENT****A. Description**

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

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 the DEP permit and railroad permit which may have already been obtained. 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 County, 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 incidental costs. He shall repair or restore all structures and property that may be damaged or disturbed during performance of the work.

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.

The Contractor shall be solely responsible for the adequacy of his workmanship, materials and equipment.

C. Public Utility Installations and Structures

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.

The Contractor shall protect all 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 County. 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 County. No separate payment shall be made for such protection or repairs to public utility installations or structures.

Public utility installations or structures owned or controlled by the County 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.

Where public utility installations or structures owned or controlled by the County 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 County, 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 County, 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.

The Contractor shall give written notice to County 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).

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 County.

1.02 PLANS AND SPECIFICATIONS

A. Plans

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

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

When, in the opinion of the County, 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 County and five paper prints thereof will be given to the Contractor.

D. Contractor to Check Plans and Data

The Contractor shall verify all dimensions, quantities and details shown on the Plans, Supplementary Drawings, Schedules, Specifications or other data received from the County, 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 therefrom 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 County, should such errors or omissions be discovered. All schedules are given for the convenience of the County 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

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

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.

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.

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

All transactions with the manufacturers or subcontractors shall be through the Contractor, unless the Contractor shall request, in writing to the County, that the manufacturer or subcontractor deal directly with the County. Any such transactions shall not in any way release the Contractor from his full responsibility under this Contract.

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

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

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.

Spare parts shall be furnished as specified.

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.

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.

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 County 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.

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 County and made of ample size and strength for the purpose intended. Substantial templates and working drawings for installation shall be furnished.

The Contractor shall 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.

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 or provide a 1/32-inch neoprene gasket between the metal surface and the concrete or grout.

E. Service of Manufacturer's Engineer

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 County, such engineer or superintendent shall make all adjustments and tests required by the County to prove that such equipment is in proper and satisfactory operating condition, and shall instruct such personnel as may be designated by the County in the proper operation and maintenance of such equipment.

1.04 INSPECTION AND TESTING

A. General

Inspection and testing of materials will be performed by the County unless otherwise specified.

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 County as a prerequisite for the acceptance of any material or equipment.

If, in the making of any test of any material or equipment, it is ascertained by the County 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 County.

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.

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 County formally takes over the operation thereof.

B. Costs

All inspection and testing of materials furnished under this Contract will be performed by the County or duly authorized inspection engineers or inspections bureaus without cost to the Contractor, unless otherwise expressly specified.

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.

Materials and equipment submitted by the Contractor as the equivalent to those specifically named in the Contract may be tested by the County for compliance. The Contractor shall reimburse the County for the expenditures incurred in making such tests on materials and equipment which are rejected for non-compliance.

C. Inspections of Materials

The Contractor shall give notice in writing to the County, 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 or preparation of materials. Upon receipt of such notice, the County 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

When inspection is waived or when the County 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

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 County notifies the Contractor, in writing, that the results of such tests are acceptable.

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

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

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.

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 County. The Supplier shall assist in the final field tests as applicable.

H. Failure of Tests

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 County 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 County, 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.

In case the County 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 County 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

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 County 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

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 County, provide a suitable temporary fence which shall be maintained until the permanent fence is replaced. The County 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

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

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

B. Safeguarding Marks

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 removing without authorization such established points, stakes and marks.

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

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

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 County, additional work is deemed necessary to avoid interference with the work, payment therefore will be made as provided for in the General Conditions.

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.

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 County. This does not preclude conforming to the requirements of the insurance underwriters. Copies of surveys, photographs, reports, etc., shall be given to the County.

Prior to the beginning of any excavations, the Contractor shall advise the County 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 County may order the Contractor, for the convenience of the County, to remove trees along the line or trench excavation. If so ordered, the County 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

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.

D. Restoration of Fences

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 County. 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

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

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

C. Noise

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.

D. Access to Public Services

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

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

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 County 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**

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 County, such material, debris, or rubbish constitutes a nuisance or is objectionable. The Contractor shall remove from the site all of his surplus materials and temporary structures when no further need therefore develops.

B. Final Cleaning

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.

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 County which results from his construction operations.

B. Protection of Wetland Areas

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

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

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

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 construction of the following.
 - 1. Recharge well head and material and equipment for operation of system.
 - 2. 24 inch pipe between the effluent pump station discharge header and the recharge well head.
 - 3. Two monitoring well heads, discharge piping, and materials and equipment for complete system.
 - 4. An ammonium sulfate solution bulk storage tank, metering pumps and chemical piping and injection system.
 - 5. All civil, structural, electrical, instrumentation and control systems for complete operating systems.
 - 6. Project coordination with other ongoing projects.
- 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 County.
- 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

Construct all the Work under a single contract.

1.03 WORK SEQUENCE

- A. 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.
- B. The Contractor shall, if necessary and feasible, construct the work in stages to accommodate the County's use of the premises during the construction period; coordinate the construction schedule and operations with the County's Representative.
- C. 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. County's Use.
 - 3. Public Use.
- B. Coordinate use of work site under direction of County'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 County or separate contractor.
- E. Obtain and pay for the use of additional storage of work areas needed for Contractor operations.

1.05 COUNTY 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 County, 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 County 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 County has the option of not accepting the entire work as a whole until it is completed, tested and approved by the County.

1.06 PARTIAL COUNTY OCCUPANCY

The Contractor shall schedule his operations for completion of portions of the Work, as designated, for the County'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**

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 County 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 County 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

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

1.03 WORK LOCATIONS

Work shall be located substantially as indicated on the drawings, but the County 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 County 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 County 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 County 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 County, permanent relocation of a utility owned by the County 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 County will notify the utility to perform the work as expeditiously as possible. The Contractor shall fully cooperate with the County 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

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 County.
- 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 County 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 County. 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 County.
- 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 County.

- C. Any changes to the traffic pattern require a Traffic Control Plan as detailed in section 01570 of this specification.

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

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 County well in advance of the interruption of any flow.

1.12 CLEANUP

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 County.

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 County. 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 County. 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 County.

1.15 CONSTRUCTION WITHIN RIGHT-OF-WAY

Where pipe lines are installed within FDOT right-of-way, all excavation backfill and compaction for the purpose of reconstructing roadways and/or adjacent slopes contiguous thereto shall be in accordance with FDOT or Manatee County Standards and Specifications, whichever is applicable. Contractor shall satisfy the authorized representative of the FDOT with respect to proper safety procedures, construction methods, required permitting, etc., within the FDOT right-of-way.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01030 SPECIAL PROJECT PROCEDURES**PART 1 GENERAL****1.01 PERMITS**

Upon notice of award, the Contractor shall immediately apply for all applicable permits not previously obtained by the County 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 County. The costs for obtaining all permits shall be borne by the Contractor.

1.02 CONNECTIONS TO EXISTING SYSTEM

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

1.03 RELOCATIONS

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 County.

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 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.
- 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.
- 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 County and shall provide suggestions on how best to resolve the issue.
- 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 County.
- 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 County 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

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 County a Hurricane Preparedness Plan. The plan should outline the necessary measures which the Contractor proposes to perform at no additional cost to the County in case of a hurricane warning.
- B. In the event of inclement weather, or whenever County 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 County, 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

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

1.08 SALVAGE

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 County and if so shall be protected for a reasonable time until picked up by the County. Any equipment or material not worthy of salvaging, as directed by the County, 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 County, in writing, at least 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 County'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 County.

1.11 CONSTRUCTION CONDITIONS

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 County for excessive noise shall not relieve the Contractor of the other portions of this specification.
- 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 County 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 County.
- 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-year warranty commencing at the time of County 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-year warranty shall not relieve the Contractor of the three-year warranty starting at the time of County 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

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 County. Do not proceed with work until County 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.

1.02 QUALIFICATION OF SURVEYOR AND ENGINEER

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

1.03 SURVEY REFERENCE POINTS

- A.** Existing basic horizontal and vertical control points for the Project are designated on the Contract Drawings.
- B.** 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.

Make no changes or relocations without prior written notice to County.

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

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

Establish replacements based on original survey control.

1.04 PROJECT SURVEY REQUIREMENTS

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

1.05 RECORDS

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.

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.

1.03 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 179I 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
MCPW UTIL STD	Manatee County Utility Engineering 4410-B 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 24 th 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

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

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 County 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

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

1.04 MEASUREMENT STANDARDS

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

1.05 AREA MEASUREMENTS

In the measurement of items to be paid for on the basis of 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

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 break-down of the lump sum totals.

1.07 UNIT PRICE ITEM

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.

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 County until as-built (record) drawings have been submitted and approved by the County.

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

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. Mobilization includes, but it not limited to: preparation and movement of personnel, equipment, supplies and incidentals such as safety and sanitary supplies/ facilities

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

Partial payments for this Bid Item will be made in accordance with the following schedule:

Percent of Original Contract Amount:	Percent Allowable Payment of Mobilization/Demobilization Bid Item Price:
5	25
10	35
25	45
50	50
75	75
100	100

These payments will be subject to the standard retainage provided in the Contract. Payment of the retainage will be made after completion of the work and demobilization.

BID ITEM 2 - FURNISH AND INSTALL RECHARGE WELL HEAD.

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the furnishing and installation of the recharge well head, 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 and acceptance by the County. The lump sum price shall also include demolition of the existing components, protection of existing structures, and any off-site material required to establish original site conditions. 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 3 - FURNISH AND INSTALL 24 INCH PIPE BETWEEN THE EFFLUENT PUMP STATION DISCHARGE HEADER AND THE RECHARGE WELL HEAD.

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the furnishing and installation of the 24 inch pipe between the effluent pump station discharge header and the recharge well head, 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 and acceptance by the County. The lump sum price shall also include demolition of the existing components, protection of existing structures, and any off-site material required to establish original site conditions. 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 4 - FURNISH AND INSTALL TWO MONITORING WELLS AND DISCHARGE PIPING.

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the furnishing and installation of two monitoring wells and discharge piping, 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 and acceptance by the County. The lump sum price shall also include demolition of the existing components, protection of existing structures, and any off-site material required to establish original site conditions. 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 5 - FURNISH AND INSTALL AN AMMONIUM SULFATE SOLUTION STORAGE TANK, METERING PUMPS AND CHEMICAL PIPING AND INJECTION SYSTEM.

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the furnishing and installation of an ammonium sulfate solution storage tank, metering pumps and chemical piping and injection system, 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 and acceptance by the County. The lump sum price shall also include demolition of the existing components, protection of existing structures, and any off-site material required to establish original site conditions. 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 6 - CLEANUP AND DEMOBILIZATION

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 County. 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 signs, walls, private irrigation systems and related items and any and all other items required to complete the project in accordance with Contract Documents.

BID ITEM 7- CONTRACT CONTINGENCY WORK

Payment for all work under this Bid Item and listed in the Bid Form shall be made only at the County's discretion in order to satisfactorily complete the project in accordance with the Plans and Specifications. This Bid Item shall not exceed 10% of the Bidder's Total Base Bid. The Bidder shall calculate and enter a dollar amount for this Bid Item.

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**

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 County and Contractor.

1.02 FORMAT AND DATA REQUIRED

- A. Submit payment requests in the form provided by the County 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 County 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

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

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 and executed by the Board before it becomes effective.
- 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 County 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.

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 County 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.
 1. Name of the County's authorized agent who ordered the work and date of the order.
 2. Date and time 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 County, 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 County for approval. The County 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. County's definition of the scope of the required changes.
 - 2. Contractor's Proposal for a change, as approved by the County.
 - 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 County and Contractor.

1.09 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/CONSTRUCTION CHANGE AUTHORIZATION

- A. Changes in work shall be made in accordance to Construction Agreement Article V.

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 County 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. County's Engineer.
 - 2. County'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. County'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 County 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 County. 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 County. Such permission, however, may be revoked at any time by the County 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.

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 County to review Contractor's planning, scheduling, management and execution of the work; to assist County 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 County 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 County to review all submittals as set forth in the Contract Documents; items of work required of County 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 County.
- 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 County, 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 County. 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 County 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 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 County, 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 progress schedules with each application for payment.

2.06 MONTHLY STATUS REPORTS

- A. Contractor shall submit 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 County and Contractor at a monthly schedule meeting and Contractor will address County'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 County 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. County shall have 10 calendar days after receipt of the submittal to respond. Upon receipt of County's comments, Contractor shall make the necessary revisions and submit the revised schedule within 10 calendar days. The resubmittal, if concurred with by County, 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 and concurrence by County. 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 County.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01340 SHOP DRAWINGS, PROJECT DATA AND SAMPLES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. The Contractor shall submit to the County 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. The Contractor is to maintain an accurate updated submittal log and will bring this log to each scheduled progress meeting with the County. This log should include the following items:
 - 1. Submittal description and number assigned.
 - 2. Date to County.
 - 3. Date returned to Contractor (from County).
 - 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.

1.03 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 County 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 County 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 County 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 County, with No Exceptions Taken or Approved As Noted.
- E. The Contractor shall submit to the County 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 County receives them.
- F. All material & product submittals, other than samples, may be transmitted electronically as a pdf file. All returns to the contractor will be as a pdf file only unless specifically requested otherwise.
- 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 County of the necessary Shop Drawings.

1.04 COUNTY'S REVIEW OF SHOP DRAWINGS AND WORKING DRAWINGS

- A. The County'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 County, 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 County finds to be in the interest of the County and to be so minor as not to involve a change in Contract Price or time for performance, the County may return the reviewed drawings without noting any exception.
- D. When reviewed by the County, 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 County on previous submissions. The Contractor shall make any corrections required by the County.
- 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 County.
- G. The County shall review a submittal/resubmittal a maximum of three (3) times after which cost of review shall be borne by the Contractor. The cost of engineering shall be equal to the County's actual payroll cost.
- H. When the Shop and Working Drawings have been completed to the satisfaction of the County, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the County.
- I. No partial submittals shall be reviewed. Incomplete submittals shall be returned to the Contractor and shall be considered not approved until resubmitted.

1.05 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 County 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 County 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 County will utilize the color "red" in marking shop drawing submittals.

1.06 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 County where required by the Contract Documents or requested by the County and shall be submitted at least thirty (30) days (unless otherwise specified by the County) 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 County, 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 County and Engineer shall not have responsibility therefor.

1.07 SAMPLES

- A. The Contractor shall furnish, for the review of the County, samples required by the Contract Documents or requested by the County. Samples shall be delivered to the County 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 County.
- 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 County. 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 County 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**

SECTION 01370 SCHEDULE OF VALUES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. The Contractor shall submit to the County 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 County, 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 County 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 pipe lines.
- 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

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 one print 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 County 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 County 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 County on digital video disks (DVD) for the permanent and exclusive use of the County 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 County. In addition, no progress payments shall be made until the preconstruction video recordings are accepted by the County.

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. County 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. County 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 County 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 County 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 County 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 County.
- H. If the test results indicate the material or equipment complies with the Contract Documents, the County 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**

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.
- 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**

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

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 01570 TRAFFIC REGULATION

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. The Contractor shall be responsible for providing safe and expeditious movement of traffic through construction zones. A construction zone is defined as the immediate areas of actual construction and all abutting areas which are used by the Contractor and which interfere with the driving or walking public.
- B. The Contractor shall remove temporary equipment and facilities when no longer required, restore grounds to original or to specified conditions.

1.02 TRAFFIC CONTROL

- A. The necessary traffic control shall include, but not be limited to, such items as proper construction warning signs, signals, lighting devices, markings, barricades, channelization and hand signaling devices. The Contractor shall be responsible for installation and maintenance of all devices and detour routes and signage for the duration of the construction period. The Contractor shall utilize the appropriate traffic plan from the FDOT Maintenance of Traffic Standards, Series 600 of the FDOT Roadway & Traffic Design Standards, Latest Edition.
- B. Should there be the necessity to close any portion of a roadway carrying vehicles or pedestrians the Contractor shall submit a Traffic Control Plan (TCP) at least 5 days before a partial or full day closure, and at least 8 days before a multi-day closure. TCP shall be submitted, along with a copy of their accreditation, by a certified IMSA or ATSA Traffic Control Specialist.
 - 1. At no time will more than one (1) lane of a roadway be closed to vehicles and pedestrians without an approved road closure from the County Transportation Department. With any such closings, adequate provision shall be made for the safe expeditious movement of each.
 - 2. All traffic control signs must be in place and inspected at least 1 day in advance of the closure. Multi-day closures notification signs shall be in place at least 3 days in advance of the closure. All signs must be covered when no in effect, and checked twice a day by the Worksite Traffic Supervisor when they are in effect.
- C. The Contractor shall be responsible for removal, relocation, or replacement of any traffic control device in the construction area which exists as part of the normal preconstruction traffic control scheme. Any such actions shall be performed by the Contractor under the supervision and in accordance with the instructions of the applicable highway department unless otherwise specified.
- D. The Contractor will consult with the County immediately on any vehicular or pedestrian safety or efficiency problem incurred as a result of construction of the project.

- E. The Contractor shall provide ready access to businesses and homes in the project area during construction. The Contractor shall be responsible for coordinating this work with affected homeowners.
- F. When conditions require the temporary installation of signs, pavement markings and traffic barriers for the protection of workers and traffic, the entire array of such devices shall be depicted on working drawings for each separate stage of work. These drawings shall be submitted to the County for review and approval prior to commencement of work on the site.
- G. Precast concrete traffic barriers shall be placed adjacent to trenches and other excavations deeper than six inches below the adjacent pavement surface.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

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 County.
 - 3. Names and titles of authorities as directed by County.
 - 4. Prime Contractor.
- B. Graphic design, style of lettering and colors: As approved by the County.
- C. Erect on the site at a lighted location of high public visibility, adjacent to main entrance to site, as approved by the County

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.

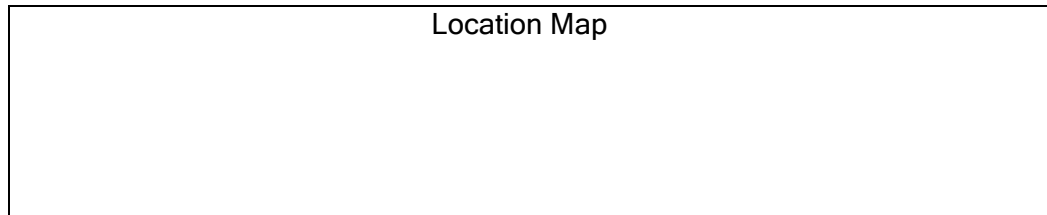
1.05 PUBLIC NOTIFICATION

- A. Door Hangers: The Contractor shall generate and 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.



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) | Project Manager
PM Address
PM Phone No. & Ext. |
| B. | Project Inspector
Inspector Phone Number | |

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 coat of primer and one coat of exterior paint.
- B. Paint graphics in styles, size and colors selected.

3.02 MAINTENANCE

The Contractor shall maintain signs and supports in a neat, clean condition; repair damages to structures, framing or sign.

3.03 REMOVAL

The Contractor shall remove signs, framing, supports and foundations at completion of project.

END OF SECTION

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 County.
 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 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 copies to County. Maintain one 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 County 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

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 01620 STORAGE AND PROTECTION

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

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 accord 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.
- A. Arrange storage in 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 continuing basis.
 - 3. Surfaces of products exposed to elements are not adversely affected. Any weathering of products, coatings and finishes is not acceptable under requirements of these Contract Documents.
- B. Mechanical and electrical equipment which requires 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 County. 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 month prior to installation without written authorization from the County.

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 County 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**

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 County 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 County determines that the work is not substantially complete:
 - 1. The County 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 County.
 - 3. The County shall reinspect the work.
- E. When the County finds that the work is substantially complete:
 - 1. The Engineer shall prepare and deliver to the County 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 County as provided in Conditions of the Contract. When the Engineer considers the work substantially complete, he will execute and deliver to the County 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 County's representative and are operational.
 5. The work is completed and ready for final inspection.
- B. The County shall make an inspection to verify the status of completion after receipt of such certification.
- C. If the County determines that the work is incomplete or defective:
1. The County 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 County that the work is complete.
 3. The County shall reinspect the work.
- D. Upon finding the work to be acceptable under the Contract Documents, the County 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 County's fees.

1.04 CONTRACTOR'S CLOSEOUT SUBMITTALS TO COUNTY

- 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 County.

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

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

SECTION 01710 CLEANING**PART 1 GENERAL****1.01 REQUIREMENTS INCLUDED**

Execute cleaning during progress of the work and at completion of the work, as required by the General Conditions.

1.02 DISPOSAL REQUIREMENTS

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 County 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 County one record copy of:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. County'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 County.

1.03 MARKING DEVICES

A. Provide felt tip marking pens for recording information in the color code designated by the County.

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 televising 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 $\pm 1/8$ 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 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 County.

- 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 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 County. 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 sealed paper drawings, signed and dated mylar drawings together with an AutoCAD version on a recordable compact disk (CD).
- C. The CD shall contain media in AutoCad Version 2004 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 County.
- B. Drawings shall meet the criteria of paragraph 1.04 D above.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01730 OPERATING AND MAINTENANCE DATA**PART 1 GENERAL****1.01 REQUIREMENTS INCLUDED**

- A. Compile product data and related information appropriate for County's maintenance and operation of products furnished under Contract.

Prepare operating and maintenance data as specified in this and as referenced in other pertinent sections of Specifications.

- B. Instruct County's personnel in maintenance of products and equipment and systems.
- C. 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 County'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 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 County's personnel.
- D. Prepare and include additional data when the need for such data becomes apparent during instruction on County's personnel.
- E. Additional requirements for operating and maintenance data: Respective sections of Specifications.

1.04 SUBMITTAL SCHEDULE

- A. Submit one copy of completed data in final form fifteen days prior to substantial completion.
 1. Copy will be returned after substantial completion, with comments (if any).
- B. Submit two 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 COUNTY'S PERSONNEL

- A. Prior to final inspection or acceptance, fully instruct County'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

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 County for review and transmittal.

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 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 County'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 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 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 County of all documents required under this section is a prerequisite to requesting a final inspection and final payment

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**TECHNICAL
SPECIFICATIONS**

SECTION 01 31 13
PROJECT COORDINATION

PART 1 GENERAL

1.01 SUBMITTALS

- A. Sequence of Construction: Within 4 weeks from notice to proceed.

1.02 RELATED WORK AT SITE

A. General:

1. Other work that is either directly or indirectly related to scheduled performance of the Work under these Contract Documents, listed henceforth, is anticipated to be performed at Site by others. The drawings of these projects are available from Owner.
 - a. SWWRF Upgrades to CI2 Residual Feedline Project, 2015, designed by Carollo.
 - b. FM 1M Project, 2015, designed by Kimley Horn.
 - c. MARS Improvement Project, 2015, designed by McKim and Creed.
2. Following projects are related to the Work. Record drawings for these projects are available from Owner.
 - a. SWWRF 10 MG Storage Tank and HSPS Record Drawings, 2015, designed by URS.
 - b. SWWRF Lake Filtration and North Pond Improvements Record Drawings, 2014, designed by McKim and Creed.
3. Coordinate the Work of these Contract Documents with work of others as specified in General Conditions.
4. Include sequencing constraints specified herein as a part of Progress Schedule.

1.03 CONSTRUCTION SAFETY PROGRAM

- A. The Contractor shall develop and maintain for the duration of this Contract, a safety program that will effectively incorporate and implement all required safety provisions. The safety program shall be consistent with all Project Site safety requirements. The Contractor shall appoint an employee who is qualified and authorized to supervise and enforce compliance with the safety program.
- B. The duty of the Engineer to conduct construction review of the Contractor's performance is not intended to include a review or approval of the adequacy of the Contractor's safety supervisor, the safety program, or any safety measures taken in, on, or near the construction site.

1.04 SAFETY EQUIPMENT

- A. The Contractor, as part of his safety program, shall maintain at his office or other well-known place at the jobsite, safety equipment applicable to the work as prescribed by the governing safety authorities, all articles necessary for giving first-aid to the injured, and shall establish the procedure for the immediate removal to a hospital or a doctor's care of any person who may be injured on the jobsite.
- B. The Contractor shall do all work necessary to protect the general public from hazards, including, but not limited to, surface irregularities or unramped grade changes in pedestrian sidewalk or walkway, and trenches or excavations in roadway. Barricades, lanterns, and proper signs shall be furnished in sufficient amount to safeguard the plant staff, public, and the work.
- C. The performance of all work and all completed construction, particularly with respect to ladders, platforms, structure openings, scaffolding, shoring, lagging, machinery guards and the like, shall be in accordance with the applicable governing safety authorities.
- D. During construction, the Contractor shall construct and at all times maintain satisfactory and substantial temporary chain link fencing, solid fencing, railing, barricades or steel plates, as applicable, at all openings, obstructions, or other hazards in streets, sidewalks, floors, roofs, and walkways. All such barriers shall have adequate warning lights as necessary, or required, for safety.

1.05 ACCIDENT REPORTS

- A. If death or serious injuries or serious damages are caused, the accident shall be reported immediately by telephone or messenger to the Engineer and Owner. In addition, the Contractor must promptly report in writing to the Engineer all accidents whatsoever arising out of, or in connection with, the performance of the work whether on, or adjacent to, the Site, giving full details and statements of witnesses.
- B. If a claim is made by anyone against the Contractor or any Subcontractor on account of any accident, the Contractor shall promptly report the facts in writing to the Engineer, giving full details of the claim.

1.06 SAFE ACCESS BY FEDERAL, STATE, AND LOCAL GOVERNMENT OFFICIALS

- A. Authorized government officials shall at all times have safe access to the work, and the Contractor shall provide proper facilities for such access and inspection.

1.07 UTILITY NOTIFICATION AND COORDINATION

- A. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during the Work. Contact Owner to obtain contact person for each utility.

1.08 FACILITY OPERATIONS

- A. Continuous operation of Owner's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.
- B. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of Owner's operations.
- C. When necessary, plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items to maintain continuous operations of Owner's facility.
- D. Do not close lines, open or close valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer. Such authorization will be considered within 48 hours after receipt of Contractor's written request.
- E. Process or Facility Shutdown:
 - 1. Provide 14 days advance written request for approval of need to shut down a process or facility to Owner and Engineer.
 - 2. Power outages will be considered upon 48 hours written request to Owner and Engineer. Describe the reason, anticipated length of time, and areas affected by the outage. Provide temporary provisions for continuous power supply to critical facility components.
- F. Do not proceed with Work affecting a facility's operation without obtaining Owner's and Engineer's advance approval of the need for and duration of such Work.
- G. Relocation of Existing Facilities:
 - 1. During construction, it is expected that minor relocations of Work will be necessary.

2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.
3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
4. Perform relocations to minimize downtime of existing facilities.
5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by Engineer.

1.09 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at Site is started, Contractor, Engineer, and affected property owners and utility owners shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.
2. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.

B. Documentation:

1. Record and submit documentation of observations made on examination inspections in accordance with Section 01720, Project Record Documents.
2. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Contractor's operations, and is for the protection of adjacent property owners, Contractor, and Owner.

1.10 REFERENCE POINTS AND SURVEYS

A. Location and elevation of bench marks are shown on Drawings.

B. Contractor's Responsibilities:

1. Provide additional survey and layout required to layout the Work.
2. Notify Engineer at least 3 working days in advance of time when grade and line to be provided by Owner will be needed.
3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
4. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.

5. Maintain complete accurate log of survey work as it progresses as a Record Document.
6. On request of Engineer, submit documentation.
7. Provide competent employee(s), tools, stakes, and other equipment and materials as Engineer may require to:
 - a. Check layout, survey, and measurement work performed by others.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CUTTING, FITTING, AND PATCHING

- A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.
- B. Obtain prior written authorization of Engineer before commencing Work to cut or otherwise alter:
 1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
 2. Weather-resistant or moisture-resistant elements.
 3. Efficiency, maintenance, or safety of element.
 4. Work of others.
- C. Refinish surfaces to provide an even finish.
 1. Refinish continuous surfaces to nearest intersection.
 2. Refinish entire assemblies.
 3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and the Work is evident in finished surfaces.
- D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown on Drawings.
- E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.
- F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.
- G. Remove specimens of installed Work for testing when requested by Engineer.

END OF SECTION

SECTION 01 45 16.13
CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. ASTM International (ASTM):
 - a. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - b. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

1.02 DEFINITIONS

A. Contractor Quality Control (CQC): The means by which Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract.

1.03 SUBMITTALS

A. Informational Submittals:

1. CQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
2. CQC Report: Submit, weekly, an original and one copy in report form.

1.04 OWNER'S QUALITY ASSURANCE

A. All Work is subject to Owner's quality assurance inspection and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.

B. Owner's quality assurance inspections and tests are for the sole benefit of Owner and do not:

1. Relieve Contractor of responsibility for providing adequate quality control measures;
2. Relieve Contractor of responsibility for damage to or loss of the material before acceptance;
3. Constitute or imply acceptance; or
4. Affect the continuing rights of Owner after acceptance of the completed Work.

- C. The presence or absence of a quality assurance inspector does not relieve Contractor from any Contract requirement.
- D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Engineer.
- E. Owner may charge Contractor for any additional cost of inspection or test when Work is not ready at the time specified by Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents.
- B. Maintain complete inspection records and make them available at all times to Owner and Engineer.
- C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

- A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the CQC Plan, schedule a meeting with Engineer and Owner to discuss the quality control system.
- B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of Contractor's management and control with the Owner's Quality Assurance.
- C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by Contractor.

3.03 QUALITY CONTROL ORGANIZATION

A. CQC System Manager:

1. Designate an individual within Contractor's organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the Contractor.
2. CQC System Manager shall be an experienced construction person, with a minimum of 3 years construction experience on similar type Work.
3. CQC System Manager shall report to the Contractor's project manager or someone higher in the organization. Project manager in this context shall mean the individual with responsibility for the overall quality and production management of the Project.
4. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
5. Identify an alternate for CQC System Manager to serve with full authority during the System Manager's absence. The requirements for the alternate will be the same as for designated CQC System Manager.

B. CQC Staff:

1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. CQC staff members shall be subject to acceptance by Engineer.
2. CQC staff shall take direction from CQC System Manager in matters pertaining to QC.
3. CQC staff must be of sufficient size to ensure adequate QC coverage of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities.
4. The actual strength of the CQC staff may vary during any specific Work period to cover the needs of the Project. Add additional staff when necessary for a proper CQC organization.

C. Organizational Changes: Obtain Engineer's acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.

3.04 QUALITY CONTROL PHASING

- A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all definable features of Work, as follows:
1. Preparatory Phase:
 - a. Notify Owner at least 48 hours in advance of beginning any of the required action of the preparatory phase.
 - b. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQC System Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required in order to meet Contract requirements.
 - c. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and attached to the QC report.
 - d. Perform prior to beginning Work on each definable feature of Work:
 - 1) Review applicable Contract Specifications.
 - 2) Review applicable Contract Drawings.
 - 3) Verify that all materials and/or equipment have been tested, submitted, and approved.
 - 4) Verify that provisions have been made to provide required control inspection and testing.
 - 5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract.
 - 6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
 - 7) Review the appropriate activity hazard analysis to verify safety requirements are met.
 - 8) Review procedures for constructing the Work, including repetitive deficiencies.
 - 9) Document construction tolerances and workmanship standards for that phase of the Work.
 - 10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Engineer.
 2. Initial Phase:
 - a. Accomplish at the beginning of a definable feature of Work:
 - 1) Notify Owner at least 48 hours in advance of beginning the initial phase.

- 2) Perform prior to beginning Work on each definable feature of Work:
 - a) Review minutes of the preparatory meeting.
 - b) Check preliminary Work to verify compliance with Contract requirements.
 - c) Verify required control inspection and testing.
 - d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
 - e) Resolve all differences.
 - f) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
 - 3) Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
 - 4) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
3. Follow-up Phase:
- a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
 - b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
 - c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.
4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.05 CONTRACTOR QUALITY CONTROL PLAN

A. General:

1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.

2. An interim plan for the first 30 days of operation will be considered.
3. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of Work to be started.

B. Content:

1. Plan shall cover the intended CQC organization for the entire Contract and shall include the following, as a minimum:
 - a. Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three-phase control system (see Paragraph QC Phasing) for all aspects of the Work specified.
 - b. CQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
 - c. Letters of Authority: A copy of a letter to the CQC System Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop Work which is not in compliance with the Contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to Owner.
 - d. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
 - e. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.
 - f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.
 - g. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
 - h. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.

- C. Acceptance of Plans: Acceptance of the Contractor's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.
- D. Notification of Changes: After acceptance of the CQC plan, Contractor shall notify Engineer, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Engineer.

3.06 CONTRACTOR QUALITY CONTROL REPORT

- A. As a minimum, prepare a CQC report for every 7 calendar days. Account for all days throughout the life of the Contract. Reports shall be signed and dated by CQC System Manager. Include copies of test reports and copies of reports prepared by QC staff.
- B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.
- C. Records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:
 1. Contractor/subcontractor and their areas of responsibility.
 2. Operating plant/equipment with hours worked, idle, or down for repair.
 3. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
 4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
 5. Material received with statement as to its acceptability and storage.
 6. Identify submittals reviewed, with Contract reference, by whom, and action taken.
 7. Offsite surveillance activities, including actions taken.
 8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
 9. List instructions given/received and conflicts in Drawings and/or Specifications.
 10. Contractor's verification statement.

11. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
12. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract.

3.07 SUBMITTAL QUALITY CONTROL

- A. Submittals shall be as specified in Section 01 33 00, Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements. Owner will furnish copies of test report forms upon request by Contractor. Contractor may use other forms as approved.

3.08 TESTING QUALITY CONTROL

- A. Testing Procedure:
 1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Perform the following activities and record the following data:
 - a. Verify testing procedures comply with contract requirements.
 - b. Verify facilities and testing equipment are available and comply with testing standards.
 - c. Check test instrument calibration data against certified standards.
 - d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
 - e. Documentation:
 - 1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
 - 2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
 - 3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.
 - 4) Provide directly to Engineer an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
 - 5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.

- B. Testing Laboratories: Laboratory facilities, including personnel and equipment, utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D3740 and ASTM E329, and be accredited by the American Association of Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), the American Association of State Highway and Transportation Officials (AASHTO), or other approved national accreditation authority. Personnel performing concrete testing shall be certified by the American Concrete Institute (ACI).

3.09 COMPLETION INSPECTION

- A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the Contract.
- B. Punchlist:
1. CQC System Manager shall develop a punchlist of items which do not conform to the Contract requirements.
 2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.
 3. CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Owner.
 4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

END OF SECTION

SECTION 01 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY OF WORK

- A. This section covers Work necessary for stabilization of soil to prevent erosion during construction and land disturbing activities.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
 - a. D638, Standard Test Method for Tensile Properties of Plastics.
 - b. D3776/D3776M, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
 - c. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in Xenon Arc Type Apparatus.
 - d. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 2. Federal Emergency Management Agency (FEMA).
 3. U.S. Department of Agriculture: Urban Hydrology for Small Watersheds; Soil Conservation Service Engineering Technical Release No. 55, 1986.
 4. U.S. Environmental Protection Agency:
 - a. Guidelines for Erosion and Sedimentation Control Planning.
 - b. Implementation, Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity.
 - c. Erosion and Sediment Control Surface Mining in Eastern United States.
 5. U.S. Weather Bureau: Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years, Technical Paper No. 40, 1981.

1.03 SYSTEM DESCRIPTION

- A. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.
- B. Soil erosion stabilization and Sedimentation control consists of the following elements: Construction of temporary erosion control facilities such as silt fences.

- C. Activities shall conform to The Florida Stormwater, Erosion, and Sedimentation Control Inspector's Manual, latest version and Drawings. In the event of a conflict, the more stringent requirement shall apply.

1.04 QUALITY ASSURANCE

- A. Water pollution control shall comply with procedures outlined in U.S. Environmental Protection Agency manuals entitled, "Guidelines for Erosion and Sedimentation Control Planning" and "Implementation, Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity".

PART 2 PRODUCTS

2.01 SILT FENCE

- A. Geotextile:

1. In accordance with requirements of Table No. 1:
2. Manufacturers and Products:
 - a. Mirafi; 100x.
 - b. Geotext; 915sc.

Table No. 1		
Physical Property	Required Value	Test Method
Weight, oz/sq yd, min.	4	ASTM D3776/D3776M
Equivalent Opening Size, max.	50-70	U.S. Standard Sieve
Grab Tensile Strength, lb, min.	160	ASTM D4632
Ultraviolet Radiation Resistance, % Strength Retention	70	ASTM D4355

- B. Support Posts: As recommended by manufacturer of geotextile.
- C. Fasteners: Heavy-duty wire staples at least 1-inch long, tie wires, or hog rings, as recommended by manufacturer of geotextile.

PART 3 EXECUTION

3.01 PREPARATION

- A. Contractor shall be responsible for phasing Work in areas allocated for their exclusive use during Project, including proposed stockpile areas and installation of temporary erosion control devices, ditches, or other facilities.
- B. Areas set aside for Contractor's use during Project may be temporarily developed to provide satisfactory working, staging, and administrative areas. Preparation of these areas shall be in accordance with other requirements contained within Specifications and completed in a manner to control sediment transport away from area.

3.02 SILT FENCE INSTALLATION

- A. Install prior to starting earth disturbing activities.
- B. Construct in accordance with manufacturer's instructions and The Florida Stormwater, Erosion, and Sedimentation Control Inspector's Manual.
- C. Install geotextile in one piece, or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench. Take precaution not to puncture geotextile during installation.
- D. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.
- E. Securely fasten geotextile to each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.
- F. When joints are necessary, splice geotextile together only at support post, with a minimum 6-inch overlap, and securely fasten both ends to support post.
- G. Geotextile shall not extend more than 34 inches above ground surface. Securely fasten to upslope side of each support post using ties. Do not staple geotextile to existing trees.
- H. Remove after upslope area has been permanently stabilized.

3.03 SOIL STOCKPILES

- A. Protect from erosion with silt fence.

- B. Sediment transport and erosion from working stockpiles shall be controlled and restricted from moving beyond immediate stockpile area by construction of temporary toe-of-slope ditches and accompanying silt fences, as necessary. Keep these temporary facilities in operational condition by regular cleaning, regrading, and maintenance.

3.04 FIELD QUALITY CONTROL

- A. Conduct inspections jointly with Engineer every 2 weeks to evaluate conformance to requirements of Specifications.
- B. Replace or repair failed or overloaded silt fences, check dams, or other temporary erosion control devices within 2 days after Site inspections.

3.05 MAINTENANCE

- A. Promptly repair or replace silt fence that becomes damaged.
- B. Silt Traps:
 - 1. Clean silt traps of collected sediment after every storm or as determined from biweekly inspections.
 - 2. Perform cleaning in a manner that will not direct sediment into storm drain piping system.
 - 3. Take removed sediment to area selected by Engineer where it can be cleaned of sticks and debris, then allowed to dry.
 - 4. Dispose of final sediment onsite as designated by Engineer.
 - 5. Dispose of debris offsite.
- C. Regrade unpaved earth drainage ditches as needed to maintain original grade and remove sediment buildup. If ditch becomes difficult to maintain, install additional erosion control devices such as check dams, temporary paving, or silt fences as directed by Engineer.
- D. Inspect, repair, and replace as necessary erosion control measures during the time period from start of construction to completion of construction.

3.06 CLEANING

- A. Dress sediment deposits remaining after fence has been removed to conform to existing grade. Prepare and sod graded area.

END OF SECTION

SECTION 01 88 15 ANCHORAGE AND BRACING

PART 1 GENERAL

1.01 SUMMARY

- A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the Florida Building Code Fifth Edition (2014), for wind, gravity, soil, and operational loads.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
 - 2. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
 - 3. International Code Council (ICC): Florida Building Code (FBC).
 - 4. State of Florida Building Code.

1.03 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

- A. General:
 - 1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of Florida.
 - 2. Design anchorage and bracing of mechanical and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
 - 3. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, wind, and operational loading.

4. Piping and ductwork, whether exempt or not exempt for this section, shall be anchored and braced so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
5. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
6. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
7. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

1. Gravity: Design anchorage and bracing for self weight and superimposed loads on components and equipment.
2. Wind: Design anchorage and bracing for wind criteria provided on 001-G-104 for exterior and wind-exposed mechanical and electrical equipment.
3. Operational:
 - a. For loading supplied by equipment manufacturer for FBC required load cases.
 - b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.
 - c. Locate braces to minimize vibration to or movement of structure.
 - d. For vibrating loads, use anchors meeting requirements of Section 05 50 00, Metal Fabrications, for anchors with designated capacities for vibratory loading per manufacturer's ICC-ES report.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. List of mechanical and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
 - b. Manufacturers' engineered hardware product data.
 - c. List of existing mechanical and electrical equipment or components to be modified in Project requiring Contractor-designed anchorage and bracing in final retrofitted condition.
 - d. Submittal will be rejected if proposed anchorage method would create an overstressed condition of supporting member. Revise anchorages and strengthening of structural support so there is no overstressed condition.

B. Informational Submittals:

1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include FBC and Project-specific criteria as noted on General Structural Notes on Drawings, in addition to manufacturer's specific criteria used for design; sealed by a professional engineer registered in the State of Florida.
 2. Manufacturer's hardware installation requirements.
- C. Deferred Submittals: Submit deferred action submittals such as shop drawings with supporting deferred informational submittals such as calculations no less than 4 weeks in advance of installation of component, equipment or distribution system to be anchored to structure.

1.06 SOURCE QUALITY CONTROL

- A. Contractor and supplier responsibilities to accommodate Owner-furnished shop fabrication related special inspections and testing are provided in Project's Statement of Special Inspections on Drawings and Section 01 45 33, Special Inspection, Observation, and Testing.
- B. All other specified, regulatory required, or repair verification inspection and testing that are not listed in Statement of Special Inspections, are to be provided by Contractor and shall meet requirements of Section 01 45 16.13, Contractor Quality Control.
- C. Source Quality Control for shall be in accordance with Section 05 50 00, Metal Fabrications.

PART 2 PRODUCTS**2.01 GENERAL**

- A. Provide anchor bolts and concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Size of anchor bolts and anchors, required minimum embedment, and spacing shall be based on calculations submitted by Contractor.
- B. Do not use expansion anchors, other than undercut anchors, for nonvibration isolated mechanical equipment rated over 10 horsepower.

PART 3 EXECUTION

3.01 GENERAL

- A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.
- B. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.
- C. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.
- D. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by Engineer.
- E. Do not attach mechanical or electrical components to more than one element of a building structure at a single restraint location across building expansion and contraction joints.

3.02 INSTALLATION

- A. Do not install components or their anchorages or restraints prior to review and acceptance by Engineer and AHJ.

3.03 FIELD QUALITY CONTROL

- A. In accordance with Section 05 50 00, Metal Fabrications.
- B. Provide any other specified, regulatory required, or required repair verification inspection and testing that is not listed, are to be provided by Contractor and shall meet requirements of Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 03 30 10
STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 GENERAL

- A. Work shall conform to requirements of ACI 301-10, Specifications for Structural Concrete, unless otherwise specified.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Concrete Institute (ACI):
 - a. 117, Specifications for Tolerances for Concrete Construction and Materials.
 - b. 301-10, Specifications for Structural Concrete.
 - c. 305.1, Specification for Hot Weather Concreting.
 - d. 308.1-11, Specification for Curing Concrete.
 - e. SP-66, Detailing Manual.
 2. ASTM International (ASTM):
 - a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - b. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - c. C33/C33M, Standard Specification for Concrete Aggregates.
 - d. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - e. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - f. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - g. C150/C150M, Standard Specification for Portland Cement.
 - h. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - i. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.
 - j. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - k. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
 - l. C595/C595M, Standard Specification for Blended Hydraulic Cements.
 - m. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

- n. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- o. C920, Specification for Elastomeric Joint Sealants.
- p. C989, Standard Specification for Slag Cement for Use in Concrete and Mortars.
- q. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
- r. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
- s. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
- t. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
- u. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
- v. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
- w. C 1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
- x. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
- y. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
- z. D226, Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
- aa. D227, Specification for Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing.
- bb. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- cc. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
- dd. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- ee. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- ff. D2240, Standard Test Method for Rubber Property – Durometer Hardness.
- gg. E329, Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.

3. Concrete Reinforcing Steel Institute (CRSI):
 - a. Manual of Standard Practice.
 - b. Recommended Practice for Placing Reinforcing Bars.
4. Corps of Engineers (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.
5. National Ready Mixed Concrete Association (NRMCA).

1.03 DEFINITIONS

- A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.
- B. Contractor's Licensed Design Engineer: Individual representing Contractor who is licensed to practice engineering as defined by statutory requirements of professional licensing laws in state or jurisdiction in which Project is to be constructed.
- C. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cracks in liquid containment structures and below grade habitable spaces that are 0.005-inch wide and wider, and cracks in other structures that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.
- D. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained.
- E. Hot Weather: As defined in ACI 305.1.
- F. Hydraulic Structure: Liquid containment structure.
- G. New Concrete: Concrete less than 60 days old.
- H. Top Bars: Horizontal bars placed such that 12 inches of fresh concrete is cast below in single placement.

1.04 DESIGN REQUIREMENTS

- A. Design formwork to provide specified concrete finishes.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Formwork and Formwork Accessories: Unless otherwise specified, conform to requirements of ACI 301.
 - b. Reinforcing steel prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66 Detailing Manual:
 - 1) Bending lists.
 - 2) Placing drawings.
 - c. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.
 - d. Construction Joints and Control Joints: Layout and location for each type.
2. Mix Design:
 - a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
 - b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
 - c. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common product Requirements, for the following:
 - 1) Portland cement.
 - 2) Fly ash.
 - 3) Slag cement.
 - 4) Aggregates, including specified class designation for coarse aggregate.
 - 5) Admixtures.
 - 6) Concrete producer has verified compatibility of constituent materials in design mix.
 - d. Test Reports:
 - 1) Cement: Chemical analysis report.
 - 2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
 - 3) Water-Soluble Chloride-Ion Content in Hardened Concrete: Unless otherwise permitted, in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
 - e. Aggregates:
 - 1) Coarse Aggregate Gradation: List gradings and percent passing through each sieve.
 - 2) Fine Aggregate Gradation: List gradings and percent passing through each sieve.
 - 3) Percent of fine aggregate weight to total aggregate weight.

- 4) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
- 5) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
- 6) Test Reports:
 - a) Alkali Aggregate Reactivity: Aggregate shall be classified as nonpotentially reactive in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
- f. Admixtures: Manufacturer's product data sheets for each admixture used in proposed mix designs.
3. Product Data: Specified ancillary materials.
4. Samples: PVC waterstop splice, joint, and fabricated cross of each size, shape, and fitting of waterstop.
5. Letter stating compatibility between liquids being contained and materials used for waterstops and joint fillers.
6. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
 - a. Procedures for measuring, and recording temperatures of reinforcement and other embedded items prior to concrete placement.
 - b. Use of retarding admixture.
 - c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
 - d. Types of shading and wind protection to be provided.
 - e. Curing methods, including use of evaporation retardant.
 - f. Procedures for measuring and recording concrete temperatures.
 - g. Procedures for preventing drying during dry, windy conditions.
7. Concrete repair techniques.

B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer's application instructions for bonding agent and bond breaker.
3. Manufacturer's Certificate of Compliance to specified standards:
 - a. Bonding agent.
 - b. Bond breaker.
 - c. Repair materials.
4. Statement of Qualification:
 - a. Batch Plant: Certification as specified herein.
 - b. Mix designer.
 - c. Installer.
 - d. Mix designer.
 - e. Testing agency.

5. Manufacturer's written instructions for product shipment, storage, handling, installation/application, and repair for:
 - a. Waterstop.
 - b. Joint filler.
6. Concrete Delivery Tickets:
 - a. For each batch of concrete before unloading at Site.
 - b. In accordance with ASTM C94/C94M, including requirements 14.2.1. through 14.2.10.
 - c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.
3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.
4. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - a. Where field testing is required of Contractor, personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

B. Preinstallation Conference:

1. Required Meeting Attendees:
 - a. Contractor, including pumping, placing and finishing, and curing subcontractors.
 - b. Ready-mix producer.
 - c. Admixture representative.
 - d. Testing and sampling personnel.
 - e. Engineer who authored Statement of Special Inspection Plan or Engineer's designee.

2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include:
 - a. Admixture types, dosage, performance, and redosing at Site.
 - b. Mix designs, test of mixes, and Submittals.
 - c. Placement methods, techniques, equipment, consolidation, and form pressures.
 - d. Slump or slump flow and placement time to maintain slump and slump flow.
 - e. Finish, curing, and water retention.
 - f. Protection procedures for weather conditions.
 - g. Other specified requirements requiring coordination.
4. Conference minutes as specified in Section 01 31 19, Project Meetings.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Unload, store, and handle bars in accordance with CRSI publication "Placing Reinforcing Bars."

PART 2 PRODUCTS

2.01 FORMWORK

- A. Form Materials:
 1. For exposed areas, use hard plastic finished plywood, overlaid waterproof particle board, or steel in "new and undamaged" condition, of sufficient strength and surface smoothness to produce specified finish.
 2. For unexposed areas, use new shiplap or plywood.
 3. Earth cuts may be used for forming footings.
- B. Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.
- C. Form Ties:
 1. Material: Steel.
 2. Spreader Inserts:
 - a. Conical or spherical type.
 - b. Design to maintain positive contact with forming material.
 - c. Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
 3. Wire ties not permitted.

2.02 CONCRETE

A. Materials:

1. Cementitious Materials:
 - a. Cement:
 - 1) Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.
 - 2) Blended Hydraulic Cement:
 - a) Unless otherwise specified, conform to requirements of ASTM C595/C595M.
 - b) Portland cement used in blended hydraulic cement; conform to requirements of ASTM C150/C150M.
 - 3) Furnish from one source.
 - b. Supplementary Cementitious Materials (SCM):
 - 1) Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
 - a) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
 - 2) Slag Cement: In accordance with ASTM C989, Grades 100 or 120.
2. Aggregates: Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.
 - a. Aggregates:
 - 1) In accordance with ASTM C33/C33M, except as modified herein.
 - a) Class Designation: 4S unless otherwise specified.
 - b) Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
 - c) Alkali Silica Reactivity: See Article Concrete Mix Design.
 - 2) Fine Aggregates:
 - a) Clean, sharp, natural sand.
 - b) ASTM C33/C33M.
 - c) Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
 - (1) Limit material finer than 75- μ m (No. 200) sieve to 3 percent mass of total sample.
 - (2) Limit coal and lignite to 0.5 percent.

- 3) Coarse Aggregate:
 - a) Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
 - b) Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.
3. Admixtures: Unless otherwise permitted, furnish from one manufacturer.
 - a. Characteristics:
 - 1) Compatible with other constituents in mix.
 - 2) Contain at most, only trace amount chlorides in solution.
 - 3) Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
 - b. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
 - c. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - d. Accelerating Admixture: ASTM C 494/C 494M, Type C.
 - e. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
 - f. Do not use calcium chloride as an admixture.
 - g. Admixtures with no standard, ASTM or other, designation may be used where permitted.
4. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water, unless alternative sources of water are permitted.
 - a. Water from alternative sources shall comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water shall be less than:
 - 1) Chloride Content: 1,000 ppm.
 - 2) Sulfate Content as SO₄: 3,000 ppm.
 - 3) Alkalis as (Na₂O + 0.658 K₂O): 600 ppm.
 - 4) Total Solids by Mass: Less than 50,000 ppm.

B. Concrete Mix Design:

1. General:
 - a. See Supplement at the end of this section for mix design requirements for each class of concrete used on Project.
 - b. Prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301, unless otherwise specified.
 - c. Selection of constituent materials and products in mix design are optional, unless specified otherwise.

- d. Unless otherwise permitted, use water-reducing admixture or high-range, water-reducing admixture, or plasticizing admixture in pumped concrete, in concrete with a water-cementitious materials ratio below 0.50, and in concrete that is part of a liquid-containment structure.
 - e. Unless otherwise permitted, use water-reducing admixture and high-range, water-reducing admixture, or plasticizing admixture in columns, piers, pilasters, and walls.
 - f. Use water-reducing admixture or high-range, water-reducing admixture, or plasticizing admixture to achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.
 - g. Use water-reducing and retarding admixture when anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.
 - h. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor, and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.
 - i. Contractor is encouraged to consider using environmentally sustainable concrete mix design technologies such as use of supplementary cementitious materials, aggregate packing, and self-consolidating concrete.
2. Potential alkali-aggregate reactivity of concrete:
- a. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).
 - b. Aggregates shall have been tested to determine potential alkali-aggregate reactivity in concrete in accordance with ASTM C1260/C1260M or ASTM C1567.
 - 1) Aggregates that indicate expansion greater than 0.10 percent at 16 days after casting shall not be used unless they have been shown to be nondeleteriously reactive in accordance with ASTM C1293, with less than 0.04 percent expansion at 1 year for cement-aggregate combinations or less than 0.04 percent expansion at 2 years for combinations with pozzolan or slag.
 - 2) Alkali content of cement used in proposed concrete mixture shall not be greater than alkali content of cement used in test for potential alkali-aggregate reactivity.
 - c. Use low alkali cement and incorporate pozzolans into the concrete mixture as necessary to satisfy testing for potential alkali reactivity.

3. Proportions:
 - a. Design mix to meet aesthetic, durability, and strength requirements.
 - b. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.
4. Slump:
 - a. Unless otherwise permitted, target slump value is 4 inches at point of delivery, for concrete without high-range, water-reducing admixture.
 - b. Design mixes that include a high-range, water-reducing admixture shall have a minimum slump of 2 inches prior to addition of admixture. Unless otherwise permitted, slump shall be 8 inches maximum at point of delivery, for concrete with a high-range, water-reducing admixture.
 - c. Slump tolerance shall meet requirements of ACI 117.

C. Concrete Mixing:

1. General: In accordance with ACI 301, except as modified herein.
2. Truck Mixers:
 - a. For every truck, test slump or slump flow of samples taken per ASTM C94/C94M, paragraph 12.5.1.
 - b. Where specified slump is more than 4 inches, and if slump tests differ by more than 2 inches, discontinue use of truck mixer, unless causing condition is corrected and satisfactory performance is verified by additional slump tests.

2.03 REINFORCING STEEL

- A. Deformed Steel Reinforcing Bars: ASTM A615/A615M, Grade 60. Welding of reinforcing bars is not permitted.
- B. Fabrication: Follow CRSI Manual of Standard Practice.

2.04 ANCILLARY MATERIALS

- A. Bonding Agent: Unless otherwise specified, in accordance with the following:
 1. ASTM C881/C881M, Type V.
 2. Two-component, moisture insensitive, 100 percent solids epoxy.
 3. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
 4. Manufacturers and Products:
 - a. BASF Building Systems Inc., Shakopee, MN; MasterInject 1500.
 - b. Euclid Chemical Co., Cleveland, OH; Euco # 352 Epoxy System LV.
 - c. Prime Resins, Conyers, GA; Prime Bond 3000 to 3900 Series.
 - d. Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.

B. Bond Breaker:

1. Nonstaining type, providing positive bond prevention.
2. Manufacturers and Products:
 - a. Dayton Superior Corporation, Kansas City, KS; EDOCO Clean Lift Bond Breaker.
 - b. Nox-Crete Products Group, Omaha, NE; Silcoseal Select.

C. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-, epoxy-, or plastic-coated wire.

D. Bar Supports and Spacers:

1. Use precast concrete bar supports and side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.

E. Plastic Waterstop:

1. Extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.
2. Specific Gravity: Approximately 1.37.
3. Shore Durometer Type A Hardness: Approximately 80.
4. Performance Requirements: COE Specification CRD-C-572.
5. Type Required in Contraction and Control Joints: 6 inches wide and parallel longitudinal ribs or protrusions on each side of strip center, as indicated on Drawings.
6. Type Required in Construction Joints: Flat ribbed with same dimensional properties as described above.
7. Corrugated or tapered type waterstops are not acceptable.
8. Thickness: Constant from center bulb (or center of waterstop), to outside stop edge.
9. Waterstop Weight: 1.60 pounds for 3/8 inch by 6 inches, minimum per foot.
10. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

11. Manufacturers and Products:

a. Center Bulb Type:

- 1) Vinylex Corp., Knoxville, TN; Catalog No. 03250/VIN: No. RB6-38H (6 inches by 3/8 inch).
- 2) Greenstreak Plastic Products, St. Louis, MO; Catalog No. 03150/GRD: Style 732 (6 inches by 3/8 inch).
- 3) Four Seasons Industries Durajoint, Garrettsville, OH; Catalog No. CSP-162: Type 9 (6 inches by 3/8 inch).
- 4) BoMetals, Carrollton, GA; Catalog No. RCB-638LB (6 inches by 3/8 inch).
- 5) Dacon Plastics LLC, Portland, OR, (903) 245-0048; Catalog No. RCB17 (6 inches by 3/8 inch).

b. Flat Ribbed Profile: Use same manufacturers as bulb type.

F. Premolded Joint Filler:

1. Sponge Rubber:

- a. Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum.
- b. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK515IHD.

2. Self-Expanding Cork:

- a. ASTM D1752, Type III.
- b. Manufacturer and Product: WR Meadows, Inc., Hampshire, IL; Self-expanding cork. (800) 342-5976.

G. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315 Type I, Class A.
2. Manufacturers and Products:
 - a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
 - b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
 - c. Vexcon Chemical, Inc.; Philadelphia, PA; Starseal 1315.
 - d. Dayton Superior; Safe Cure and Seal 1315 EF.

H. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
 - a. BASF Construction Chemicals, Shakopee, MN; MasterKure ER 50.
 - b. Euclid Chemical Co., Cleveland, OH; Eucobar.

I. Nonshrink Grout:

1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
 - a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
 - b. Temperatures of 40 degrees F, 80 degrees F, and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1 yard to 9 yard loads in ready-mix truck.
8. Manufacturers and Products:
 - a. BASF Building Systems, Inc., Shakopee, MN; MasterFlow 928.
 - b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
 - c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
 - d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.

J. Repair Material:

1. Contain only trace amounts of chlorides and other chemicals that can potentially cause steel to oxidize.
2. Where repairs of exposed concrete are required, prepare mockup using proposed repair materials and methods, for confirmation of appearance compatibility prior to use.
3. Obtain Manufacturer's Certificate of Compliance that products selected are appropriate for specific applications.
4. Repair mortar shall be Site mixed.
5. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.
6. Manufacturers and Products:
 - a. BASF Building Systems Inc., Shakopee, MN; MasterEmacoS-Series products.
 - b. Sika Chemical Corp., Lyndhurst, NJ; SikaTop-Series.

K. Crack Repair:

1. Obtain Letter of Certification from manufacturer's technical representative, that products selected are appropriate for the specific applications.
2. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.

3. When crack repair is deemed by Engineer as requiring a structural repair, use part epoxy injection resin.
 - a. Manufacturers:
 - 1) BASF Construction Chemicals, LLC-Building Systems Shakopee, MN; MasterInject series.
 - 2) Euclid Chemical Co., Cleveland, OH.; Euco Series (#452).
 - 3) Sika Chemical Corp., Lyndhurst, NJ.; Sikadur Series.
4. When leak repair is deemed by Engineer as requiring a non-structural repair, use hydrophilic polyurethane injection resin.
 - a. Manufacturers:
 - 1) BASF Construction Chemicals, LLC-Building Systems Shakopee, MN; MasterInject 1210 IUG.
 - 2) Euclid Chemical Co., Cleveland, OH.; Dural Aqua –Fil.
 - 3) Sika Chemical Corp., Lyndhurst, NJ.; SikaFix HH Hydrophilic.
 - 4) Prime Resins, Inc., Conyers, GA.; Prime Flex 900 XLV.

2.05 SOURCE QUALITY CONTROL

- A. Source Quality Control Inspection: Engineer shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and Subcontractors, providing products included in this section.

PART 3 EXECUTION

3.01 FORMWORK

- A. Form Construction:
 1. Construct forms and provide smooth-form finish.
 2. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
 3. Make joints tight to prevent escape of mortar and to avoid formation of fins.
 4. Brace as required to prevent distortion during concrete placement.
 5. On exposed surfaces, locate form ties in uniform pattern or as shown.
 6. Construct so ties remain embedded in the member with no metal within 1 inch of concrete surface when forms, inserts, and tie ends are removed.
- B. Form Removal:
 1. Nonsupporting forms (walls and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
 - a. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
 - b. Curing and protection operations are maintained.
 2. Remove forms with care to prevent scarring and damaging the surface.

3.02 PLACING REINFORCING STEEL

- A. Unless otherwise specified, place reinforcing steel in accordance with CRSI Recommended Practice for Placing Reinforcing Bars.
- B. Splices and Laps:
 - 1. Lap splice reinforcing: Refer to Structural General Notes in Drawings for additional information.
 - 2. Tie splices with 18-gauge annealed wire as specified in CRSI Standard.

3.03 INSTALLATION OF WATERSTOPS

- A. General:
 - 1. Continuous waterstop (as specified) shall be installed in all construction joints in walls and slabs of water holding basins and channels and in walls of belowgrade structures, unless specifically noted otherwise.
 - 2. Join waterstop at intersections to provide continuous seal.
 - 3. Center waterstop on joint.
 - 4. Secure waterstop in correct position. Tie waterstop to reinforcing steel using grommets, "Hog Rings," or tie wire at maximum spacing of 12 inches. Do not displace waterstop during concrete placement.
 - 5. Repair or replace damaged waterstop.
 - 6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.
 - 7. Joints in Footings and Slabs:
 - a. Ensure that space beneath plastic waterstop is completely filled with concrete.
 - b. During concrete placement, make visual inspection of waterstop area.
 - c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.
 - 8. Plastic Waterstop:
 - a. Install in accordance with manufacturer's written instructions.
 - b. Splice in accordance with waterstop manufacturer's written instructions using Teflon-coated thermostatically controlled heating iron at approximately 380 degrees F.
 - 1) Allow at least 10 minutes before new splice is pulled or strained in any way.
 - 2) Finished splices shall provide cross section that is dense and free of porosity with tensile strength of not less than 80 percent of unspliced materials.

- 3) Use only factory made waterstop fabrications for all intersections, changes of directions and transitions.
- 4) Field splice permitted only for straight butt welds.
- c. Wire looped plastic waterstop may be substituted for plastic waterstop.

3.04 CONCRETE PLACEMENT INTO FORMWORK

- A. Inspection: Notify Engineer and Special Inspector at least one work day in advance before starting to place concrete.
- B. Placement into Formwork:
 - 1. Reinforcement: Secure in position before placing concrete.
 - 2. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs that shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
 - 3. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
 - 4. Use placement devices, for example, chutes, pouring spouts, and pumps as required to prevent segregation.
 - 5. Vertical Free Fall Drop to Final Placement:
 - 6. Forms 8 Inches or Less Wide: 5 feet.
 - 7. Forms Wider than 8 Inches: 8 feet, except as specified.
 - 8. For placements where drops are greater than specified, use placement device such that free fall below placement device conforms to required value.
 - a. Limit free fall to prevent segregation caused by aggregates hitting steel reinforcement.
 - 9. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
 - 10. Joints in Footings and Slabs:
 - a. Ensure space beneath plastic waterstop completely fills with concrete.
 - b. During concrete placement, make visual inspection of entire waterstop area.
 - c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift waterstop to confirm full consolidation without voids, and place remaining concrete to full height of slab.
 - d. Apply procedure to full length of waterstop.
 - 11. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.

C. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Wipe clean with device that does not allow mortar to adhere to belt.
4. Cover conveyor belts and chutes.

D. Retempering: Not permitted for concrete where cement has partially hydrated.

E. Pumping of Concrete:

1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

F. Retempering: Not permitted for concrete where cement has partially hydrated.

G. Maximum Size of Concrete Placements:

1. Limit size of each placement to allow for strength gain and volume change as a result of shrinkage.
2. Locate control and contraction joints where shown.
3. Construction Joints: Unless otherwise shown or permitted, locate construction joints as follows:
 - a. Locate construction joints as shown on Drawings or where approved in the joint location submittal.
 - b. Locate control, and contraction joints where shown on Drawings.
 - c. Provide vertical construction joints at maximum spacing of 40 feet unless shown or approved otherwise.
 - d. When vertical contraction or control joint spacing does not exceed 60 feet, intermediate construction joints are not required.
 - e. Uniformly space vertical construction joints within straight sections of walls, avoiding penetrations.
4. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

H. Minimum Time between Adjacent Placements:

1. Construction Joints: 7 days.
2. Construction joint between top of footing or slab, and wall: As soon as can safely be done without damaging previously cast concrete or interrupting curing thereof, but not less than 24 hours.

3.05 CONSOLIDATION AND VISUAL OBSERVATION

- A. Provide at least one standby vibrator in operable condition at placement Site prior to placing concrete.

3.06 HOT WEATHER PLACEMENT

- A. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
1. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
 2. Internal concrete temperature in structure shall not exceed 158 degrees F, and maximum temperature differential between center of section and external surfaces of concrete shall not exceed 35 degrees F.
 3. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
 4. Cure as specified.

3.07 CONCRETE BONDING

- A. Construction Joints at Existing Concrete:
1. Thoroughly clean and roughen existing concrete surfaces to roughness profile of 1/4 inch.
 2. Saturate surface with water for 24 hours prior to placing new concrete.

3.08 PREMOLDED JOINT FILLER INSTALLATION

- A. Sufficient in width to completely fill joint space where shown.
- B. Drive nails approximately 1 foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.
- C. Secure premolded joint filler in forms before concrete is placed.

3.09 FINISHING FORMED SURFACES

- A. Provide surface finish 2.0 (SF-2.0) in accordance with ACI 301 and as herein specified.
- B. Tie Holes: Unless otherwise specified, fill with specified repair material.
 - 1. Prepare substrate and mix, place, and cure repair material per manufacturer's written recommendations.
- C. Repair defective areas of concrete.
 - 1. Cut edges perpendicular to surface at least 1/2 inch deep. Do not feather edges. Soak area with water for 24 hours.
 - 2. Patch with specified repair material.
 - 3. Repair concrete surfaces using specified materials. Select system, submit for review, and obtain approval from Engineer prior to use.
 - 4. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Engineer.
 - 5. Obtain quantities of repair material and manufacturer's detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
 - 6. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Engineer.
- D. Inject cracks that leak.

3.10 FINISHING UNFORMED SURFACES

- A. General:
 - 1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
 - 2. Do not use "jitterbugs" or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
 - 3. Do not dust surfaces with dry materials nor add water to surfaces.
 - 4. Cure concrete as specified.
- B. Slab Tolerances:
 - 1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.

2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
3. Steel gauge block 5/16 inch thick.
4. Finish Slab Elevation: Slope slabs to floor drain and gutter, and shall adequately drain regardless of tolerances.
5. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

C. Exterior Slab Finish:

1. Provide broom finish unless specified otherwise.
2. Finish exposed edges with steel edging tool.
3. Mark sidewalks transversely at 5-foot intervals with jointing tool.

3.11 EXPOSED METAL OBJECTS

- A. Remove metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
- B. Repair area of chipped-out concrete as specified for defective areas.

3.12 BLOCKOUTS AT PIPES OR OTHER PENETRATIONS

- A. Where shown, install in accordance with requirements of Drawings.

3.13 PROTECTION AND CURING

- A. Protect and cure concrete in accordance with requirements of ACI 301, ACI 308.1, and as follows:
 1. Protect fresh concrete from direct rays of sunlight, drying winds, and wash by rain.
 2. Keep concrete slabs continuously wet for a 7-day period. Intermittent wetting is not acceptable.
 3. Use curing compound only where approved by Engineer.
 4. Cure formed surfaces with curing compound applied in accordance with manufacturer's written instructions as soon as forms are removed and finishing is completed.
 5. Remove and replace concrete damaged by freezing.
 6. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.14 NONSHRINK GROUT

- A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's written instructions.

3.15 BACKFILL AGAINST STRUCTURES

- A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.
- B. Refer to General Structural Notes on the Drawings for additional requirements, including elevated slab and diaphragm completion prior to backfill.
- C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.16 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. General:
 - 1. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.
 - 2. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
 - 3. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
 - 4. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
 - 5. Evaluation will be in accordance with ACI 301 and Specifications.
 - 6. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
 - 7. Frequency of testing may be changed at discretion of Engineer.
 - 8. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M.
 - 9. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.

B. Concrete Strength Test:

1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing by 7 additional days.
3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Engineer.

C. Slab Finish Tolerances and Slope Tolerances:

1. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
2. Compliance with designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

3.17 MANUFACTURER'S SERVICES

A. Provide representative at Site for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

B. Concrete Producer Representative:

1. Concrete Producer Representative:
 - a. Observe how concrete mixes are performing.
 - b. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
 - c. Establish control limits on concrete mix designs.
 - d. Provide equipment for control of concrete redosing for air entrainment or high-range, water-reducing admixture, superplasticizers, at Site to maintain proper slump or slump flow, and air content when specified.
2. Admixture Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.
3. Bonding Agent Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.18 SUPPLEMENTS

A. Requirements of concrete mix designs following “End of Section,” are a part of this Specification and supplement requirements of Part 1 through Part 3 of this section:

1. Concrete Mix Design, Class 4500F1S1P1C1.

END OF SECTION

CONCRETE MIX DESIGN, CLASS 4500F1S1P1C1:

- A. Mix Locations: Typical, unless otherwise specified.
- B. Exposure Categories and Classifications: F1S1P1C1
- C. Mix Properties:
 - 1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.42.
 - 2. Minimum concrete compressive strength (f'_c) shall be 4,000 psi at 28 days and 4,500 psi at 56 days.
 - 3. Concrete mix shall be designed to conform to shrinkage limits.
 - 4. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
 - a. Slabs to receive hard-troweled finish.
 - b. Slabs to receive dry shake floor hardener.
 - c. Slabs to receive topping placed monolithically as two-course floor on top of plastic concrete.
 - 5. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
3/8	6.0
1/2	5.5
3/4	5.0
1	4.5

‡ See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

* Tolerance of air content is $\pm 1\frac{1}{2}$ percent.

§ Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.

- 6. Provide cementitious materials in accordance with one of the following:
 - a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.

- b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
 - 1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
 - 2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
 - c. ASTM C595/C595M Types IP or IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
 - 1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months
 - 7. Unless otherwise permitted, minimum cementitious materials content in mix design shall be as follows:
 - a. 515 pounds per cubic yard for concrete with 1-1/2-inch nominal maximum size aggregate.
 - b. 535 pounds per cubic yard for 1-inch nominal maximum size aggregate.
 - c. 560 pounds per cubic yard for 3/4-inch nominal maximum size aggregate.
 - d. 580 pounds per cubic yard for 1/2-inch nominal maximum size aggregate.
 - e. 600 pounds per cubic yard for 3/8-inch nominal maximum size aggregate.
 - f. Unless otherwise permitted, limit cementitious materials content to 100 pounds per cubic yard greater than specified minimum cementitious materials content in mix design.
 - 8. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent, unless otherwise specified.
 - a. Limits are stated in terms of chloride ions in percent by weight of cement.
 - b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to PART 1 through PART 3 of this Section for additional requirements.

**SECTION 03 63 00
CONCRETE DOWELING**

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).
 2. ASTM International (ASTM):
 - a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
 3. International Code Council (ICC):
 - a. Florida Building Code Fifth Edition (2014).
 - b. Evaluation Services Reports.

1.02 DEFINITIONS

- A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.
- B. Inspection: As defined in the FBC.

1.03 SUBMITTALS

- A. Action Submittals:
1. Product Data: Manufacturer's catalog information.
- B. Informational Submittals:
1. Manufacturer's instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
 2. Manufacturer's written letter of certification identifying installer's qualifications to install products.
 3. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Installer: Trained and certified by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Container Markings: Include manufacturer's name, product name, batch number, [mix ratio by volume], product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

B. Store adhesive components in accordance with manufacturer's written instructions.

C. Dispose of when:

1. Shelf life has expired.
2. Stored other than per manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive:

1. Approved by an ICC Evaluation Services Report for conformance to FBC requirements for doweling of steel reinforcing bars in cracked concrete.
2. Suitable for long-term loads as well as for wind loads.
3. Meet requirements of ASTM C881/C881M.
4. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
5. Disposable, Self-Contained Cartridge System:
6. Capable of dispensing both components in proper mixing ratio.
7. Fit into manually or pneumatically operated caulking gun.
8. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
9. Manufacturers and Products:
 - a. Hilti, Inc., Tulsa, OK; HIT-RE 500-SD or HIT-HY 200 Adhesive Anchors.
 - b. Powers Fasteners, Brewster, NY; Power PURE110+ Epoxy Adhesive Anchor System.
 - c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors.

- B. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.
- C. Reinforcing Dowels: As specified in Section 03 10 00, Structural Concrete.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Drilling Equipment:
 - 1. Drilling Hammers for Dowel Holes:
 - a. Electric or pneumatic rotary type with medium or light impact.
 - b. Hollow drills with flushing air systems are preferred.
 - 2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.
- B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.
- C. Obstructions in Drill Path: When existing steel reinforcement is encountered during drilling, obtain Engineer approval for proposed fix.
- D. Doweling:
 - 1. Install per details shown on Drawings and in accordance with adhesive manufacturer's instructions.
 - 2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
 - 3. Bent Bar Dowels: Where edge distances are critical, and intersection with steel reinforcement is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.
- E. Adhesive:
 - 1. Install in accordance with written manufacturer's instructions.
 - 2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 05 50 00 METAL FABRICATIONS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
2. American Galvanizers Association (AGA):
 - a. Inspection of Hot-Dip Galvanized Steel Products.
 - b. Quality Assurance Manual.
3. American Iron and Steel Institute (AISI): Stainless Steel Types.
4. American Ladder Institute (ALI): A14.3, Ladders - Fixed - Safety Requirements.
5. American National Standards Institute (ANSI).
6. American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
7. American Welding Society (AWS):
 - a. D1.1/D1.1M, Structural Welding Code - Steel.
 - b. D1.2/D1.2M, Structural Welding Code - Aluminum.
 - c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
8. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A48/A48M, Specification for Gray Iron Castings.
 - c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

- j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- k. A276, Standard Specification for Stainless Steel Bars and Shapes.
- l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
- o. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
- p. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
- q. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
- r. A489, Standard Specification for Carbon Steel Lifting Eyes.
- s. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- t. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- u. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- v. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- w. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- x. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
- y. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
- z. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
- aa. A992/A992M, Standard Specification for Structural Steel Shapes.
- bb. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- cc. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
- dd. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

- ee. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
- ff. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- gg. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
- hh. F436, Standard Specification for Hardened Steel Washers.
- ii. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
- jj. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- kk. F594, Standard Specification for Stainless Steel Nuts.
- ll. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
- mm. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- 9. International Code Council Evaluation Service (ICC-ES):
 - a. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
 - b. AC106, Acceptance Criteria for Pre drilled Fasteners (Screw Anchors) in Masonry Elements.
 - c. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
 - d. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
 - e. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
- 10. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
- 11. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR 1910.27, Fixed Ladders.
 - b. 29 CFR 1926.105, Safety Nets.
 - c. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.
- 12. Specialty Steel Industry of North America (SSINA):
 - a. Specifications for Stainless Steel.
 - b. Design Guidelines for the Selection and Use of Stainless Steel.
 - c. Stainless Steel Fabrication.
 - d. Stainless Steel Fasteners.

1.02 DEFINITIONS

- A. Anchor Bolt: Cast-in-place anchor; concrete or masonry.
- B. Concrete Anchor: Post-installed concrete anchors listed in this Specification.

- C. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.
- D. Exterior Area: Location not protected from weather by building or other enclosed structure.
- E. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.
- F. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.
- G. Masonry Anchor: Post-installed masonry anchors listed in this specification.
- H. Submerged: Location at or below top of wall of open water-holding structure, such as basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Metal fabrications, including welding and fastener information.
 - b. Specific instructions for concrete anchor installation, including drilled hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.
 - 2. Samples: Color samples of abrasive stair nosings.
- B. Informational Submittals:
 - 1. Concrete and Masonry Post-Installed Anchors:
 - a. Manufacturer's product description and printed installation instructions.
 - b. Current ICC-ES Report for each type of post-installed anchor to be used.
 - c. Adhesive Anchor Installer Certification.
 - 2. U-Channel Concrete Inserts:
 - a. Manufacturer's product description.
 - b. Allowable load tables.
 - 3. Ladders: Letter of certification that ladder meets OSHA 29 CFR 1910.27 requirements.
 - 4. Passivation method for stainless steel members.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Adhesive Anchor Installer: Trained to install adhesive anchors in accordance with manufacturer's printed installation instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Insofar as practical, factory assemble specified items. Assemblies, because of necessity, have to be shipped unassembled shall be packaged and tagged in manner that will protect materials from damage and will facilitate identification and field assembly.
- B. Package stainless steel items in a manner to provide protection from carbon impregnation.
- C. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.
- D. Store fabricated items in dry area, not in direct contact with ground.
- E. Store adhesives anchors at service temperature ranges recommended by manufacturer.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 304 (304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)

Item	ASTM Reference
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Condition CW
Nuts	F594, AISI Type 316, Condition CW
Aluminum Plates and Structural Shapes	B209 and B308/B308M, Alloy 6061-T6

- B. Bolts, Washers, and Nuts: Use stainless steel as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

- A. Cast-In-Place Anchor Bolts:

1. Headed type, unless otherwise shown on Drawings.
2. Material type and protective coating as shown in Fastener Schedule at end of this section.

- B. Anchor Bolt Sleeves:

1. Plastic:
 - a. Single unit construction with corrugated sleeve.
 - b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
 - c. Material: High-density polyethylene.
 - d. Manufacturer: Sinco Products, Inc., Middletown, CT, (800) 243-6753.
2. Fabricated Steel: ASTM A36/A36M.

2.03 POST-INSTALLED CONCRETE ANCHORS

- A. General:

1. AISI Type 316 stainless as shown in Fastener Schedule at end of this section.
2. Current ICC-ES Report indicating acceptance per FBC 2014 for anchors at structural applications in cracked concrete.
3. Anchors shall be suitable for long-term loads, as well as for wind loads.

B. Adhesive Anchors (Epoxy Anchors):

1. If approved by Engineer, adhesive anchors used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report that demonstrates compliance with ICC-ES AC308 for cracked concrete.
2. Threaded Rod:
 - a. ASTM F593 stainless steel threaded rod, diameter as shown on Drawings.
 - b. Length as required, to provide minimum depth of embedment.
 - c. Clean and free of grease, oil, or other deleterious material.
 - d. For hollow-unit masonry, provide galvanized or stainless steel wire cloth screen tube to fit threaded rod.
3. Adhesive:
 - a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
 - b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
 - c. Mixed Adhesive: Nonsag light paste consistency with ability to remain in 1-inch diameter overhead drilled hole without runout.
 - d. Meet requirements of ASTM C881/C881M.
4. Packaging and Storage:
 - a. Disposable, self-contained cartridge system capable of dispensing both components in proper mixing ratio and fitting into manually or pneumatically operated caulking gun.
 - b. Store adhesive cartridges and adhesive components on pallets or shelving in covered storage area.
 - c. Container Markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
 - d. Dispose of when:
 - 1) Shelf life has expired.
 - 2) Stored other than in accordance with manufacturer's instructions.
5. Manufacturers and Products:
 - a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 SD.
 - b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors.
 - c. Powers Fasteners, Brewster NY, PE1000+ Adhesive anchoring system.

C. Adhesive Threaded Inserts:

1. Stainless steel, internally threaded inserts.
2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500-SD adhesive.

2.04 POST-INSTALLED MASONRY ANCHORS

- A. General: AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in Fastener Schedule at end of this section.
- B. Current ICC Evaluation Report indicating acceptance per FBC 2014 for anchors at structural applications in masonry.
- C. Manufacturers and Products:
1. Hilti, Inc., Tulsa, OK; Kwik-Bolt-3 (KB-3) (ESR-1385), for grout-filled masonry.
 2. Powers Fasteners, Brewster NY, T308+ Epoxy Adhesive Anchoring System in Unreinforced Masonry (ESR-3149), Power-Stud+ SD1 (ESR-2966) for grout-filled masonry, Wedgebolt+ (ESR-1678) for grout-filled masonry.

2.05 EMBEDDED STEEL SUPPORT FRAMES FOR FLOOR PLATE AND GRATING

- A. Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.
- B. Welded anchors for stainless steel support frames shall also be stainless steel.

2.06 U-CHANNEL CONCRETE INSERTS

- A. Rolled ASTM A240/A240M, AISI Type 316 stainless steel, 0.105-inch-thick, 1-5/8 inches wide by 1-3/8 inches deep, with stainless steel anchors at 10-inch maximum spacing, styrofoam fillers, and end caps.
- B. Nut and Bolt Hardware: Type 316 stainless steel, 5/8-inch minimum diameter, unless indicated otherwise. Manufacturer's standard to match insert.
- C. Manufacturers and Products:
1. Power-Strut, Wayne, MI; PS 349 Series.
 2. B-Line Systems, Inc., Highland, IL; B32 Series.
 3. Halfen Anchoring Systems, Converse, TX; Channel Type 4141HTA.

2.07 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

1. Suitable for potable water supply.
2. Resists washout.
3. Manufacturers and Products:
 - a. Bostik, Middleton, MA; Neverseez.
 - b. Saf-T-Eze Div., STL Corp., Lombard, IL; Anti-Seize.

B. Neoprene Gasket:

1. ASTM D1056, 2C1, soft, closed-cell neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown on Drawings.
2. Thickness: Minimum 1/4 inch.
3. Furnish without skin coat.
4. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK1111LD.

2.08 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Aluminum: Meet requirements of AWS D1.2/D1.2M.
4. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
5. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1/D1.1M, Section 7, and manufacturer's instructions.
6. Complete welding before applying finish.

C. Painting:

1. Shop prime with rust-inhibitive primer as specified in Section 09 90 00, Painting and Coating, unless otherwise indicated.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

D. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385/A385M.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
7. Galvanized steel sheets in accordance with ASTM A653/A653M.
8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

E. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.

F. Watertight Seal: Where required or shown, furnish neoprene gasket covering full bearing surfaces.

G. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

H. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.09 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

1. Aluminum: AWS D1.2/D1.2M.
2. Stainless Steel: AWS D1.6/D1.6M.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Install manufactured products in accordance with manufacturer's recommendations.
4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.

B. Aluminum:

1. Do not remove mill markings from concealed surfaces.
2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
3. Fabrication, mechanical connections, and welded construction shall be in accordance with the AA Aluminum Design Manual.

3.02 CAST-IN-PLACE ANCHOR BOLTS

- A. Locate and hold anchor bolts in place with templates at time concrete is placed.
- B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.
- C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.03 CONCRETE AND MASONRY POST-INSTALLED ANCHORS

- A. Begin installation only after concrete or masonry to receive anchors has attained design strength.

- B. Install in accordance with manufacturer's instructions.
- C. Provide minimum embedment, edge distance, and spacing as follows, unless indicated otherwise by anchor manufacturer's instructions or shown otherwise on Drawings:

Anchor Type	Minimum Embedment (Bolt Diameters)	Minimum Edge Distance (Bolt Diameters)	Minimum Spacing (Bolt Diameters)
Adhesive	9	9	13.5

- D. Use only drill type and bit type and diameter recommended by anchor manufacturer. Clean hole of debris and dust with brush and compressed air per manufacturer's printed installation instructions.
- E. When embedded steel or rebar is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than 10 degrees to clear obstruction, notify Engineer for direction on how to proceed.
- F. Adhesive Anchors:
1. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F, unless cold temperature adhesives, compliant with ACI 308 are used. Refer to the respective ICC-ES report and manufacturer's printed installation instructions.
 2. Remove water from hole with oil-free compressed air. Damp or water filled holes may be allowed only if approved in manufacturer's printed installation instructions and ICC-ES report.
 3. For hollow-unit masonry, install screen tube in accordance with manufacturer's printed installation instructions.
 4. Do not disturb anchor during recommended curing time.
 5. Do not exceed maximum torque as specified in manufacturer's printed installation instructions.

3.04 U-CHANNEL CONCRETE INSERTS

- A. Provide as indicated for pipe supports and where otherwise shown on Drawings.
- B. Except for interior dry areas, use plastic clips or similar dielectric material to isolate channel anchors from concrete reinforcing steel.

3.05 ELECTROLYTIC PROTECTION

A. Aluminum:

1. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
2. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
3. Allow coating to dry before installation of the material.
4. Protect coated surfaces during installation.
5. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

B. Stainless Steel:

1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
5. After treatment, visually inspect surfaces for compliance.

3.06 PAINTING

- #### A. Painted Galvanized Surfaces: Prepare as specified in Section 09 90 00, Painting and Coating.

3.07 FIELD QUALITY CONTROL

A. Owner-Furnished Quality Assurance.

B. Contractor-Furnished Quality Control:

1. Inspection and testing required in Section 01 45 16.13, Contractor Quality Control.
2. Manufacturer's Certificate of Compliance for test results, or calculations, or drawings that ensure material and equipment design and design criteria meet requirements of Section 01 88 15, Anchorage and Bracing.

3.08 FASTENER SCHEDULE

A. Unless indicated otherwise on Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating	See Section 09 90 00, Painting and Coating
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 90 00, Painting and Coating
3. Drilled Anchors for Metal Components to Cast-in-Place Concrete (e.g., Ladders, Handrail Posts, Electrical Panels, and Equipment)		
Submerged, Exterior, Interior Wet, and Corrosive Areas	Adhesive stainless steel anchors	
4. Anchors in Hollow Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Stainless steel sleeve anchors, or stainless steel adhesive anchors with screen tube	
5. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
9. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

- B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION

SECTION 06 82 00
GLASS-FIBER-REINFORCED PLASTIC

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus.
 - b. D570, Standard Test Method for Water Absorption of Plastics.
 - c. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning Plastics in a Horizontal Position.
 - d. D638, Standard Test Method for Tensile Properties of Plastics.
 - e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
 - f. D696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 Degrees C and 30 Degrees C.
 - g. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - h. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) by Plastics Displacement.
 - i. D2344, Standard Test Method for Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short-Beam Method.
 - j. D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
 - k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. International Code Council (ICC): Florida Building Code (FBC).
3. Occupational Safety and Health Act (OSHA): 29 CFR 19.10, Code of Federal Regulations.
4. Underwriters' Laboratories, Inc. (UL): 94, UL Standard for Safety Test for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Product Data: Catalog information and catalog cuts showing materials, design tasks, and showing load, span, and deflection; include manufacturer's specifications.
 - b. Grating: Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
 - c. Grating Supports: Show dimensions, weight, size, location, and anchorage to supporting structure.

B. Informational Submittals:

1. Handling and storage requirements.
2. Manufacturer's installation instructions.
3. Factory test reports for physical properties of product.
4. Manufacturer's Certification of Compliance for specified products.
5. Fabricator's qualification experience.
6. Manufacturer's qualification experience.
7. Independent laboratory test report, dated within 2 years of submittal date, of fire retardant testing conducted on exact type of grating proposed (not a resin test report).

1.03 QUALIFICATIONS

- A. Manufacturer: Minimum of 5 years' experience in manufacturing of products meeting these specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:

1. Insofar as is practical, factory assemble items provided hereunder.
2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect materials from damage, and facilitate identification and final assembly in field.

- B. Storage and Handling: In accordance with manufacturer's recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.

PART 2 PRODUCTS**2.01 GENERAL**

- A. Like Items of Materials: Where possible, provide end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.
- B. Unless otherwise specified, all products shall be manufactured by a pultruded process using vinyl ester resin.
- C. Products shall be manufactured with ultra-violet (UV) inhibitor additives.
- D. Exterior surfaces shall have a synthetic surface veil covering.
- E. Furnish molded products as an option where permitted by specifications.
- F. Fire Retardance:
 - 1. Flame spread shall be less than 25 as measured by ASTM E84.
 - 2. Include combinations of aluminum trihydrate, halogen, and antimony trioxide, where required to meet fire retardance, in the resin system.
 - 3. Meet self-extinguishing requirements of ASTM D635.
- G. Color pigment shall be dispersed in resin system.
- H. Fabricate FRP products exposed to outdoor conditions with an additional 1-mil thick UV coating to shield product from UV light.
- I. All cut ends, holes, and abrasions of FRP shapes shall be sealed with resin to prevent intrusion of moisture.

2.02 GRATING

- A. General:
 - 1. 100 psf minimum, unless otherwise shown.
 - 2. Maximum Deflection: 1/4 inch, unless otherwise shown.
- B. Molded Type:
 - 1. Nonskid grit affixed to top of bar surface or a concave, meniscus top to all bars, providing skid resistance.
 - 2. Load bars in both directions with equal stiffness.
 - 3. Square mesh with 1-1/2-inch maximum spacing.

C. Pultruded Type:

1. Main bars joined by cross bars secured in holes drilled in main bars.
2. Cross bars with 6-inch maximum spacing shall mechanically lock main bars in position such that they prevent movement.
3. Intersections: Bond using adhesive as corrosive-resistant as pultrusion resin.
4. Main Bar Ends: Minimum bearing support width of 1-1/2 inches.
5. Skid-Resistant Surface: Grit adhesively bonded, manufacturer's standard.
6. Provide extra stiffness around openings.

D. Hold-Down Clamps: Type 316 stainless steel.

E. Bolts and Connectors:

1. Corrosion-resistant Type 316 stainless steel.
2. Size and strength to meet FBC requirements.

F. Fabrications:

1. Field measure areas to receive grating. Verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
2. Section Length: Sufficient to prevent it falling through clear opening when oriented in span direction when one end is touching either concrete or vertical leg of grating support.

G. Manufacturers:

1. Fibergrate Composite Structures, Inc., Addison, TX.
2. IKG/Borden, Clark, NJ.
3. Strongwell Corp., Bristol Division, Bristol, VA or Chatfield Division, Chatfield, MN.
4. International Grating, Inc., Houston, TX.

PART 3 EXECUTION

3.01 GENERAL

- A. Install in accordance with manufacturer's written instructions.
- B. Install plumb or level, rigid and neat, as applicable.

- C. Furnish fasteners and anchorages for complete installation.
- D. Seal field cut holes, edges, and abrasions with catalyzed resin compatible with original resin.

3.02 GRATING

- A. Anchor grating securely to supports to prevent displacement.
- B. Install each grating section such that it is easily removable.
- C. Clearance (Grating to Vertical Surfaces): 1/4 inch (plus or minus 1/8-inch tolerance).

END OF SECTION

SECTION 09 90 00 PAINTING AND COATING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
 - a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot-Applied.
 - b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
 - c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
5. Occupational Safety and Health Act (OSHA).
6. The Society for Protective Coatings (SSPC):
 - a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
 - b. PA 3, Guide to Safety in Paint Applications.
 - c. SP 1, Solvent Cleaning.
 - d. SP 2, Hand Tool Cleaning.
 - e. SP 3, Power Tool Cleaning.
 - f. SP 5, White Metal Blast Cleaning.
 - g. SP 6, Commercial Blast Cleaning.
 - h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
 - i. SP 10, Near-White Blast Cleaning.
 - j. SP 11, Power Tool Cleaning to Bare Metal.
 - k. SP 12, Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating.
 - l. SP 13, Surface Preparation of Concrete.
 - m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
6. Mil: Thousandth of an inch.
7. PDS: Product Data Sheet.
8. PSDS: Paint System Data Sheet.
9. PVC: Polyvinyl Chloride.
10. SFPG: Square Feet per Gallon.
11. SFPGPC: Square Feet per Gallon per Coat.
12. SP: Surface Preparation.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Data Sheets:
 - 1) For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.
 - 2) For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
 - 3) Technical and performance information that demonstrates compliance with Specification.
 - 4) Furnish copies of paint system submittals to the coating applicator.
 - 5) Indiscriminate submittal of only manufacturer's literature is not acceptable.
 - b. Detailed chemical and gradation analysis for each proposed abrasive material.
2. Samples:
 - a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.

b. Reference Panel:

1) Surface Preparation:

- a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
- b) Provide panel representative of the steel used; prevent deterioration of surface quality.
- c) Panel to be reference source for inspection upon approval by Engineer.

2) Paint:

- a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
- b) Furnish additional samples as required until colors, finishes, and textures are approved.
- c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

- 1. Applicator's Qualification: List of references substantiating experience.
- 2. Coating Manufacturer's Certificate of Compliance.
- 3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
- 4. Manufacturer's written verification that submitted material is suitable for the intended use.
- 5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
- 6. Manufacturer's written instructions and special details for applying each type of paint.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

- 1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.

2. Perform surface preparation and painting in accordance with recommendations of the following:
 - a. Paint manufacturer's instructions.
 - b. SSPC PA 3, Guide to Safety in Paint Applications.
 - c. Federal, state, and local agencies having jurisdiction.

C. Mockup:

1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
2. After Engineer approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

B. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

PART 2 PRODUCTS**2.01 GENERAL**

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MANUFACTURERS

- A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.
- B. Minimum of 5 years' verifiable experience in manufacture of specified product.
- C. Each of the following manufacturers is capable of supplying most of the products specified herein:
 - 1. Carboline.
 - 2. Sherwin Williams.
 - 3. Tenemec.
 - 4. PPG.

2.03 ABRASIVE MATERIALS

- A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.04 PAINT MATERIALS

- A. General:
 - 1. Manufacturer's highest quality products suitable for intended service.
 - 2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.

3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Epoxy Primer— Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish

2.05 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

- B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.06 SHOP FINISHES

- A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.

- B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:

1. When required by equipment Specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.

2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

D. Pipe:

1. Ductile Iron Pipe:
 - a. Use SSPC standards as a guide for desired prepared surface. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
 - b. The surface preparation and application of the primer and finish coats shall be performed by pipe manufacturer.
 - c. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
 - d. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.
- B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer's absence.
- C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

3.02 EXAMINATION

- A. Factory Finished Items:
 1. Schedule inspection with Engineer before repairing damaged factory-finished items delivered to Site.
 2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

- B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
- B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- D. Mask openings in motors to prevent paint and other materials from entering.
- E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

- A. Field Abrasive Blasting:
 - 1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
 - 2. Refer to coating systems for degree of abrasive blasting required.
 - 3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.
- B. Metal Surface Preparation:
 - 1. Where indicated, meet requirements of SSPC Specifications summarized below:
 - a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
 - b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
 - c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.

- d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
 - e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
 - f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
 - g. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
 - h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.
 - i. SP 12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating: Surface preparation using high-pressure and ultrahigh-pressure water jetting to achieve specified surface cleanliness condition. Surface cleanliness conditions are defined in SSPC SP 12 and are designated WJ-1 through WJ-4 for visual surface preparation definitions and SC-1 through SC-3 for nonvisual surface preparation definitions.
2. The words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, and “blast cleaning”, or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.
 3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.

4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. Welds and Adjacent Areas:
 - a. Prepare such that there is:
 - 1) No undercutting or reverse ridges on weld bead.
 - 2) No weld spatter on or adjacent to weld or any area to be painted.
 - 3) No sharp peaks or ridges along weld bead.
 - b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
8. Preblast Cleaning Requirements:
 - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
 - b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
 - c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
9. Blast Cleaning Requirements:
 - a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
 - b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
 - c. Use only dry blast cleaning methods.
 - d. Do not reuse abrasive, except for designed recyclable systems.
 - e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
10. Post-Blast Cleaning and Other Cleaning Requirements:
 - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
 - b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

3.05 SURFACE CLEANING

A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

B. Acid Etching:

1. After precleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
2. Application:
 - a. Rate: Approximately 2 gallons per 100 square feet.
 - b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
 - c. Acid will react vigorously for a few minutes, during which time brushing shall be continued.
 - d. After bubbling subsides (10 minutes), hose down remaining slurry with high pressure clean water.
 - e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
 - f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
3. Ensure surface is completely dry before application of coating.
4. Apply acid etching to obtain a "grit sandpaper" surface profile. If not, repeat treatment.

C. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for new, exterior surfaces to be painted, whether specifically mentioned or not, except as specified otherwise.
2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
5. Sand wood lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Water-Resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 10 specification.
3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

C. Porous Surfaces, Such As Concrete and Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
 - a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

D. Film Thickness and Coverage:

1. Number of Coats:
 - a. Minimum required without regard to coating thickness.
 - b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
 - a. Do not exceed coating manufacturer's recommendations.
 - b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
 - a. Perform with properly calibrated instruments.
 - b. Recoat and repair as necessary for compliance with Specification.
 - c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

- A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

- B. Additional requirements are included in the Piping Schedule.
- C. See Section 09 96 35, Chemical Resistant Coating, for coating system for liquid ammonium sulfate storage tank pad and trench surfaces.
- D. System No. 4 Exposed Metal—Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer— Ferrous Metal	1 coat, 2.5 MDFT
	High Build Epoxy	1 coat, 4 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:
 - a. Exposed metal surfaces.

- E. System No. 25 Exposed PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Semigloss	2 coats, 320 SFPGPC

1. Use on the following items or areas:
 - a. All exposed-to-view PVC surfaces.

3.08 COLORS

- A. Provide as and shown in Piping Schedule.
- B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.
- C. Equipment Colors:
1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
 2. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
 - a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
 - b. Fire Protection Equipment and Apparatus: OSHA Red.

- c. Radiation Hazards: OSHA Purple.
- d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:

- 1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
- 2. Pipe Color Coding: In accordance with Piping Schedule.
- 3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.

3.09 FIELD QUALITY CONTROL

A. Testing Equipment:

- 1. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
- 2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
- 3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

B. Testing:

- 1. Thickness and Continuity Testing:
 - a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
 - b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE RP0188.

- c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE RP0188.
 - d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.
- C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.
- D. Unsatisfactory Application:
 - 1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
 - 2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
 - 3. Repair defects in accordance with written recommendations of coating manufacturer.
- E. Damaged Coatings, Pinholes, and Holidays:
 - 1. Feather edges and repair in accordance with recommendations of paint manufacturer.
 - 2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
 - 3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.10 MANUFACTURER'S SERVICES

- A. Coating manufacturer's representative shall be present at Site as follows:
 - 1. On first day of application of any coating system.
 - 2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
 - 3. As required to resolve field problems attributable to or associated with manufacturer's product.
 - 4. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.11 CLEANUP

- A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.
- B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.
- C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.12 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are a part of this Specification:
 - 1. Paint System Data Sheet (PSDS).
 - 2. Product Data Sheet (PDS).

END OF SECTION

PAINT SYSTEM DATA SHEET

Complete this PSDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	Product Name/Number (Proprietary)	Min. Coats, Coverage

PAINT PRODUCT DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio: _____

Maximum Permissible Thinning: _____

Ambient Temperature Limitations: min.: _____ max.: _____

Surface Temperature Limitations: min.: _____ max.: _____

Surface Profile Requirements: min.: _____ max.: _____

SECTION 09 96 35
CHEMICAL-RESISTANT COATINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. D522, Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
 - b. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
 - c. F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - d. F2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In Situ Probes.
2. International Concrete Restoration Institute (ICRI): Guideline 03732, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymers.
3. The Society for Protective Coatings (SSPC): SSPC-SP13/NACE 6, Surface Preparation of Concrete.

1.02 ABBREVIATIONS

- A. CRC: Chemical Resistant Coating.
- B. MDFT: Minimum Dry Film Thickness per Coat.
- C. Mil: One thousandth of an inch.
- D. SSPC SP: Surface Preparation Standard for Protective Coatings.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Furnish a CRC Data Sheet (CRCDS) for each CRC system. The CRCDS form is appended to the end of this Section.
 - b. Indiscriminate submittal of manufacturer's literature only is not acceptable.

- c. The following information shall be appended to each CRCDS:
 - 1) Manufacturer's technical data sheets.
 - 2) Chemical resistance test results for exposure to service conditions.
 - a) Provide specific chemical resistance data for chemicals not listed in the manufacturer's standard data sheets.
 - 3) Manufacturer's application specification.
 - 4) Scaled drawings showing installation plan, including configuration details for the following:
 - a) Expansion joints and structural isolation joints.
 - b) Construction joints.
 - c) Cracks.
 - d) Wall base details.
 - e) Equipment bolts (when installed before or after CRC application).
 - f) Metal angle frames at trenches, gratings, or hatches.
 - g) Floor drains.
 - h) Transition and termination detail at edge of CRC system.
 - i) Pipe penetrations (vertical and horizontal).
 - j) Other details specific to the structure being coated.
- 2. Samples: 4-inch square complete system proposed for use showing thickness and finish.

B. Informational Submittals:

- 1. Letter from CRC manufacturer stating that:
 - a. Applicator has notified manufacturer of proposed installation.
 - b. Manufacturer is in agreement with the intended application.
 - c. Applicator is qualified to do the Work and meets the quality assurance minimum experience requirements.
- 2. Applicator's Qualifications:
 - a. List of references substantiating experience.
 - b. Certification from coating manufacturer showing current status as an approved applicator.
- 3. Installation instructions.
- 4. Quality Control plan.
- 5. Field inspection and test reports.
- 6. Manufacturer's Certificate of Proper Installation.
- 7. MSDS sheets.

1.04 QUALITY ASSURANCE

- A. Manufacturer's Experience: Minimum 5 years manufacturing proposed products.
- B. Applicator's Experience: Minimum 3 years applying proposed products. Applicator shall be certified by the coating manufacturer for application of the specified products.
- C. Applicator Quality Control Plan: Applicator shall maintain an in-house quality assurance program that monitors surface preparation, coating application, and quality control testing for coating and lining operations. Level of experience, quality assurance program, and quality control testing by the applicator shall meet the minimum requirements specified herein, the coating manufacturer's instructions, and related government regulations.
- D. The Subcontractor is solely responsible for quality control inspection and testing. Subcontractor shall monitor and be responsible for all environmental, surface preparation, application and quality control testing compliance at the locations where coating work is undertaken.
- E. Mockups:
 - 1. Required for coating systems over 1,000 square feet in area or exposed to view in service.
 - 2. Before proceeding with Work under this Section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of Work, and special details.
 - 3. Procedure:
 - a. Prepare, prime and coat one section of concrete, 10 feet by 10 feet, at a location mutually agreed upon by the Contractor and Owner. Use a "step" down mockup as follows:
 - 1) Leave one-quarter of the surface exposed to allow observation of the surface preparation.
 - 2) Apply primer to three-quarters of remaining surface.
 - 3) Apply filler/surfacer to one-half of the surface, over the primer, leaving one-quarter of the surface exposed with primer.
 - 4) Apply finish coats with fiberglass reinforcing to filler/surfacer, leaving one-quarter of the surface exposed with surfacer/filler.
 - b. Mockup shall include concrete cuts for coating terminations and one example of a penetration.

- c. Leave mockup in place to serve as a reference and standard for the remaining Work.
 - d. At completion of Project, clean and prepare all surfaces that are not complete and finish coat the mockup area for incorporation into the Work.
4. After Owner review and approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

F. Preinstallation Meeting:

- 1. Prior to beginning painting Work, schedule a meeting and be prepared to discuss the following subjects, as a minimum:
 - a. Required schedule.
 - b. Sequence of critical path work items.
 - c. Use of Site, access, office and storage areas, security, and temporary facilities.
 - d. Major product delivery and priorities.
 - e. Safety plan.
- 2. Attendees shall include:
 - a. Owner's representatives.
 - b. Contractor's office representative.
 - c. Contractor's resident superintendent.
 - d. Contractor's quality control representative.
 - e. Subcontractors' representatives whom Contractor may desire or Engineer may request to attend.
 - f. Engineer's representative.
 - g. Paint manufacturer's technical representative.
 - h. Others as appropriate.

1.05 PERFORMANCE CRITERIA

A. CRC No. 2:

- 1. Exposure: Suitable for continuous contact with 38-percent ammonium sulfate for 8 hours or with concentrated vapors for 24 hours. The coating shall show no effects except moderate softening or slight discoloration for the duration of the contact, with no permanent damage.
- 2. Crack Bridging: Coating system shall bridge substrate cracks up to 15 mils wide, as measured in accordance with ASTM D522, that may occur before or after coating application. The coating system shall remain liquid-tight under the specified conditions of service.
- 3. Traffic Exposure:
 - a. Foot Traffic: Containment area surfaces exposed to continuous personnel foot traffic.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original, unopened containers.
- B. Storage: Maintain materials in clean and dry condition. Follow manufacturer's instructions.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Temperature: Apply coating only when substrate, ambient air, and coating material are at, or above, the manufacturer's written requirements.
- B. Substrate: Not wet or have standing water.
- C. Ventilation: Provide during and after application to meet all applicable safety and health regulations.

1.08 SPECIAL GUARANTEE

- A. Furnish extended guarantee or warranty. Special guarantee shall provide for correction, or at the option of Owner, removal and replacement of Work specified in this Specification section found defective during a period of 2 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.
 - 1. 24-Month Warranty Period Inspection: Owner will conduct inspection of interior and exterior coated surfaces prior to the end of warranty period. Owner will notify Contractor in advance of inspection and Contractor may attend at its option. Owner will prepare list of coating defects and failures identified during inspection and transmit to Contractor. List shall serve as notice of repairs required under warranty.
 - 2. Repairs:
 - a. If repairs are required, requirements of Contract shall apply including, but not limited to, requirements to remove standing water and perform repair work.
 - b. Repair defective coatings using coating materials, equipment, and methods similar to those used in original work. Materials shall be of fresh manufacture and within manufacturer's stated shelf life at time of application.
 - c. Provide extended warranty of 1 year for repairs.
 - d. Complete repairs within 30 calendar days of Warranty Period Inspection.

1.09 EXTRA MATERIALS

- A. Furnish minimum 2 gallons of unopened topcoating material for future use by Owner.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Carboline.
- B. Ceilcote.
- C. Dudick.
- D. Sherwin Williams.

2.02 MATERIALS

- A. Manufacturer's highest quality products suitable for the intended service.
- B. Only compatible materials from a single manufacturer shall be used within any system.
- C. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
- D. Materials shall not contain lead or lead compounds.
- E. Joints:
 - 1. General: Provide joint filler material type, size, and composition as recommended by the CRC manufacturer for the particular joint condition.
 - a. Joint Materials: Designed to maintain a liquid-tight joint for the life of the coating system.
 - b. Chemical Resistance of Joint: Same or better than the coating system.
 - c. Backing Material: As recommended by the CRC manufacturer.

2.03 COATING MATERIAL

- A. Chemical-Resistant Coatings: A mixture of liquid resin-based material, setting agent, and filler designed to be troweled or sprayed into place to cure to a hard state.

- B. Material Quality: Manufacturer's highest quality products and suitable for intended exposure.
- C. Compatibility: Only compatible materials from a single manufacturer shall be used.
- D. Materials:
 - 1. Primer: Penetrating epoxy, per manufacturer's recommendation.
 - 2. Surfacer/Filler: 100-percent solids, trowelable, epoxy for filling concrete imperfections and making transitions.
 - 3. Chemical Resistant Coating: 100-percent solids, flake filled Novolac epoxy.
 - 4. Slip Resistance Aggregate: Aluminum oxide.

2.04 MIXING

- A. Thoroughly mix until homogeneous following manufacturer's instructions.
- B. Mix only components furnished by coating manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Surface Preparation:
 - 1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of the system manufacturer whose product is to be applied.
 - 2. Provide Owner minimum 7 days' advance notice of start of surface preparation and system application Work.
 - 3. Perform Work only in presence of Owner, unless Owner grants prior approval to perform Work in Owner's absence.
- B. Schedule inspection with Owner in advance for cleaned surfaces and system application Work.

3.02 PREPARATION

- A. In accordance with the manufacturer's printed directions and recommendations.
- B. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning and disposition of removed coating, spent aggregate and debris.

C. Concrete Surfaces:

1. Do not begin until 30 days after concrete has been placed.
2. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
3. Prepare surface according to SSPC-SP 13. Brushoff blast clean to remove loose concrete and provide a tooth for binding. Minimum surface profile shall meet ICRI CSP 5, or higher, if required by the coating manufacturer.
4. Fill holes and cracks with manufacturer's recommended materials to produce even surface for application of systems. Secure coating manufacturer's recommendations for additional preparation if required for excessive bug holes exposed after blasting.
5. Ensure surfaces are dry prior to coating, as required by the coating manufacturer.
 - a. Conduct tests to verify that concrete surfaces are sufficiently dry for coating. Test for moisture using plastic sheets in accordance with ASTM D4263.
 - b. If the test indicates evidence of moisture, conduct tests to determine quantity of water present in accordance with ASTM F1869. Moisture content shall not exceed 3 pounds per 1,000 square feet in a 24-hour period.
 - c. All tests using electronic moisture meters shall conform to ASTM F2170.

3.03 APPLICATION

A. General:

1. Apply primer.
2. Surfacer/Filler: Apply surfacer/filler to concrete with methods recommended by the coating manufacturer as required to provide a surface that is a continuous, smooth, void-free surface. Force material into voids and irregularities, and remove excess filler before the material sets.
3. Spray or trowel apply coating systems in accordance with manufacturer's printed instructions.
4. Cove comers at vertical and horizontal intersections, and reinforce as specified in paragraph Joints, this Section.
5. Broadcast aggregate as recommended by coating manufacturer. Remove excess material before application of finish coat.

6. Provide the minimum number of coats required for each coating system, regardless of application method. Do not apply succeeding coats until previous coat has cured in accordance with the coating manufacturer's recommendations.
 7. Observe manufacturer's published recoat windows. If recoat window is exceeded, mechanically abrade before recoating in accordance with the manufacturer's directions and as approved by Owner.
- B. Priming and Holiday Prevention on Concrete and Substrates: Follow manufacturer's written instructions related to application during decreasing substrate temperature conditions, adequate surface preparation and other application techniques that may be necessary to reduce the potential for outgassing and formation of pinholes during coating application and cure. If necessary or as required by the coating manufacturer, apply an epoxy penetrating primer to minimize the effects of vapor transmission from the concrete.
- C. Film Thickness:
1. Provide specified thickness of material. Use screeds or wet film gauges to monitor thickness during application.
 2. All coated surfaces shall be visually inspected to ensure proper and complete coverage has been obtained.
 3. After repaired and recoated areas have sufficiently dried, coating thickness tests may be conducted by Owner to verify thickness complies with the manufacturer's recommendations.
- D. Provide temporary facilities and enclosures as necessary to protect Work areas during the preparation, application and curing.
- E. Mixing:
1. Thoroughly mix epoxy resin coatings until homogeneous following manufacturer's instructions.
 2. Mix only components furnished by coating manufacturer.
- F. Joints:
1. Provide continuous sealant, backing material, and joint-lining treatment recommended by the coating manufacturer at all expansion, isolation, and construction joints.
 2. Provide continuous sealant bead at joints between different coating systems.
 3. Provide fiberglass or synthetic fabric reinforcement at construction joints and large substrate cracks to maintain liquid-tight requirements under the specified service conditions.

- G. Penetrations: Coat over or around equipment anchors, base plates, pipes, and similar items installed in areas receiving CRC to maintain continuous liquid tight seal. Provide written instructions for treatment of penetrations.
- H. Terminations: Conform to manufacturer's details.

3.04 UNSATISFACTORY APPLICATION

- A. If an item has an improper appearance or insufficient film thickness, the surface shall be cleaned, prepared, and top-coated as required to achieve proper appearance and/or thickness. Provide specific procedures in writing from the CRC manufacturer prior to cleaning and preparation.

3.05 DAMAGED COATINGS

- A. Damaged coatings, pinholes, and holidays shall have the edges feathered and repaired in accordance with the recommendations of the coating manufacturer.
- B. All finish coats, including touchup and damage-repair coats, shall be applied in a manner that will present a uniform texture and color-matched appearance.
- C. All visible areas of chipped, peeled, or abraded coatings shall be hand or power sanded. Prime and finish coat these in accordance with these Specifications and the manufacturer's recommendations.

3.06 FIELD QUALITY CONTROL

- A. Inspection: Inspect finished system for complete, uniform coverage of specified area. Evidence of defects include improper thickness, hardness, and appearance.
- B. Holiday Testing:
 - 1. All surfaces lined with CRC shall be electrically checked with high voltage holiday test equipment to determine the location of discontinuities:
 - a. Provide suitable electrical contact to reinforcing steel. Verify conductivity of electrical contact by touching the second, ungrounded, electrode to another metallic ground connected to the concrete structure.
 - 1) Do not perform electrical inspection until the CRC is sufficiently cured, as determined by the CRC manufacturer.
 - b. All electrical inspection testing shall be performed in accordance with NACE SP0188.
 - c. Perform all electrical tests at 100 volts/mil for the minimum approved thickness of the lining material.

2. Perform holiday testing after each section of containment coating is applied. Perform a final holiday test of all coated surfaces after all coating work has been complete.
3. Repair all lining defects in accordance with the manufacturer's written instructions.
4. After repaired and recoated areas have dried sufficiently, retest each.

3.07 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site, for installation assistance, inspection, and Manufacturer's Certificate of Proper Installation.
- B. Manufacturer's representative shall visit the Project site at the following intervals:
 1. At preconstruction conference.
 2. On the first day of application of the CRC system.
 3. As necessary, or as directed by Owner, during surface preparation and application to ensure installations are made in accordance with the manufacturer's recommendations.
 4. As required to resolve field problems attributed to or associated with manufacturer's product.
 5. Minimum number of site visits required:
 - a. Three site visits, each for a minimum of 3 hours.
 - b. Travel time is not included as part of durations listed above.

3.08 APPLICATION SCHEDULE

- A. Unless otherwise shown or specified, apply coatings in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Owner before starting Work in question.
- B. Coating System CRC-2A – Containment Area:

Surface Preparation	Product	No. of Coats, Thickness
In accordance with Paragraph Preparation	Primer	1 coat, 2 to 3 MDFT
	Surfacer/Filler	As required to fill voids and level surface
	Novolac Epoxy	2 coats, 15 to 20 MDFTPC

1. Use this system on the following:
 - a. All concrete surfaces of the containment area as shown on the Drawings, including but not limited to, floor, walls, trenches, sumps and sides and tops of tank pads.

3.09 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Chemical Resistant Coating Data Sheet (CRCDS).
2. Chemical Resistant Coating Product Data Sheet (CRCPDS).

END OF SECTION

CORROSION CONTROL ASSISTANCE FORM

TO: Corrosion Control Specialist. DATE: _____
CH2M HILL

FROM: Name: _____ Title: _____
Address: _____
Project Description: _____
Project No.: _____

Area Requiring Specific Protection: _____

Items to be Coated: _____

Site Location: _____

SERVICE CONDITIONS
(Check Appropriate Items)

Immersion _____ Splash/Spillage _____ Chemical Fumes _____

Marine/Offshore _____ Industrial _____ Other _____

Chemicals Involved _____

New Construction _____ Existing Structure _____ Uncoated _____

Coated _____ Coated With (If Known) _____

Operating Temp. Range _____ Ambient Conditions _____

Surface Preparation Possible: Abrasive Blast _____

Power Tool Cleaning _____ Other _____

Other Pertinent Data: _____

Feedback Required By (Date): _____

SECTION 10 14 00 SIGNAGE

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
 2. ASTM International (ASTM):
 - a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - b. D709, Standard Specification for Laminated Thermosetting Materials.
 3. The Chlorine Institute, Inc.: WC-1, Wall Chart: Handling Chlorine Cylinders and Ton Containers.
 4. International Code Council (ICC):
 - a. A117.1, Accessible and Usable Buildings and Facilities.
 - b. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
 5. National Fire Protection Association (NFPA):
 - a. 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
 - b. HAZ-01, Fire Protection Guide to Hazardous Materials.
 6. Occupational Safety and Health Act (OSHA).
 7. U.S. Department of Transportation, Federal Highway Administration: Manual on Uniform Traffic Control Devices for Streets and Highways.

1.02 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings:
 - a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
 - b. Manufacturer's literature showing letter sizes and styles, sign materials, and standard mounting details.
- B. Informational Submittals: Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 SIGNS

A. Fiberglass Sign (Type C):

1. Material: Three-ply laminated fiberglass, minimum 1/8 inch thick, with contrasting color core message layer between two clear weather-resistant surface layers.
2. Manufacturers:
 - a. Best Manufacturing Co.
 - b. Brady Signmark.

B. Hazardous Material Sign (Type H):

1. Conform to NFPA 704 and NFPA HAZ-01.
2. Material: Fiberglass 1/8 inch thick.
3. Background, Letters, and Numbers: Die-cut vinyl with pressure sensitive adhesive.
4. Manufacturers:
 - a. Brady Signmark.
 - b. Emed Co., Inc.

2.02 IDENTIFICATION LABELS

A. Pipe Labels:

1. Labels: Self-adhesive tape, with separate directional flow arrows.
2. Material: Pressure sensitive vinyl.
3. Letters and Arrows: Black on OSHA safety yellow background.
4. Color Field and Letter Height: ASME A13.1.
5. Message: Piping system name as indicated on Piping Schedule.
6. Manufacturers and Products:
 - a. Brady Signmark; B-946 Self-Sticking Vinyl Pipe Markers and Vinyl Arrows.
 - b. Seton Identification Products; Opti-Code Markers and Directional Arrows.

B. Equipment Labels:

1. Applies to equipment with assigned tag numbers, where specified.
2. Letters: White engraved 3/4 inch minimum high.
3. Background: Black.
4. Materials: Stainless steel with a baked-on finish suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
5. Furnish 1-inch margin with holes at each end of label, for mounting. On fiberglass labels, furnish grommets at each hole.

6. Size:
 - a. 2 inches minimum and 3 inches maximum high, by 14 inches minimum and 18 inches maximum long.
 - b. Furnish same size base dimensions for all labels.
7. Message: Equipment names and tag numbers as used in sections where equipment is specified.
8. Manufacturers:
 - a. Brady Signmark.
 - b. Seton Identification Products.

2.03 ANCILLARY MATERIALS

- A. Fasteners: Stainless steel screws or bolts of appropriate sizes.
- B. Pipe Posts: 2-1/2-inch galvanized steel pipe meeting ASTM A53/A53M, Type S, Grade B.
- C. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.
- D. Manufacturer's standard brackets for wall mounting of two-sided exit signs.

PART 3 EXECUTION

3.01 INSTALLATION—GENERAL

- A. In accordance with manufacturer's recommendations.
- B. Mount securely, plumb, and level.

3.02 SIGNS

- A. General:
 1. Fasten to walls or posts, or hang as scheduled.
 2. Anchor in place for easy removal and reinstallation with ordinary hand tools.
- B. Hazardous Material Sign:
 1. Install where required by NFPA No. 704 and IFC, Chapter 27.
 2. Install at entrances to spaces where hazardous materials are stored, dispensed, used, or handled, and on sides of stationary tanks.

3. Specific Materials:

Hazardous Materials					
Mark	Material	Health Hazard (Blue)	Flammability Hazard (Red)	Instability Hazard (Yellow)	Special Hazard (White)
H-1	Liquid Ammonia Sulfate (38% solution)	1	0	1	

3.03 IDENTIFICATION LABELS

A. Pipe Labels:

1. Locate at connections to equipment, valves, or branching fittings at wall boundaries.
2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.
4. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.
5. Apply to pipe after painting in vicinity is complete, or as approved by Engineer.
6. Install in accordance with manufacturer's instructions.

B. Equipment Labels:

1. Locate and install on equipment or concrete equipment base.
2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

3.04 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Sign Schedule: Tabulation of characteristics and mounting information for each sign. Provide items as scheduled. Meet requirements of Occupational Safety and Health Act (OSHA).

END OF SECTION

Sign Schedule														
Sign														Other Requirements
No. ¹	Type ²	Format ³	Size		Color	Mounting								
			Width	Height		Location	Method	Height to Top	Height	Style	Color	Message	Faces	
C-1	C	N/A	12”	8”	Yellow	Fill Pipe	Chain	---	2" min.	Helvetica	Black	Liquid Ammonia Sulfate Fill Station	1	
C-2	C	N/A	12”	8”	Yellow	Liquid Ammonia Sulfate Tank Ladder Top	Chain	---	2" min.	Helvetica	Black	Do not step on top of tank	1	
H-1	H	As required.				Storage Tank Wall	Adhesive	5'-6”	2" min.	Helvetica	---	Liquid Ammonia Sulfate	1	Facing North
¹ Numbers refer to a particular sign type with a particular message. ² Letters refer to sign types specified in this section. ³ Numbers refer to Design Details that show sign layout. ⁴ Verify requirements for this sign with Laws and Regulations in state where Project is located.														

SECTION 26 05 02
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. Requirements specified within this section apply to all Divisions in Contract. Work specified herein shall be performed as if specified in the individual sections.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Institute of Electrical and Electronics Engineers (IEEE): 1584, Guide for Performing Arc-Flash Calculations.
 2. National Electrical Contractors Association (NECA).
 3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
 4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 70E, Electrical Safety Requirements for Employee Workplaces

1.03 SUBMITTALS

- A. Action Submittals:
1. Provide manufacturers' data for the following: Nameplates, signs, and labels.
- B. 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 26, Electrical sections.

1.04 AUTHORITY HAVING JURISDICTION APPROVAL

- A. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

1.05 DEMOLITION

- A. Remove electrical work associated with equipment scheduled for demolition except those portions indicated to remain or be reused.
- B. Remove unused exposed conduit and wiring back to point of concealment including abandoned conduit above accessible ceiling finishes. Remove unused wiring in concealed conduits back to source (or nearest point of usage).
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide stainless steel blank covers for abandoned outlets which are not removed.
- D. Disconnect and remove abandoned panelboards, transformers, disconnect switches, control stations, distribution equipment, etc.
- E. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers and other accessories.
- F. Disconnect electrical circuits in the way of demolition work and re-establish circuits to remaining outlets, fixtures, equipment, etc. Disconnect electrical systems in wall, floors and ceilings scheduled for removal.
- G. Provide temporary wiring and connections to maintain existing systems in service during construction.
- H. New lighting shall be in-place or safe lighting levels maintained for plant operation during the construction period. Where new lighting cannot be installed due to construction sequencing, provide temporary lighting to maintain safe lighting levels.
- I. Repair adjacent construction and finishes damaged during demolition and extension work.
- J. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation.

- K. Coordinate outages in systems with the Owner. Where duration on proposed outage cannot be allowed by the Owner, provide temporary connections as required to maintain service.
- L. Removal and relocation of existing conduit, wire and equipment have not been detailed on the Drawings. Survey the affected areas before submitting Bid proposal.
- M. Trace out existing wiring that is to be relocated, or removed and perform the relocation or removal work as required for a complete operating and safe system.
- N. Continuous service is required on all circuits and outlets affected by these changes, except where the Owner will permit an outage for a specific time. Obtain Owner's consent before removing any circuit from continuous service.
- O. Remove exposed conduits, wireways, outlet boxes, pull boxes, and hangers made obsolete by the alterations, unless specifically designated to remain. Patch surfaces and provide stainless steel blank covers for abandoned outlets which are removed.
- P. All equipment, materials, controls, motor starters, branch and feeder breakers, panelboards, transformers, wiring, raceways, etc, furnished and installed to temporarily keep circuits energized shall be removed when the permanent installation is fully operational.
- Q. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to maintain the integrity of the grounding systems.
- R. Conduit and wires shall be abandoned or removed where shown. All wires in abandoned conduits shall be removed, salvaged and stored. Abandoned conduits concealed in floor or ceiling slabs or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduit shall be suitably plugged and the area repaired in a flush, smooth and approved manner. Exposed conduit and their supports shall be disassembles and removed from the site. Repair all areas of work to prevent rust spots on exposed surfaces.
- S. Wall switches, receptacles, and other miscellaneous electrical equipment, shall be removed and disposed of off the Site as required. Care shall be taken in removing all equipment so as to minimize damage to architectural and structural members. Any damage incurred shall be repaired.

1.10 DISPOSITION OF REMOVED MATERIALS AND EQUIPMENT

- A. In general, it is intended that material and equipment indicated to be removed and disposed of by the Contractor shall, upon removal, become the Contractor's property and shall be disposed of off the site by the Contractor, unless otherwise directed by the Owner. Any fees or charges incurred for disposal of such equipment or material shall be paid by the Contractor. A receipt showing acceptable disposal of any legally regulated materials or equipment shall be given to the Owner.
- B. Ballasts in each existing lighting fixture shall be assumed to contain PCBs unless specifically marked with a label indicating "No PCBs". Remove ballasts from each lighting fixture and pack them in accordance with EPA PCB regulations. Ship ballasts in approved containers to an EPA approved recycling facility and pay all shipping, packaging and recycle costs.

PART 2 PRODUCTS

2.01 GENERAL

- A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.
- B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 degrees F to 104 degrees F.
- C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range stated in Section 01 61 00, Common Product Requirements.
- D. Provide equip panels installed outdoors in direct sun with sun shields.

2.02 EQUIPMENT FINISH

- A. Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with ANSI No. 61, light gray color.

2.03 NAMEPLATES

- A. Material: Laminated plastic, 1/8- inch thick minimum.
- B. Attachment Screws: Stainless steel.
- C. Color: White, engraved to a black core.

D. Letter Height:

1. Pushbuttons/Selector Switches: 1/8 inch.
2. Other electrical equipment: 1/4 inch.

2.04 SIGNS AND LABELS

- A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.
- B. Warning labels for arc flash hazards shall be provided per NEC and Section 26 05 70, Electrical Systems Analysis.

PART 3 EXECUTION

3.01 GENERAL

- A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer. Coordinate the conduit installation with other trades and the actual supplied equipment. Obtain information relevant to the placing at electrical work and in case of any interference with other work, processed as directed by the Engineer and furnished all labor and materials necessary to complete the Work in an approved manner.
- B. Check approximate locations of electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing. Any adjustments required in the field shall be provided at no change in Contract.
- C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.
- D. Keep openings in boxes and equipment closed during construction.
- E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.
- F. Unless otherwise approved by the Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.
- G. Where circuits are shown as “homeruns” all necessary fittings and boxes shall be provided for a complete raceway installation.

- H. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of the approved equipment at no change in Contract.
- I. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement or equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the Engineer for approval. No change in Contract will be provided for changes in the work, either his/her own or others, caused by such redesign.
- J. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by 1/2-inch spacers to provide a clearance between wall and equipment.
- K. All floor mounted electrical equipment shall be placed on 4-inch thick (3/4-inch, 45-degree chamfer at all exposed edges) concrete pads, provide reinforcement, anchors, etc.
- L. The Contractor shall coordinate the work of the different trades so that interferences between conduits, piping, equipment, architectural and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc., required to accomplish this shall be furnished and installed by the Contractor without change in Contract. In case interference develops, the Engineer is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.
- M. Provide #10 wire instead of #12 wire for all 20 ampere 120 volt, 240 volt, or 208Y/120 volt circuits exceeding 150 feet conduit length.
- N. Raceways and conductors for lighting, switches, receptacles, and other miscellaneous low voltage power and signal system as specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Homeruns, as shown on the Drawings, are to assist the Contractor in identifying raceways to be run exposed and raceways to be run concealed. Raceways shall be installed concealed in all finished spaces and may be installed exposed or concealed in all process spaces. Raceways installed exposed shall be near the ceiling or along walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes hoists, monorails, equipment hatches, doors, windows, etc. Raceways installed concealed shall be run in the center of concrete floor slabs, above suspended ceilings, or in partitions as required.
- O. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.

- P. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.
- Q. Based on the results of arc-flash calculations performed as specified in Section 26 05 70, Electrical Systems Analysis, provide appropriate warning labels on all electrical equipment.

3.02 COMBINING CIRCUITS INTO COMMON RACEWAY

- A. Homerun circuits shown on Drawings indicate functional wiring requirements for power and control circuits. Circuits may be combined into common raceways in accordance with the following requirements:
 - 1. Analog control circuits from devices in same general area to same destination.
 - a. No power or AC discrete control circuits shall be combined in same conduit with analog circuits.
 - b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, paging system circuits shall be combined with power or Class 1 circuits.
 - c. Analog circuits shall be continuous from source to destination. Do not add TJB, splice, or combine into a multi-pair cable without authorization of Engineer.
 - d. Raceways shall be sized per General Circuit and Raceway Schedule and do not exceed 40 percent fill.
 - e. Changes shall be documented on Record Drawings.
 - 2. Discrete control circuits from devices in the same general area to the same destination.
 - a. No power or analog control circuits shall be combined in same conduit with discrete circuits.
 - b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, and paging system circuits shall be combined with power or Class 1 circuits.
 - c. Raceways shall be sized per the General Circuit and Raceway Schedule and do not exceed 40 percent fill.
 - d. Changes shall be documented on Record Drawings.
 - 3. Power circuits from loads in same general area to same source location (such as: panelboard, switchboard, low voltage motor control center).
 - a. Lighting Circuits: Combine no more than three circuits to a single raceway. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.

- b. Receptacle Circuits, 120-Volt Only: Combine no more than three circuits to a single raceway. Provide a separate neutral conductor for each circuit. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
- c. All Other Power Circuits: Do not combine power circuits without authorization of Engineer.

3.03 NAMEPLATES, SIGNS, AND LABELS

- A. Arc Flash Protection Warning Signs: Field mark pad-mounted switchgear, switchboards, motor control centers, panelboards, etc. to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
- B. Multiple Power Supply Sign: Install permanent plaque or directory at each service disconnect location denoting other services, feeders, and branch circuits supplying a building, and the area served by each.
- C. Equipment Nameplates:
 - 1. Provide a nameplate to label electrical equipment including automatic transfer switch, switchgear, switchboards, motor control centers, panelboards, motor starters, transformers, terminal junction boxes, disconnect switches, switches and control stations.
 - 2. Switchgear, motor control center, dry-type transformer, and terminal junction box nameplates shall include equipment designation.
 - 3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
 - 4. Switchboard and panelboard nameplates shall include equipment designation, service voltage, and phases.
- D. Procedural Signs: Provide procedural signs for Kirk-Key interlocks, main-tie-main operation scanners.

3.04 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, panelboards, 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.

3.05 SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.
- B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain Shop Drawings and templates from equipment vendors or other subcontractors and locate the concealed conduits before the floor slab is poured.
- C. Where setting Drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installation of such conduits to be exposed. Request for this deviation must be submitted in writing. No additional compensation for such change will be allowed.
- D. Seal all openings, sleeves, penetrations and slots as specified in Section 26 05 33, Raceway and Boxes.

3.06 CUTTING AND PATCHING

- A. Cutting and patching shall be done in a thoroughly workmanlike manner and be in compliance with modifications and repair to concrete as specified in Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.
- B. Core drill holes in existing concrete floors and wall as required.
- C. Install work at such time as to require the minimum amount of cutting and patching.
- D. Do not cut joists, beams, girders, columns, or any other structural members.
- E. Cut openings only large enough to allow easy installation of the conduit.
- F. Patching to be of the same kind and quality of material as was removed.
- G. The completed patching work shall restore the surface to its original appearance or better.
- H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.
- I. Remove rubble and excess patching materials from the premises.
- J. When existing conduits are cut at the floor line, they shall be filled with grout or suitable patching material.

3.07 CLEANING AND TOUCHUP PAINTING

- A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.
- B. Touchup Paint:
 - 1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
 - 2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

3.08 PROTECTION FOLLOWING INSTALLATION

- A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.
- B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.
- C. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer at the Engineer's discretion.

3.09 CHECKOUT AND STARTUP

- A. Voltage Field Test:
 - 1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.
 - 2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
 - 3. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day.
 - a. Submit Voltage Field Test Report within 5 days of test.
 - 4. Unbalance Corrections:
 - a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
 - b. Obtain a written certification from a responsible power company official that the voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

END OF SECTION

SECTION 26 05 04 BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - b. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
 - c. E814, Method of Fire Tests of Through-Penetration Fire Stops.
2. Canadian Standards Association (CSA).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
4. International Society of Automation (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
5. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. AB 1, Molded Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
 - c. C12.1 Code for Electricity Metering
 - d. C12.6 Phase-Shifting Devices Used in Metering, Marking and Arrangement of, Terminals for
 - e. CP 1, Shunt Capacitors.
 - f. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
 - g. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
 - h. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories Inc. (UL):
 - a. 98, Standard for Enclosed and Dead-Front Switches.
 - b. 248, Standard for Low Voltage Fuses.
 - c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.

- d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
- e. 508, Standard for Industrial Control Equipment.
- f. 810, Standard for Capacitors.
- g. 943, Standard for Ground-Fault Circuit-Interrupters.
- h. 1059, Standard for Terminal Blocks.
- i. 1479, Fire Tests of Through-Penetration Fire Stops.

1.02 SUBMITTALS

A. Action Submittals:

- 1. Provide manufacturers' data for the following:
 - a. Control devices.
 - b. Control relays.
 - c. Circuit breakers.
 - d. Fused switches.
 - e. Nonfused switches.
 - f. Timers.
 - g. Fuses.
 - h. Magnetic contactors.
 - i. Intrinsic safety barriers.
 - j. Firestopping.
 - k. Enclosures: Include enclosure data for products having enclosures.

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

- 1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

PART 2 PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. General:

- 1. Type: Molded case.
- 2. Trip Ratings: 15-800 amps.
- 3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.
- 4. Suitable for mounting and operating in any position.
- 5. NEMA AB 1 and UL 489.

B. Operating Mechanism:

1. Overcenter, trip-free, toggle type handle.
2. Quick-make, quick-break action.
3. Locking provisions for padlocking breaker in open position.
4. ON/OFF and TRIPPED indicating positions of operating handle.
5. Operating handle to assume a center position when tripped.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.
7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

D. Short Circuit Interrupting Ratings:

1. Not less than the following RMS symmetrical currents for the indicated trip ratings:
 - a. Less than 250V ac: 10,000 amps or greater if shown.
 - b. 250-600V ac: 42,000 amps or greater if shown.
2. Series Connected Ratings: Do not apply series connected short circuit ratings.

E. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).

1. Ground fault sensor shall be rated same as circuit breaker.
2. Push-to-test button.

F. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL-listed for equipment ground fault protection).

G. Magnetic Only Type Breakers: Where shown; instantaneous trip adjustment which simultaneously sets magnetic trip level of each individual pole continuously through a 3X to 10X trip range.

- H. Accessories: Shunt trip, auxiliary switches, handle lock ON devices, mechanical interlocks, key interlocks, unit mounting bases, double lugs as shown or otherwise required. Shunt trip operators shall be continuous duty rated or have coil-clearing contacts.
- I. Connections:
 - 1. Supply (line side) at either end.
 - 2. Mechanical wire lugs, except crimp compression lugs where shown.
 - 3. Lugs removable/replaceable for breaker frames greater than 100 amperes.
 - 4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
 - 5. Use bolted bus connections, except where bolt-on is not compatible with existing breaker provisions.
- J. Enclosures for Independent Mounting:
 - 1. See Article Enclosures.
 - 2. Service Entrance Use: Breakers in required enclosure and required accessories shall be UL 489 listed.
 - 3. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

2.02 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

- A. UL 98 listed for use and location of installation.
- B. NEMA KS 1.
- C. Short Circuit Rating: 200,000 amps RMS symmetrical with Class R, Class J, or Class L fuses installed.
- D. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
- E. Connections:
 - 1. Mechanical lugs, except crimp compression lugs where shown.
 - 2. Lugs removable/replaceable.
 - 3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.

F. Fuse Provisions:

1. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.
2. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.

G. Enclosures: See Article Enclosures.

H. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

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. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.

D. Enclosures: See Article Enclosures.

E. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.04 FUSE, 250-VOLT AND 600-VOLT

A. Power Distribution, General:

1. Current-limiting, with 200,000 ampere rms interrupting rating.
2. Provide to fit mountings specified with switches.
3. UL 248.

B. Power Distribution, Ampere Ratings 1 Amp to 600 Amps:

1. Class: RK-1.
2. Type: Dual element, with time delay.
3. Manufacturers and Products:
 - a. Bussmann; Types LPS-RK (600 volts) and LPN-RK (250 volts).
 - b. Littelfuse; Types LLS-RK (600 volts) and LLN-RK (250 volts).

C. Power Distribution, Ampere Ratings 601 Amps to 6,000 Amps:

1. Class: L.
2. Double O-rings and silver links.

3. Manufacturers and Products:
 - a. Bussmann; Type KRP-C.
 - b. Littelfuse, Inc.; Type KLPC.

D. Ferrule:

1. 600V or less, rated for applied voltage, small dimension.
2. Ampere Ratings: 1/10 amp to 30 amps.
3. Dual-element time-delay, time-delay, or nontime-delay as required.
4. Provide with blocks or holders as indicated and suitable for location and use.
5. Manufacturers:
 - a. Bussmann.
 - b. Littlefuse, Inc.

2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

- A. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.
- B. Selector Switch Operating Lever: Standard.
- C. Indicating Light: Push-to-test. LED.
- D. Pushbutton Color:
 1. ON or START: Red.
 2. OFF or STOP: Black or green.
- E. Pushbutton and selector switch lockable in OFF position where indicated.
- F. Legend Plate:
 1. Material: Aluminum.
 2. Engraving: Enamel filled in high contrasting color.
 3. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
 4. Letter Height: 7/64-inch.
- G. Manufacturers and Products:
 1. Heavy-Duty, Oil-Tight Type:
 - a. General Electric Co.; Type CR 104P.
 - b. Square D Co.; Type T.
 - c. Eaton/Cutler-Hammer; Type 10250T.

2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
 - a. Square D Co.; Type SK.
 - b. General Electric Co.; Type CR 104P.
 - c. Eaton/Cutler-Hammer; Type E34.
 - d. Crouse-Hinds; Type NCS.

2.06 TERMINAL BLOCK, 600 VOLTS

- A. UL 486E and UL 1059.
- B. Size components to allow insertion of necessary wire sizes.
- C. Capable of termination of 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 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, Inc.
 2. Ideal.
 3. Electrovert USA Corp.

2.07 MAGNETIC CONTROL RELAY

- A. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.
- B. NEMA ICS 2, Designation: A600 (600 volts).

C. Manufacturers and Products:

1. Eaton/Cutler-Hammer; Type M-600.
2. General Electric Co.; Type CR120B.

2.08 TIME DELAY RELAY

- A. Industrial relay with contacts rated 5 amps continuous, 3,600VA make, 360VA break.
- B. NEMA ICS 2 Designation: B150 (150 volts).
- C. Solid-state electronic, field convertible ON/OFF delay.
- D. One normally open and one normally closed contact (minimum).
- E. Repeat accuracy plus or minus 2 percent.
- F. Timer adjustment from 1 second to 60 seconds, unless otherwise indicated on Drawings.
- G. Manufacturers and Products:
 1. Square D Co.; Type F.
 2. Eaton/Cutler-Hammer.
 3. General Electric Co.

2.09 RESET TIMER

- A. Drive: Synchronous motor, solenoid-operated clutch.
- B. Mounting: Semiflush panel.
- C. Contacts: 10 amps, 120 volts.
- D. Manufacturers and Products:
 1. Eagle Signal Controls; Bulletin 125.
 2. Automatic Timing and Controls; Bulletin 305.

2.10 ELAPSED TIME METER

- A. Drive: Synchronous motor.
- B. Range: 0 hour to 99,999.9 hours, nonreset type.
- C. Mounting: Semiflush panel.

D. Manufacturers and Products:

1. General Electric Co.; Type 240, 2-1/2-inch Big Look.
2. Eagle Signal Controls; Bulletin 705.

2.11 MAGNETIC CONTACTOR

A. UL listed.

B. Electrically operated, electrically held.

C. Main Contacts:

1. Power driven in one direction with mechanical spring dropout.
2. Silver alloy with wiping action and arc quenchers.
3. Continuous-duty, rated as shown.
4. Poles: As shown.

D. Control: As shown.

E. Auxiliary Contacts: One normally open and one normally closed or quantity as shown, rated 7200VA make, 720VA break, at 600V, A600 per NEMA ICS 5.

F. Enclosures: See Article Enclosures.

G. Manufacturers and Products:

1. Eaton/Cutler-Hammer; Class A201.
2. General Electric Co.; CR 353.
3. Square D Co.; Class 8910.

2.12 PHASE MONITOR RELAY

A. Features:

1. Voltage and phase monitor relay shall drop out on low voltage, voltage unbalance, loss of phase, or phase reversal.
2. Contacts: Single-pole, double-throw, 10 amperes, 120/240V ac. Where additional contacts are shown or required, provide magnetic control relays.
3. Adjustable trip and time delay settings.
4. Transient Protection: 1,000V ac.
5. Mounting: Multipin plug-in socket base.

B. Manufacturer and Product: Automatic Timing and Controls; SLD Series.

2.13 MAGNETIC LIGHTING CONTACTOR

- A. Comply with NEMA ICS 2; provide UL 508 listing.
- B. Electrically operated by dual-acting, single coil mechanism.
- C. Inherently interlocked and mechanically held in both OPEN and CLOSED position.
- D. Main Contacts:
 - 1. Double-break, continuous-duty, rated 30 amperes unless otherwise shown, 600 volts, withstand rating of 22,000 amps rms symmetrical at 250 volts, 42,000 amps rms symmetrical at 480 volts.
 - 2. Marked for electric discharge lamps, tungsten, and general purpose loads.
 - 3. Position not dependent on gravity, hooks, latches, or semipermanent magnets.
 - 4. Capable of operating in any position.
 - 5. Visual indication for each contact.
- E. Auxiliary contact relay for two-wire control.
- F. One normally open and one normally closed auxiliary contact rated 10 amperes continuous, 7,200VA make, 720VA break with NEMA designation of A600 (600 volts).
- G. 200 percent rated neutral terminal.
- H. Provision for remote pilot lamp with use of auxiliary contacts.
- I. Clamp type, self-rising terminal plates for solderless connections.
- J. Enclosures: See Article Enclosures.
- K. Manufacturers and Products:
 - 1. ASCO.
 - 2. Eaton/Cutler-Hammer; Class A202.
 - 3. General Electric Co.; Class CR360 (mechanically held).
 - 4. Square D; Class 8903, Type LL (mechanically held).

2.14 SUPPORT AND FRAMING CHANNELS

- A. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12-gauge minimum.

B. Extruded Aluminum Framing Channel:

1. Material: Extruded from Type 6063-T6 aluminum alloy.
2. Fittings fabricated from Alloy 5052-H32.

C. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.
3. Aickinstrut.

2.15 INTRINSIC SAFETY BARRIER

- A. Provides a safe energy level for exposed wiring in a Class I, Division 1 or Division 2 hazardous area when circuit is connected to power source in nonhazardous area.
- B. Rating: Power source shall be rated 24 volts dc, nominal, with not more than 250 volts available under fault conditions.
- C. Contact Rating: 5 amps, 250 volts ac.
- D. Mounting: Rail or surface.
- E. Manufacturers and Products:
 1. MTL, Inc.; Series 2000 or Series 3000.
 2. R. Stahl, Inc.

2.16 SWITCHBOARD MATTING

- A. Provide matting having a breakdown of 20 kV minimum.
- B. Manufacturer: U.S. Mat and Rubber Company.

2.17 FIRESTOPS

- A. General:
 1. Provide UL 1479 classified hourly fire-rating equal to, or greater than, the assembly penetrated.
 2. Prevent the passage of cold smoke, toxic fumes, and water before and after exposure to flame.
 3. Sealants and accessories shall have fire-resistance ratings as established by testing identical assemblies in accordance with ASTM E814, by Underwriters Laboratories Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

B. Firestop System:

1. Formulated for use in through-penetration firestopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.
2. Fill, Void, or Cavity Material: 3M Brand Fire Barrier Caulk CP25, Putty 303, Wrap/Strip FS195, Composite Sheet CS195 and Penetration Sealing Systems 7902 and 7904 Series.
3. Two-Part, Foamed-In-Place, Silicone Sealant: Dow Corning Corp. Fire Stop Foam, General Electric Co. Pensil 851.
4. Fire Stop Devices: See Section 26 05 33, Raceway and Boxes, for raceway and cable fittings.

2.18 ENCLOSURES

- A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrodeposition process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.
- B. Color: Manufacturer's standard color (gray) baked-on enamel, unless otherwise shown.
- C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.
- D. Enclosure Selections: Except as shown otherwise, provide electrical enclosures according to the following table:

ENCLOSURES			
Location	Finish	Environment	NEMA 250 Type
Indoor	Finished	Dry	1
Indoor	Unfinished	Dry	1
Indoor and Outdoor	Any	Denoted "WP"	4X Stainless Steel
Indoor and Outdoor	Any	Wet and/or Corrosive	4X Stainless Steel

ART 3 EXECUTION**3.01 GENERAL**

- A. Install equipment in accordance with manufacturer's recommendations.

3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

- A. Unless otherwise shown, install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.
- B. Unless otherwise shown, install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas.

3.03 SUPPORT AND FRAMING CHANNEL

- A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.
- B. Channel Type:
 - 1. Interior, Wet or Dry (Noncorrosive) Locations:
 - a. Aluminum Raceway: Extruded aluminum.
 - b. PVC-Coated Conduit: Type 316 stainless steel.
 - 2. Interior, Corrosive (Wet or Dry) Locations:
 - a. Aluminum Raceway: Extruded aluminum.
 - b. PVC Conduit: Type 316 stainless steel.
 - c. PVC-Coated Conduit and Other Systems Not Covered: Type 316 stainless steel.
 - 3. Outdoor, Noncorrosive Locations:
 - a. Aluminum Raceway and Other Systems Not Covered: Aluminum framing channel.
 - 4. Outdoor Corrosive Locations:
 - a. PVC Conduit: Type 316 stainless steel.
 - b. Aluminum Raceway: Aluminum.
 - c. Other Systems Not Covered: Type 316 stainless steel.

3.04 INTRINSIC SAFETY BARRIERS

- A. Install in compliance with ISA RP12.06.01.
- B. Arrange conductors such that wiring from hazardous areas cannot short to wiring from nonhazardous area.
- C. Stencil “INTRINSICALLY SAFE CIRCUIT” on all boxes enclosing barriers.

3.05 SWITCHBOARD MATTING

- A. Install 36-inch width at switchgear, switchboard, motor control centers, and panelboards.

- B. Matting shall run full length of all sides of equipment that have operator controls or afford access to devices.

3.06 FIRESTOPS

- A. Install in strict conformance with manufacturer's instructions. Comply with installation requirements established by testing and inspecting agency.
- B. Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide firestops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs.

END OF SECTION

SECTION 26 05 05 CONDUCTORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Association of Edison Illuminating Companies (AEIC): CS 8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 kV through 46 kV.
2. ASTM International (ASTM):
 - a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel 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. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV Through 500 kV.
 - b. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
 - c. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500000 V.
4. Insulated Cable Engineer's Association, Inc. (ICEA):
 - a. S-58-679, Standard for Control Cable Conductor Identification.
 - b. S-73-532, Standard for Control Thermocouple Extensions and Instrumentation Cables.
 - c. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 Btu/hour.
5. National Electrical Manufacturers' Association (NEMA):
 - a. CC 1, Electric Power Connectors for Substations.
 - b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables.
 - c. WC 70, Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
 - d. WC 71, Standard for Nonshielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy.
 - e. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
7. Telecommunications Industry Association (TIA): TIA-568-C, Commercial Building Telecommunications Cabling Standard.
8. Underwriters Laboratories Inc. (UL):
 - a. 13, Standard for Safety for Power-Limited Circuit Cables.
 - b. 44, Standard for Safety for Thermoset-Insulated Wires and Cables.
 - c. 62, Standard for Safety for Flexible Cord and Cables.
 - d. 486A-486B, Standard for Safety for Wire Connectors.
 - e. 486C, Standard for Safety for Splicing Wire Connectors.
 - f. 510, Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
 - g. 854, Standard for Safety for Service-Entrance Cables.
 - h. 1072, Standard for Safety for Medium-Voltage Power Cables.
 - i. 1277, Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
 - j. 1569, Standard for Safety for Metal-Clad Cables.
 - k. 1581, Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data:
 - a. Wire and cable.
 - b. Wire and cable accessories.
 - c. Cable fault detection system.
2. Cable Pulling Calculations:
 - a. Ensure submitted and reviewed before cable installation.
 - b. Provide for the following cable installations:
 - 1) Medium voltage cable runs that cannot be hand pulled.
 - 2) Multiconductor 600-volt cable sizes larger than 2 AWG that cannot be hand pulled.
 - 3) Power and control conductor, and control and instrumentation cable installations in ductbanks that cannot be hand pulled.
 - 4) Feeder circuits; single conductors #4/0 and larger that cannot be hand pulled.

B. Informational Submittals:

1. Journeyman lineman or electrician splicing credentials.
2. Certified Factory Test Report for conductors 600 volts and below.
3. Certified Factory Test Report per AEIC CS 8, including AEIC qualification report for conductors above 600 volts.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70. Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied UL listing mark.

B. Terminations and Splices for Conductors above 600 Volts: Work shall be done by journeyman lineman with splicing credentials or electrician certified to use materials approved for cable splices and terminations.

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 70.

B. Conductor Type:

1. 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
2. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN-2, except for sizes No. 6 and larger, with XHHW-2 insulation.

D. Direct Burial and Aerial Conductors and Cables:

1. Type USE/RHH/RHW insulation, UL 854 listed, or Type RHW-2/USE-2.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

E. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

2.02 600-VOLT RATED CABLE

A. General:

1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 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. Type 1, Multiconductor Control Cable:

1. Conductors:
 - a. 14 AWG, seven-strand copper.
 - b. Insulation: 15-mil PVC with 4-mil nylon.
 - c. UL 1581 listed as Type THHN/THWN rated VW-1.
 - d. Conductor group bound with spiral wrap of barrier tape.
 - e. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.
2. Cable: Passes the ICEA T-29-520, 210,000 Btu per hour 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	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
 - a. Okonite Co.
 - b. Southwire.

C. Type 2, Multiconductor Power Cable:

1. General:
 - a. Meet or exceed UL 1581 for cable tray use.
 - b. Meet or exceed UL 1277 for direct burial and sunlight-resistance.
 - c. Overall Jacket: PVC.
2. Conductors:
 - a. Class B stranded, coated copper.
 - b. Insulation: Chemically cross-linked ethylene-propylene or cross-linked polyethylene.
 - c. UL rated VW-1 or listed Type XHHW-2.
 - d. Color Code:
 - 1) Conductors, size 8 AWG and smaller, colored conductors, ICEA S-58-679, Method 1, Table 1.
 - 2) Conductors, size 6 AWG and larger, ICEA S-73-532, Method 4.
3. Cable shall pass ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
4. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. of Current Carrying Conductors	Max. Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2	0.42	45
		3	0.45	
		4	0.49	
10	10	2	0.54	60
		3	0.58	
		4	0.63	
8	10	3	0.66	60
		4	0.75	
6	8	3	0.74	60
		4	0.88	
4	6	3	0.88	60
		4	1.04	80
2	6	3	1.01	80
		4	1.16	
1	6	3	1.10	80
		4	1.25	
1/0	6	3	1.22	80
		4	1.35	

Conductor Size	Minimum Ground Wire Size	No. of Current Carrying Conductors	Max. Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
2/0	4	3	1.32	80
		4	1.53	
3/0	4	3	1.40	80
		4	1.60	
4/0	4	3	1.56	80
		4	1.78	

5. Manufacturers:
 - a. Okonite Co.
 - b. Southwire.

D. Type 3, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 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.
 - c. Belden.

E. Type 4, 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 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 blue.
 - 5. Manufacturers:
 - a. Okonite Co.
 - b. Alpha Wire Corp.
 - c. Belden.
- F. Type 5, 18 AWG, Multitwisted Shielded Pairs, with a Common Overall Shield, Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 57 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.
 - c. Belden.

- G. Type 6, 18 AWG, Multitwisted Pairs with Common Overall Shield
Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 57.

1. Conductors:
 - a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
 - b. Tinned copper drain wire size AWG 18.
 - 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.

Cable Sizes: Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.48	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.10	80
36	1.21	80
50	1.50	80

3. Manufacturers:
 - a. Okonite Co.
 - b. Alpha Wire Corp.
 - c. Belden.

2.03 SPECIAL CABLES

- A. Type 30, Unshielded Twisted Pair (UTP) Telephone and Data Cable, 300V:

1. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568-C Category 6 requirements.
2. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.
3. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.
4. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.
5. Cable shall withstand a bend radius of 1-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
6. Manufacturer and Product: Belden; 7852A.

2.04 GROUNDING CONDUCTORS

- A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.
- B. Direct Buried: Bare stranded tinned copper.

2.05 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. Arc and Fireproofing:
 - a. 30-mil, elastomer.
 - b. Manufacturers and Products:
 - 1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
 - 2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tapebinder.
- B. Identification Devices:
 - 1. Sleeve:
 - a. Permanent, PVC, yellow or white, with legible machine-printed black markings.
 - b. Manufacturers and Products:
 - 1) Raychem; Type D-SCE or ZH-SCE.
 - 2) Brady, Type 3PS.
 - 2. Heat Bond Marker:
 - a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
 - b. Self-laminating protective shield over text.
 - c. Machine printed black text.
 - d. Manufacturer and Product: 3M Co.; Type SCS-HB.
 - 3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
 - 4. Tie-On Cable Marker Tags:
 - a. Chemical-resistant white tag.
 - b. Size: 1/2 inch by 2 inches.
 - c. Manufacturer and Product: Raychem; Type CM-SCE.
 - 5. 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; Insulug.
 - 3) ILSCO.
2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
 - a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
 - b. Seamless.
 - c. Manufacturers and Products:
 - 1) Thomas & Betts; Sta-Kon.
 - 2) Burndy; Insulink.
 - 3) ILSCO; ILSCONS.
3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
 - a. UL 486C.
 - b. Plated steel, square wire springs.
 - c. Manufacturers and Products:
 - 1) Thomas & Betts.
 - 2) Ideal; Twister.
4. Self-Insulated, Set Screw Wire Connector:
 - a. Two piece compression type with set screw in brass barrel.
 - b. Insulated by insulator cap screwed over brass barrel.
 - c. Manufacturers:
 - 1) 3M Co.
 - 2) Thomas & Betts.
 - 3) Marrette.

D. Cable Lugs:

1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Uninsulated Crimp Connectors and Terminators:
 - a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
 - b. Manufacturers and Products:
 - 1) Thomas & Betts; Color-Keyed.
 - 2) Burndy; Hydent.
 - 3) ILSCO.
4. Uninsulated, Bolted, Two-Way Connectors and Terminators:
 - a. Manufacturers and Products:
 - 1) Thomas & Betts; Locktite.
 - 2) Burndy; Quiklug.
 - 3) ILSCO.

E. Cable Ties:

1. Nylon, adjustable, self-locking, and reusable.
2. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation:

1. Thermally stabilized cross-linked polyolefin.
2. Single wall for insulation and strain relief.
3. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
4. Manufacturers and Products:
 - a. Thomas & Betts; SHRINK-KON.
 - b. Raychem; RNF-100 and ES-2000.

G. Data Cable Accessories: Terminators, connectors, and junctions necessary for a complete Modbus RTU/RS 485 system.

2.06 PULLING COMPOUND

- A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.
- B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.
- C. Approved for intended use by cable manufacturer.
- D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.
- E. Manufacturers:
 1. Ideal Co.
 2. Polywater, Inc.
 3. Cable Grip Co.

2.07 WARNING TAPE

- A. As specified in Section 26 05 33, Raceway and Boxes.

2.08 SOURCE QUALITY CONTROL

- A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.

PART 3 EXECUTION

3.01 GENERAL

- A. Conductor installation shall be in accordance with manufacturer's recommendations.
- B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.
- C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
- D. Terminate conductors and cables, unless otherwise indicated.
- E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors and aluminum conductors.
- F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.
- G. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.
- H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.
- I. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

3.02 POWER CONDUCTOR COLOR CODING

- A. Conductors 600 Volts and Below:
 - 1. 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 area 1-1/2 inches to 2 inches wide.
 - 2. 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	White Brown Orange Yellow
Note: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with identifiable colored strip, other than green, in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

- A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
- B. Circuits Appearing in Circuit Schedules: Identify using circuit schedule designations.
- C. 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.
- D. Method:
 1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.

2. Cables and Conductors 2 AWG and Larger:
 - a. Identify with marker plates or tie-on cable marker tags.
 - b. Attach 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 6 AWG and larger, unless specifically indicated or approved by Engineer.
- C. Connections and Terminations:
 1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
 2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
 3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
 4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
 5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
 6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
 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. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
 - b. Do not use plier type crimpers.
- D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Insulate uninsulated connections.
2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
3. Outdoors, Dry Locations: Use flame retardant, cold- and weather-resistant tape or single wall heat shrink.
4. Below Grade and Wet or Damp Locations: Use dual wall heat shrink.

F. Cap spare 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 burrs, 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 Section 40 90 00, Instrumentation and Control for Process Systems, leave pigtails of adequate length for bundled connections.
5. Cable Protection:
 - a. Under Infinite Access Floors: May install without bundling.
 - b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under 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 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 CONDUCTOR ARC AND FIREPROOFING

- A. Install arc and fireproofing tape on 600-volt single conductors and cables, except those rated Type TC throughout entire exposed length in manholes, handholes, vaults, cable trays, and other indicated locations.
- B. Wrap conductors of same circuit entering from separate conduit together as single cable.
- C. Follow tape manufacturer's installation instructions.
- D. Secure tape at intervals of 5 feet with bands of tapebinder. Each band to consist of a minimum of two wraps directly over each other.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
 2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.02 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings: Product data for the following:
 - a. Exothermic weld connectors.
 - b. Compression connectors.
 - c. Ground rods.
 - d. Grounding wells.

1.03 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
 2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

PART 2 PRODUCTS

2.01 GROUND ROD

- A. Material: Copper-clad.
- B. Diameter: Minimum 3/4 inch.
- C. Length: 20 feet.

2.02 GROUND CONDUCTORS

- A. As specified in Section 26 05 05, Conductors.

2.03 CONNECTORS

- A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Utilize 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 prefilled with oxide-inhibiting and antiseizing compound and sealed.
5. Manufacturers:
 - a. Burndy Corp.
 - b. Thomas and Betts Co.
 - c. ILSCO.

2.04 GROUNDING WELLS

- A. H-20 rated precast concrete ground rod box complete with cast iron riser ring and H-20 traffic cover marked GROUND ROD.
- B. Manufacturers and Products:
1. Christy Co. No. G5.
 2. Lightning and Grounding Systems, Inc. I-R Series.

PART 3 EXECUTION

3.01 GENERAL

- A. Grounding shall be in compliance with NFPA 70 and IEEE 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 noncurrent-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 Instrumentation Cables:
 - 1. Ground shield to ground bus at power supply for analog signal.
 - 2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
 - 3. Do not ground instrumentation 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 equipment grounding conductor connected at both ends to noncurrent-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 noncurrent-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.
- C. Space multiple ground rods by one rod length.

3.05 GROUNDING WELLS

- A. Install inside buildings, asphalt, and paved areas.
- B. Install riser ring and cover flush with surface.
- C. Place 12 inches of crushed rock in bottom of each well.

3.06 CONNECTIONS

- A. General:
 - 1. Abovegrade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.
 - 2. Belowgrade Connections: Install exothermic weld or compression type connectors.
 - 3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
 - 4. Notify Engineer prior to 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.

3.07 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.
- D. Install a ground ring around all structures and objects provided at or above finished grade as indicated on the Drawings. Ground ring shall be No. 4/0 or larger tinned bare copper conductor with ground rods at all corners (4 minimum) and at intervals not exceeding 50 feet. Provide ground test wells at a minimum of one ground rod per structure. Install 30 inches below finished grade with 2-inch, red, detectable, electrical warning tape directly above conductor and 12 inches below finished grade. Maintain 3 feet minimum clearance to all objects and structures at or above finished grade. Cad weld ground ring and radial ground conductors to all ground rods. Cad weld radial ground cables at every ground rod to steel reinforcement members in concrete. Ground cables may exit protective conduit at these cad welds.
- E. Where railings, ladders, steps, gratings, framing, process equipment, or other conductive items which are normally not energized are installed outdoors, bond to ground ring with No. 4/0 minimum tinned bare copper conductor, UL listed clamps above grade and cad welds below grade. Items such as railings which are installed as multiple sections shall be bonded together with No. 4/0 copper conductor or equivalent tinned copper strap to avoid isolation from a ground ring of any item which is required to be grounded.

- F. Conductive enclosures and other exterior metal components of instruments and controls which are not normally energized shall be grounded with No. 6 minimum tinned copper conductor.
- G. Ground conductors shall be protected with Schedule 80 PVC conduit above grade.

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 noncurrent-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 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.

END OF SECTION

**SECTION 26 05 33
RACEWAY AND BOXES**

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): HB, Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
 - a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
 - b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
 - e. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
3. Telecommunications Industry Association (TIA): 569B, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. National Electrical Contractor's Association, Inc. (NECA): Installation standards.
5. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. C80.1, Electrical Rigid Steel Conduit (ERSC).
 - c. C80.3, Steel Electrical Metallic Tubing (EMT).
 - d. C80.5, Electrical Rigid Aluminum Conduit (ERAC).
 - e. C80.6, Electrical Intermediate Metal Conduit (EIMC).
 - f. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - g. TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
 - h. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - i. TC 6, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
 - j. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
 - k. 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 for Flexible Metal Conduit.
 - b. 5, Standard for Safety for Surface Metal Raceways and Fittings.
 - c. 6, Standard for Safety for Electrical Rigid Metal Conduit – Steel.
 - d. 6A, Standard for Safety for Electrical Rigid Metal Conduit – Aluminum, Red Brass and Stainless.
 - e. 360, Standard for Safety for Liquid-Tight Flexible Steel Conduit.
 - f. 514B, Standard for Safety for Conduit, Tubing, and Cable Fittings.
 - g. 651, Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
 - h. 651A, Standard for Safety for Type EB and A Rigid PVC Conduit and HDPE Conduit.
 - i. 797, Standard for Safety for Electrical Metallic Tubing – Steel.
 - j. 870, Standard for Safety for Wireways, Auxiliary Gutters, and Associated Fittings.
 - k. 1242, Standard for Safety for Electrical Intermediate Metal Conduit – Steel.
 - l. 1660, Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.
 - m. 1684, Standard for Safety for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
 - n. 2024, Standard for Safety for Optical Fiber and Communication Cable Raceway.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's Literature:
 - a. Rigid aluminum conduit.
 - b. PVC Schedule 40 conduit.
 - c. PVC Schedule 80 conduit.
 - d. PVC-coated rigid aluminum conduit, submittal to include copy of manufacturer's warranty.
 - e. Flexible metal, liquid-tight conduit.
 - f. Flexible, nonmetallic, liquid-tight conduit.
 - g. Flexible metal, nonliquid-tight conduit.
 - h. Conduit fittings.
 - i. Wireways.
 - j. Device boxes for use in hazardous areas.
 - k. Large junction and pull boxes.
 - l. Terminal junction boxes.

2. Precast Manholes and Handholes:
 - a. Dimensional drawings and descriptive literature.
 - b. Traffic loading calculations.
 - c. Accessory information.
 3. Equipment and machinery proposed for bending metal conduit.
 4. Method for bending PVC conduit less than 30 degrees.
 5. Conduit Layout:
 - a. Provide drawings for conduit installations underground and concealed conduits including, but not limited to ductbanks, under floor slabs, concealed in floor slabs, and concealed in walls.
 - b. Provide plan and section 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.
 - c. Reproducible; scale not greater than 1 inch equals 20 feet.
- B. Informational Submittals: Manufacturer's certification of training for PVC-coated rigid galvanized steel conduit installer.

1.03 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
 2. Materials and equipment manufactured within scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.
- B. PVC-Coated, Rigid Metallic Conduit Installer: Certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

- A. Rigid Aluminum Conduit:
1. Meet requirements of NEMA C80.5 and UL 6A.
 2. Material: Type 6063, copper-free aluminum alloy.

B. 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.
3. Furnish without factory-formed bell.

C. PVC Schedule 80 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.
3. Furnish without factory-formed bell.

D. Rigid Stainless Steel Conduit:

1. Meet requirements of UL 6, UL514A/B, NEC.
2. Type 316 stainless steel.
3. Manufacturers:
 - a. Cal Conduit Products (stainlessconduit.com).
 - b. Gibson Stainless & Specialty, Inc. (gibsonstainless.com).

E. PVC-Coated Rigid Aluminum Conduit:

1. Meet requirements of NEMA RN 1.
2. Material: Type 6063, copper-free aluminum alloy.
 - a. Meet requirements of NEMA C80.5 and UL 6A.
 - b. Exterior Finish: PVC coating, 40-mil nominal thickness; bond to metal shall have tensile strength greater than PVC.
 - c. Interior Finish: Urethane coating, 2-mil nominal thickness.

F. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of NEMA RN 1.
2. Material:
 - a. Meet requirements of NEMA C80.1 and UL 6.
 - b. Exterior Finish: PVC coating, 40-mil nominal thickness; bond to metal shall have tensile strength greater than PVC.
 - c. Interior finish: Urethane coating, 2-mil nominal thickness.
3. Threads: Hot-dipped galvanized and factory coated with urethane.
4. Bendable without damage to interior or exterior coating.

G. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel with extruded PVC jacket.

H. Flexible Metal, Nonliquid-Tight Conduit:

1. Meet requirements of UL 1.
2. Material: Aluminum.

I. 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 and Products:
 - a. Carlon; Carflex or X-Flex.
 - b. T & B; Xtraflex LTC or EFC.

J. Innerduct:

1. Resistant to spread of fire, per requirements of UL 2024.
2. Smooth or corrugated HDPE.
3. Textile Manufacturer: Maxcell.

2.02 FITTINGS

A. 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 and Product: 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 and Product: O-Z/Gedney; Type ABLG.
4. Conduit Hub:
 - a. Material: Cast aluminum, with insulated throat.
 - b. UL listed for use in wet locations.
 - c. Manufacturers and Products:
 - 1) O-Z/Gedney; Type CHA.
 - 2) Thomas & Betts; Series 370AL.
 - 3) Meyers; Series SA.

5. Conduit Bodies:
 - a. Manufacturers and Products (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:
 - a. Manufacturers and Products:
 - 1) Appleton; Type EYF-AL or EYM-AL.
 - 2) Crouse-Hinds; Type EYS-SA or EZS-SA.
 - 3) Killark; Type EY or Type EYS.
 8. Drain Seal:
 - a. Manufacturers and Products:
 - 1) Appleton; Type EYDM-A.
 - 2) Crouse-Hinds; Type EYD-SA or Type EZD-SA.
 9. Drain/Breather Fitting:
 - a. Manufacturers and Products:
 - 1) Appleton; Type ECDB.
 - 2) Crouse-Hinds; ECD.
 10. Expansion Fitting:
 - a. Manufacturers and Products:
 - 1) Deflection/Expansion Movement: Steel City; Type DF-A.
 - 2) Expansion Movement Only: Steel City; Type AF-A.
 11. Cable Sealing Fittings:
 - a. To form watertight nonslip cord or cable connection to conduit.
 - b. Bushing: Neoprene at connector entry.
 - c. Manufacturer and Product: Appleton; CG-S.
- B. PVC Conduit and Tubing:
1. Meet requirements of NEMA TC 3.
 2. Type: PVC, slip-on.
- C. Stainless Steel:
1. General:
 - a. Meet requirements of UL 514B.
 - b. Threaded Only: Setscrew and compression type not permitted except Myers hubs are required for entry into enclosures if threaded bosses are not provided.
 - c. Type 316 stainless steel.

2. Conduit Bodies:
 - a. Size as required by NFPA-70.
 - b. Cast with integral threaded hubs.
 - c. With stainless steel cover and screws and neoprene gasket.
 - d. Cal Conduit Products S6 Series.
 - e. Gibson Stainless Specialty Series 7000.
3. Couplings: As supplied by conduit manufacturer.
4. Clamps:
 - a. Two hole.
 - b. Cal Conduit Products S6 Series.
 - c. Gibson Stainless Specialty Series 7000

D. PVC-Coated Rigid Aluminum Conduit:

1. Meet requirements of UL 514B.
2. Fittings: As listed for rigid aluminum conduit.
3. Finish: 40-mil PVC exterior, 2-mil urethane interior.
4. Overlapping pressure-sealing sleeves.
5. Conduit Hangers, Attachments, and Accessories: PVC-coated.
6. Manufacturers:
 - a. Robroy Industries.
 - b. Ocal.

E. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of UL 514B.
2. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.
3. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.
4. Finish: 40-mil PVC exterior, 2-mil urethane interior.
5. Overlapping pressure-sealing sleeves.
6. Conduit Hangers, Attachments, and Accessories: PVC-coated.
7. Manufacturers:
 - a. Robroy Industries.
 - b. Ocal.
8. Expansion Fitting:
 - a. Manufacturer and Product: Ocal; OCAL-BLUE XJG

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. Manufacturers and Products:
 - a. Thomas & Betts; Series 5331.
 - b. O-Z/Gedney; Series 4Q.
- G. Flexible Metal, Nonliquid-Tight Conduit:
 1. Meet requirements of UL 514B.
 2. Body: Galvanized malleable iron.
 3. Throat: Nylon insulated.
 4. 1-1/4-Inch Conduit and Smaller: One screw body.
 5. 1-1/2-Inch Conduit and Larger: Two screw body.
 6. Manufacturer and Product: Appleton; Series 7400.
- H. Flexible, Nonmetallic, Liquid-Tight Conduit:
 1. Meet requirements of UL 514B.
 2. Type: High strength plastic body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
 3. Body/compression nut (gland) design to ensure high mechanical pullout strength and watertight seal.
 4. Manufacturers and Products:
 - a. Carlon; Type LT.
 - b. O-Z/Gedney; Type 4Q-P.
 - c. Thomas & Betts; Series 6300.
- I. Flexible Coupling, Hazardous Locations:
 1. Approved for use in atmosphere involved.
 2. Rating: Watertight and UL listed for use in Class I, Division 1 and 2 areas.
 3. Outer bronze braid and an insulating liner.
 4. Conductivity equal to a similar length of rigid metal conduit.
 5. Manufacturers and Products:
 - a. Crouse-Hinds; Type ECGJH or Type ECLK.
 - b. Appleton; EXGJH or EXLK.
- J. 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 and Product: O-Z/Gedney; Type FSK or Type WSK, as required.
 2. Cored-Hole Application:
 - a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
 - b. Manufacturer and Product: O-Z/Gedney; Series CSM.

2.03 OUTLET AND DEVICE BOXES

A. 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 and Products, Nonhazardous Locations:
 - a. Crouse-Hinds; Type FS-SA or Type FD-SA.
 - b. Appleton; Type FS or Type FD.
 - c. Killark.
5. Manufacturers and Products, Hazardous Locations:
 - a. Crouse-Hinds; Type GUA-SA.
 - b. Appleton; Type GR.

B. PVC-Coated Cast Metal:

1. Type: One-piece.
2. Material: Cast aluminum.
3. Coating:
 - a. Exterior Surfaces: 40-mil PVC.
 - b. Interior Surfaces: 2-mil urethane.
4. Manufacturers:
 - a. Robroy Industries.
 - b. Ocal.

2.04 JUNCTION AND PULL BOXES

A. Outlet Box Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.

C. Large Cast Aluminum Box:

1. NEMA 250 Type 4.
2. Box: Cast copper-free aluminum, with drilled and tapped conduit entrances and exterior mounting lugs.
3. Cover: Nonhinged.
4. Gasket: Neoprene.

5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
6. Manufacturers and Products, Surface Mounted Type:
 - a. Crouse-Hinds; Series W-SA.
 - b. O-Z/Gedney; Series YS-A, YL-A.
 - c. Killark.

D. Large Stainless Steel Box:

1. NEMA 250 Type 4X.
2. Box: 14-gauge, ASTM A240/A240M, Type 316 stainless steel with white enamel painted interior mounting panel.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Robroy Industries.
 - c. Wiegman.

E. Concrete Box:

1. Box: Reinforced, cast concrete with extension and bottom slab.
2. Cover: Steel checked plate; H/20 loading with screw down.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Manufacturers and Products:
 - a. Christy, Concrete Products, Inc.; B1017BOX.
 - b. Utility Vault Co.; 3030 SB.

2.05 TELEPHONE TERMINAL CABINET

- A. Material: Code-gauge galvanized steel box with hinged doors and 3/4-inch fire-resistant plywood backboard, meeting requirements of telephone service provider.
- B. Finish: Provide gray finish as approved by Owner.
- C. Minimum Size: 18 inches high by 18 inches wide by 6 inches deep.

2.06 TELEPHONE AND DATA OUTLET

- A. Provide outlet boxes and cover plates meeting requirements of TIA 569B.

2.07 TERMINAL JUNCTION BOX

- A. Cover: Hinged, unless otherwise shown.
- B. Interior Finish: Paint with white enamel or lacquer.

C. Terminal Blocks:

1. Separate connection point for each conductor entering or leaving box.
2. Spare Terminal Points: 25 percent, minimum.

2.08 METAL WIREWAYS

- A. Meet requirements of UL 870.
- B. Type: Aluminum or stainless steel-enclosed, lay-in type.
- C. Cover: Removable, screw type.
- D. Rating: Outdoor raintight.
- E. Finish: Rust inhibiting phosphatizing primer and gray baked enamel.
- F. Hardware: Plated to prevent corrosion; screws installed toward the inside protected by spring nuts or otherwise guarded to prevent wire insulation damage.
- G. Knockouts: Without knockouts, unless otherwise indicated.
- H. Manufacturers:
 1. Circle AW.
 2. Hoffman.
 3. Square D.
 4. P.W. Industries.

2.09 PRECAST MANHOLES AND HANDHOLES

- A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.
- B. Loading: AASHTO, H-20 in accordance with ASTM C857.
- C. Access: Provide cast concrete 6-inch 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 nondraining areas.
 2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and a minimum 4-inch outlet and outlet pipe.

E. Raceway Entrances:

1. Provide on all four sides.
2. 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 feet on center for inside perimeter of manhole.
 - c. Arrange in order that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:

1. Material: Machined cast iron.
2. Diameter: 36-1/2 inch.
3. Cover Type: Indented, solid top design, with two drop handles each.
4. Cover Loading: AASHTO H-20.
5. 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, hinged, torsion spring, of checkered diamond design.

3. Cover Loading: AASHTO 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, Type 316 stainless steel.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:

1. Utility Vault Co.
2. Penn-Cast Products, Inc.
3. Concrete Conduit Co.
4. Associated Concrete Products, Inc.
5. Pipe, Inc.

2.10 ACCESSORIES

A. Duct Bank Spacers:

1. Modular Type:
 - a. Nonmetallic, interlocking, for multiple conduit sizes.
 - b. Suitable for all types of conduit.
 - c. Manufacturers:
 - 1) Underground Device, Inc.
 - 2) Carlon.
2. Template Type:
 - a. Nonmetallic, custom made one-piece spacers.
 - b. Suitable for all types of conduit.
 - c. Material: HDPE or polypropylene, 1/2-inch minimum thickness.
 - d. Conduit openings cut 1 inch larger than conduit outside diameter.
 - e. Additional openings for stake-down, rebar, and concrete flow through as required.
 - f. Manufacturer and Product: SP Products; Quik Duct.

B. Identification Devices:

1. Raceway Tags:
 - a. Material: Permanent, nonferrous metal.
 - 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 with detectable strip.
 - b. Color: Red.

- c. Width: Minimum 3 inches.
- d. Designation: Warning on tape that electric circuit is located below tape.
- e. Identifying Letters: Minimum 1-inch high permanent black lettering imprinted continuously over entire length.
- f. Manufacturers and Products:
 - 1) Panduit; Type HTDU.
 - 2) Reef Industries; Terra Tape.
- 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: Engrave 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: Clean and paint in accordance with Section 09 90 00, Painting and Coating.
- D. Heat Shrinkable Tubing:
 - 1. Material: Heat-shrinkable, cross-linked polyolefin.
 - 2. Semi-flexible with meltable adhesive inner liner.
 - 3. Color: Black.
 - 4. Manufacturers:
 - a. Raychem.
 - b. 3M.
- E. Wraparound Duct Band:
 - 1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
 - 2. Width: 50 mm minimum.
 - 3. Manufacturer and Product: Raychem; Type TWDB.

PART 3 EXECUTION

3.01 GENERAL

- A. Conduit and tubing sizes shown are based on use of copper conductors.
- B. Comply with NECA Installation Standards.
- 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. Install in PVC sleeve or cored hole through concrete walls and slabs.
- 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 or vertical cell with reinforcing steel.
- N. Install watertight fittings in outdoor, underground, or wet locations.
- O. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
- P. Do not install raceways in concrete equipment pads, foundations, or beams without Engineer approval.
- Q. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
- R. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
- S. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.
- T. All conduit of a given type shall be the product of one manufacturer.
- U. Provide enclosures and boxes of same material as conduit and NEMA 250 type as required in Specification section titled Basic Electrical Materials and Methods.

3.02 REUSE OF EXISTING CONDUITS

- A. Where Drawings indicate existing conduits may be reused, they may be reused only where they meet the following criteria.
 - 1. Conduit is in useable condition with no deformation, corrosion, or damage to exterior surface.
 - 2. Conduit is sized per the NEC.
 - 3. Conduit is of the type specified in Contract Documents.
 - 4. Conduit is supported as specified in Contract Documents.
- B. Conduit shall be reamed with wire brush, then with a mandrel approximately 1/4-inch smaller than raceway inside diameter then cleaned prior to pulling new conductors.

3.03 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

- A. Minimum Cover: 2 inches, including fittings.
- B. Conduit placement shall not require changes in reinforcing steel location or configuration.
- C. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.
- D. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns, or beams unless approved by Engineer.
- E. Slabs and Walls (Requires Engineer Approval):
 - 1. Trade size of conduit not to exceed one-fourth of slab or wall thickness.
 - 2. Install within middle two-fourths of slab or wall.
 - 3. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
 - 4. Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
 - 5. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
 - 6. Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.
 - 7. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.

F. Columns and Beams (Requires Engineer Approval):

1. Trade size of conduit not to exceed one-fourth of beam thickness.
2. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

3.04 CONDUIT APPLICATION

- A. Diameter: Minimum 3/4 inch.
- B. Exterior, Exposed: Rigid aluminum.
- C. Interior, Exposed: Rigid aluminum.
- D. Interior, Concealed (Not Embedded in Concrete): Rigid aluminum.
- E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: PVC Schedule 40.
- F. Direct Earth Burial: PVC Schedule 80.
- G. Concrete-Encased Ductbank: PVC Schedule 40.
- H. Under Slabs-On-Grade: PVC Schedule 80.
- I. Transition from Underground or Concrete Embedded to Exposed: PVC-coated rigid aluminum conduit.
- J. Under Equipment Mounting Pads: PVC Schedule 80 conduit.
- K. Exterior Light Pole Foundations: PVC Schedule 80 conduit.
- L. Corrosive Areas: PVC-coated rigid aluminum.

3.05 FLEXIBLE CONNECTIONS

- A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other locations approved by Engineer where flexible connection is required to minimize vibration:
 1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
 2. Conduit Size Over 4 Inches: Nonflexible.
 3. Wet or Corrosive Areas: Flexible, nonmetallic or flexible metal liquid-tight.
 4. Dry Areas: Flexible, metallic liquid-tight.

- B. Suspended Lighting Fixtures in Dry Areas: Flexible aluminum, 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. Flexible Conduit Length: 18 inches minimum, 60 inches maximum; sufficient to allow movement or adjustment of equipment.

3.06 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: Firestop openings around penetrations to maintain fire-resistance rating as specified in Section 26 05 04, Basic Electrical Materials and Methods.
- D. Apply heat shrinkable tubing or two layers of wraparound duct band to metallic conduit protruding through concrete floor slabs to a point 4 inches above and 4 inches below 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 first box or outlet with oakum or expandable plastic compound to prevent 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 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 conduit attached to exterior surface of equipment prior to penetrating equipment.

- c. Seal penetration with one-part Polyurethane, Immersible:
 - 1) Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25.
 - 2) Capable of being continuously immersed in water.
 - 3) Manufacturers and Products for Nonsag:
 - a) Sika Chemical Corp.; Sikaflex-1a.
 - b) Tremco; Vulkem 116.
 - 4) Manufacturers and Products for Self-leveling:
 - a) BASF; Sonneborn, SL-1.
 - b) Tremco; Vulkem 45.
 - c) Sika Chemical Corp.; Sikaflex 1c SL.
- 4. Corrosive-Sensitive Areas:
 - a. Seal conduit passing through chlorine and ammonia room walls.
 - b. Seal conduit entering equipment panel boards and field panels containing electronic equipment.
 - c. Seal penetration with one-part Polyurethane, Immersible:
 - 1) Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25.
 - 2) Capable of being continuously immersed in water.
 - 3) Manufacturers and Products for Nonsag:
 - a) Sika Chemical Corp.; Sikaflex-1a.
 - b) Tremco; Vulkem 116.
 - 4) Manufacturers and Products for Self-leveling:
 - a) BASF; Sonneborn, SL-1.
 - b) Tremco; Vulkem 45.
 - c) Sika Chemical Corp.; Sikaflex 1c SL.
- 5. Existing or Precast Wall (Underground): Core drill wall and install 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 expandable plastic compound or oakum and lead joint, 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.

3.07 SUPPORT

- A. Support from structural members only, at intervals not exceeding NFPA 70 requirements. Do not exceed 10 feet in any application. Do not support from piping, pipe supports, or other raceways.

- B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 20 percent extra space for future conduit.
- C. Application/Type of Conduit Strap:
 - 1. Aluminum Conduit: Aluminum or stainless steel.
 - 2. PVC-Coated Rigid Aluminum Conduit: PVC-coated metal or stainless steel.
 - 3. Nonmetallic Conduit: PVC-coated metal or stainless steel.
- D. 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.
 - 5. Location/Type of Hardware:
 - a. Dry, Noncorrosive Areas: Stainless steel.
 - b. Wet, Noncorrosive Areas: Stainless steel.
 - c. Corrosive Areas: Stainless steel.
- E. 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.
- F. Support aluminum conduit on concrete surfaces with stainless steel or nonmetallic spacers, or aluminum or nonmetallic framing channel.

3.08 BENDS

- A. Install concealed raceways with a minimum of bends in the shortest practical distance.
- B. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.
- 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 Degrees and Larger: Provide factory-made elbows.
 - 2. 90-Degree Bends: Provide rigid aluminum elbows, PVC-coated where direct buried.
 - 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.

3.09 EXPANSION/DEFLECTION FITTINGS

- A. Provide on raceways at 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.

3.10 PVC CONDUIT

- A. Solvent Welding:
 - 1. Apply manufacturer recommended solvent to joints.
 - 2. Install in order that joint is watertight.
- B. Adapters:
 - 1. PVC to Metallic Fittings: PVC terminal type.
 - 2. PVC to Rigid Metal Conduit: PVC female adapter.
- C. Belled-End Conduit: Bevel unbelled end of joint prior to joining.

3.11 PVC-COATED RIGID ALUMINUM CONDUIT

- A. Install in accordance with manufacturer's instructions.
- B. Tools and equipment used in cutting, bending, threading and installation of PVC-coated rigid conduit shall be designed to limit damage to PVC coating.
- C. Provide PVC boot to cover exposed threading.

3.12 WIREWAYS

- A. Install in accordance with manufacturer's instructions.
- B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.
- C. Applications:
 - 1. Metal wireway in indoor dry locations.
 - 2. Nonmetallic wireway in indoor wet, outdoor, and corrosive locations.

3.13 TERMINATION AT ENCLOSURES

- A. Cast Metal Enclosure: Install manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.
- B. Nonmetallic, Cabinets, and Enclosures:
 - 1. Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
 - 2. Metallic Conduit: Provide ground terminal for connection to maintain continuity of ground system.
- C. Sheet Metal Boxes, Cabinets, and Enclosures:
 - 1. General:
 - a. Install insulated bushing on ends of conduit where grounding is not required.
 - b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
 - c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 3R and NEMA 12 enclosures.
 - d. Terminate conduits at threaded hubs at the tops of NEMA 3R and NEMA 12 boxes and enclosures.
 - e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.
 - 2. Rigid Aluminum Conduit:
 - a. Install grounding bushing at source enclosure.
 - b. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
 - 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 Aluminum Conduit: Provide PVC-coated, liquid-tight, metallic connector.
 6. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut, except where threaded hubs required above.
- D. Motor Control Center, Switchboard, Switchgear and Free-Standing Enclosures:
1. Terminate metal conduit entering bottom with grounding bushing; provide grounding jumper extending to equipment ground bus or grounding pad.
 2. Terminate PVC conduit entering bottom with bell end fittings.

3.14 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 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. Transition from Underground to Exposed: PVC-coated rigid aluminum conduit.
- I. 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.

- J. Metallic Raceway Coating: Along entire length, clean and paint in accordance with Section 09 90 00, Painting and Coating, apply wraparound duct band with one-half tape width overlap to obtain two complete layers or apply heat shrinkable tubing.
- K. Concrete Encasement:
 - 1. As specified in Section 03 30 00, Cast-in-Place Concrete.
 - 2. Concrete Color: Red.
- L. Backfill:
 - 1. As specified in Section 31 23 23.15, Trench Backfill. Controlled low strength fill is an acceptable bedding and pipe zone material.
 - 2. Do not backfill until inspected by Engineer.

3.15 UNDER SLAB RACEWAYS

- A. Make routing changes as necessary to avoid obstructions or conflicts.
- B. Support raceways so as to prevent bending or displacement during backfilling or concrete placement.
- C. Install raceways with no part embedded within slab and with no interference with slab on grade construction.
- D. Raceway spacing, in a single layer or multiple layers:
 - 1. 3 inches clear between adjacent 2-inch or larger raceway.
 - 2. 2 inches clear between adjacent 1-1/2-inch or smaller raceway.
- E. Multiple Layers of Raceways: Install under slab on grade in trench below backfill zone, as specified in Section 31 23 23.15, Trench Backfill.
- F. Individual Raceways and Single Layer Multiple Raceways: Install at lowest elevation of backfill zone with spacing as specified herein. Where conduits cross at perpendicular orientation, installation of conduits shall not interfere with placement of under slab fill that meets compaction and void limitations of earthwork specifications.
- G. Under slab raceways that emerge from below slab to top of slab as exposed, shall be located to avoid conflicts with structural slab rebar. Coordinate raceway stub ups with location of structural rebar.

H. Fittings:

1. Union type fittings are not permitted.
2. Provide expansion/deflection fittings in raceway runs that exit building or structure below slab. Locate fittings 18 inches, maximum, beyond exterior wall. Raceway type between building exterior wall to fitting shall be PVC-coated rigid aluminum.
3. Couplings: In multiple raceway runs, stagger so couplings in adjacent runs are not in same traverse line.

3.16 OUTLET AND DEVICE BOXES

A. General:

1. Install plumb and level.
2. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
3. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
4. Install galvanized mounting hardware in industrial areas.

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 device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch 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 Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown.

D. Mounting Height:

1. General:
 - a. Dimensions given to centerline of box.
 - b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference.
 - c. Do not straddle CMU block or other construction joints.

2. Light Switch:
 - a. 48 inches above floor.
 - b. When located next to door, install on lock side of door.
 3. Thermostat: 54 inches above floor.
 4. Telephone Outlet:
 - a. 15 inches above floor.
 - b. 6 inches above counter tops.
 - c. Wall Mounted: 52 inches above floor.
 5. 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 backsplash, or 6 inches above counter tops without backsplash.
 - c. Industrial Areas, Workshops: 48 inches above floor.
 - d. Outdoor Areas: 24 inches above finished grade.
 6. Special-Purpose Receptacle: 15 inches above floor or as shown.
 7. Switch, Motor Starting: 48 inches above floor, unless otherwise indicated on Drawings.
- E. 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.
- F. Supports:
1. Support boxes independently of conduit by attachment to building structure or structural member.
 2. Install bar hangers in frame construction or fasten boxes directly as follows:
 - a. Wood: Wood screws.
 - b. Concrete or Brick: Bolts and expansion shields.
 - c. Hollow Masonry Units: Toggle bolts.
 - d. Steelwork: Machine screws.
 3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
 4. Provide plaster rings where necessary.
 5. Boxes embedded in concrete or masonry need not be additionally supported.

- G. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.
- H. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

3.17 JUNCTION AND PULL BOXES

A. General:

1. Install plumb and level.
2. Installed boxes shall be accessible.
3. Do not install on finished surfaces.
4. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
5. Use conduit bodies as junction and pull boxes where no splices are required and allowed by applicable codes.
6. Install pull boxes where necessary in raceway system to facilitate conductor installation.
7. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
8. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

B. 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.

C. Mounting Hardware:

1. Noncorrosive Dry Areas: Stainless steel.
2. Noncorrosive Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

D. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
 - a. Wood: Wood screws.
 - b. Concrete or Brick: Bolts and expansion shields.
 - c. Hollow Masonry Units: Toggle bolts.
 - d. Steelwork: Machine screws.

3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Boxes embedded in concrete or masonry need not be additionally supported.

E. At or Below Grade:

1. Install boxes for below grade conduit 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.

F. Install Drain/breather fittings in NEMA 250 Type 4 and Type 4X enclosures.

3.18 TELEPHONE TERMINAL CABINET

- A. Install with top of cabinet 6 feet above floor.
- B. Door Opening: 120 degrees, minimum.

3.19 TELEPHONE AND DATA OUTLET

- A. Provide empty 4-11/16-inch square, deep outlet box.
- B. Provide blank single gang raised device cover if cables are not installed.

3.20 MANHOLES AND HANDHOLES

- A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.
- B. Do not install until final raceway grading has been determined.
- C. Install such that raceway enters at nearly right angle and as near as possible to end of wall, unless otherwise shown.
- D. Grounding: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.
- E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

3.21 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 Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.22 IDENTIFICATION DEVICES

- A. Raceway Tags:
 - 1. Identify origin and destination.
 - 2. For exposed raceways, install tags at each terminus, near midpoint, and at minimum intervals of every 50 feet, whether in ceiling space or surface mounted.
 - 3. Install tags at each terminus for concealed raceways.
 - 4. Provide noncorrosive wire 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 run.

3.23 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 conduit openings during construction.
- C. Touchup painted conduit threads after assembly to cover nicks or scars.
- D. Touchup coating damage to PVC-coated conduit with patching compound approved by manufacturer. Compound shall be kept refrigerated according to manufacturers' instructions until time of use.

END OF SECTION

SECTION 26 05 70
ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI).
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
 - b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - c. 399, Recommended Practice for Industrial and Commercial Power System Analysis.

1.02 SUBMITTALS

A. Action Submittals: Provide five copies of study in hard cover, three-ring binders, to include:

1. Short circuit study.
2. Protective Device Coordination Study.
3. Arc Flash Study.
4. Arc Flash Warning Labels.
5. Power Company correspondence and contact information.

1.03 QUALITY ASSURANCE

- A. Short circuit and protective device coordination studies shall be prepared by the manufacturer furnishing the major electrical equipment or a professional electrical engineer registered in the State of Florida, in accordance with IEEE 242 and IEEE 399.
- B. The studies shall be prepared by a professional Engineer registered in the State of Florida. That Engineer shall sign and seal all submittals, including preliminary and final.

1.04 SPECIAL PROJECT REQUIREMENTS

- A. The complete short circuit, protective device coordination and arc-flash studies must be submitted, reviewed, and approved before the Engineer will approve any Shop Drawings for electrical equipment with short circuit interrupting or withstand ratings. It is imperative that the Electrical Subcontractor begin this work immediately after award of the contract. This task requires extensive coordination and work with numerous vendors. Failure of the Electrical Subcontractor to provide the completed short circuit, protective device coordination and arc-flash studies before any Shop Drawings for any major electrical equipment will result in rejecting the Shop Drawings without review.

1.05 SEQUENCING AND SCHEDULING

- A. Complete short circuit, protective device coordination and arc-flash studies must be submitted, reviewed, and approved before Engineer will approve Shop Drawings for pad-mounted switchgear, pad-mounted transformers , motor control centers, panelboards, and dry-type transformers.
- B. The short circuit, protective device coordination, and arc-flash studies shall be updated prior to Project Substantial Completion. Utilize characteristics of as-installed equipment and materials.
- C. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to project substantial completion.

1.06 GENERAL

- A. Equipment and component titles used in the studies shall be identical to the equipment and component titles shown on the Drawings.
- B. Perform studies using digital computer (i.e., SKM software) and verify results with handwritten computations.
- C. Perform complete phase and ground fault calculations for each existing and proposed source combination.
- D. Source combination may include present and future power company supply circuits, large motors, or generators. Obtain and verify with the power company in writing all information needed to conduct this study. Provide this correspondence and information including contacts and phone numbers with the study submittal.
- E. Utilize proposed and existing load data for the study obtained from Contract Documents, Owner as-built record drawings, and from field investigation of system configuration, wiring information, and equipment.

F. Existing System and Equipment:

1. Extent of existing system to be included in study is limited to system elements that affect new system and equipment.
2. Include fault contribution of existing motors in the study.
3. Include impedance elements that affects new system and equipment.
4. Include protective devices in series with new equipment.
5. Obtain required existing equipment data.

G. Device coordination time-current curves for medium and low voltage distribution system(s); include: Individual protective device time-current characteristics.

1.07 SHORT CIRCUIT STUDY

A. General:

1. Prepare in accordance with IEEE 399.
2. Use cable impedances based on copper conductors.
3. Use bus impedances based on copper bus bars.
4. Use cable and bus resistances calculated at 25 degrees C.
5. Use medium voltage cable reactances based on use of typical dimensions of shielded cables with 133 percent insulation levels.
6. Use 600-volt cable reactances based on use of typical dimensions of THHN/THWN and XHHW conductors.
7. Use transformer impedances 92.5 percent of “nominal” impedance based on tolerances specified in IEEE C57.12.00.

B. Provide:

1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagrams.
4. Source impedance data, including electric utility system and motor fault contribution characteristics.
5. Impedance diagrams.
6. Zero sequence impedance diagrams.
7. Typical calculation.
8. Tabulations of calculated quantities.
9. Results, conclusions, and recommendations.

C. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:

1. Motor control center in north blower building.
2. All branch circuit panelboards.

3. Other significant locations throughout the system.
 4. Future load contributions as shown on one-line diagram.
- D. Provide bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.
- E. Provide bolted line-to-line fault current study for areas as defined for three-phase bolted fault short circuit study.
- F. Verify:
1. Equipment and protective devices are applied within their ratings.
 2. Adequacy of pad-mounted switchgear, unit substations, motor control centers, and panelboards bus bars to withstand short circuit stresses.
 3. Adequacy of transformer windings to withstand short circuit stresses.
 4. Cable and busway sizes for ability to withstand short circuit heating, besides normal load currents.
- G. Tabulations:
1. General Data:
 - a. Short circuit reactances of rotating machines.
 - b. Cable and conduit material data.
 - c. Bus data.
 - d. Transformer data.
 - e. Circuit resistance and reactance values.
 2. Short Circuit Data (for each source combination):
 - a. Fault impedances.
 - b. X to R ratios.
 - c. Asymmetry factors.
 - d. Motor contributions.
 - e. Short circuit kVA.
 - f. Symmetrical and asymmetrical fault currents.
 3. Equipment Evaluation:
 - a. Equipment bus bracing, equipment short circuit rating, transformer, cable, busway.
 - b. Maximum fault current available.
- H. Written Summary:
1. Scope of studies performed.
 2. Explanation of bus and branch numbering system.
 3. Prevailing conditions.
 4. Selected equipment deficiencies.
 5. Results of short circuit study.
 6. Comments or suggestions.

- I. Suggest changes and additions to equipment rating and/or characteristics.
- J. Notify Engineer in writing of existing circuit protective devices improperly rated for new fault conditions.
- K. Revise data for “as-installed” condition.

1.08 PROTECTIVE DEVICE COORDINATION STUDY

- A. Prepare in accordance with IEEE 242.
- B. Proposed protective device coordination time-current curves for distribution system, graphically displayed on conventional log-log curve sheets.
- C. Provide separate curve sheets for phase and ground fault coordination for each scenario.
- D. Each curve sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet. Limit number of devices show to six.
- E. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
- F. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, instantaneous and other settings recommended.
- G. Apply motor protection methods that comply with NFPA 70.
- H. Plot Characteristics on Curve Sheets:
 - 1. Low voltage equipment circuit breaker trip devices, including manufacturers tolerance bands.
 - 2. Low-voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands.
 - 3. Pertinent transformer full-load currents at 100 and 600 percent.
 - 4. Transformer magnetizing inrush currents.
 - 5. Transformer damage curves.
 - 6. ANSI transformer withstand parameters.
 - 7. Significant symmetrical and asymmetrical fault currents.
 - 8. Ground fault protective device settings.
 - 9. Motor overload relay settings.
 - 10. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center.

- I. Primary Protective Device Settings for Delta-Wye Connected Transformer:
 - 1. Secondary Line-to-Ground Fault Protection: Primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of IEEE C57.12.00 withstand point.
 - 2. Secondary Line-To-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.
- J. Tabulate Recommended Protective Device Settings:
 - 1. Relays:
 - a. Current tap.
 - b. Time dial.
 - c. Instantaneous pickup.
 - d. Electronic settings data file.
 - 2. Circuit Breakers:
 - a. Adjustable pickups.
 - b. Adjustable time-current characteristics.
 - c. Adjustable time delays.
 - d. Adjustable instantaneous pickups.
 - e. I^2t In/Out.
 - f. Electronic settings data file.
- K. Written Summary:
 - 1. Scope of studies performed.
 - 2. Summary of protective device coordination methodology.
 - 3. Prevailing conditions.
 - 4. Selected equipment deficiencies.
 - 5. Results of coordination study.
 - 6. Appendix of complete relay and circuit breaker electronic setting files, submit electronic data files from manufacturer's software.
 - 7. Comments or suggestions.

1.09 ARC FLASH STUDY

- A. Perform arc flash hazard study after short circuit and protective device coordination study has been completed.
- B. Perform arc flash study in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.

- C. Base Calculation: For each major part of the electrical power system, determine the following:
1. Arc Flash Hazard:
 - a. Arc flash hazard protective boundary.
 - b. Incident energy level.
 - c. Working distance.
 2. Shock Hazard:
 - a. Limited approach boundary.
 - b. Restricted approach boundary.
 - c. Prohibited approach boundary.
 - d. Bus voltage.
 - e. Glove class.
- D. Produce arc flash warning labels that list items in Paragraph Base Calculation and the following additional items.
1. Bus name.
 2. Calculation method.
 3. Label expiration date.
 4. Reference to NFPA 70E for PPE requirements.
- E. Produce bus detail sheets that list items in Paragraph Base Calculation and the following additional items:
1. Bus name.
 2. Upstream protective device name, type, and settings.
 3. Bus line to line voltage.
- F. Produce arc flash evaluation summary sheet listing the following additional items:
1. Bus name.
 2. Upstream protective device name, type, settings.
 3. Bus line to line voltage.
 4. Bus bolted fault.
 5. Protective device bolted fault current.
 6. Arcing fault current.
 7. Protective device trip/delay time.
 8. Breaker opening time.
 9. Solidly grounded column.
 10. Equipment type.
 11. Gap.
 12. Arc flash boundary.
 13. Working distance.
 14. Incident energy.
 15. Required protective arc rated clothing type and class.
 16. Table of required PPE.

- G. Analyze short circuit, protective device coordination, and arc flash calculations and highlight equipment that is determined to be underrated or causes incident energy values greater than 40 cal/cm^2 . Propose approaches to reduce the energy levels.
- H. Prepare a report summarizing the arc flash study with conclusions and recommendations which may affect the integrity of electric power distribution system. As a minimum, include the following in the report:
 - 1. Equipment manufacturer's information used to prepare study.
 - 2. Assumptions made during study.
 - 3. Reduced copy of one-line drawing; 11 inches by 17 inches maximum.
 - 4. Arc flash evaluations summary spreadsheet.
 - 5. Bus detail sheets.
 - 6. Arc flash warning labels printed in color on adhesive backed labels.

PART 2 PRODUCTS

2.01 ARC FLASH WARNING LABELS

- A. Printed in multi-color on adhesive backed labels or laminated plastic and be riveted on equipment.

PART 3 EXECUTION

3.01 GENERAL

- A. Adjust relay and protective device settings according to values established by coordination study.
- B. Make minor modifications to equipment as required to accomplish conformance with the short circuit and protective device coordination studies.
- C. Notify Engineer in writing of any required major equipment modifications.
- D. If the thermal magnetic circuit breaker characteristic curves cannot be separated by the minimum 0.4-second time margin, the circuit breakers shall be replaced with electronic trip circuit breakers to activate the required separation.
- E. Provide laminated one-line diagrams (minimum size 11 inches by 17 inches) to post on interior of electrical room.
- F. Provide arc-flash warning labels on equipment as specified in this section.

END OF SECTION

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
 - b. D923, Standard Practice for Sampling Electrical Insulating Liquids.
 - c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
 - d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
 - e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
 - f. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
 - g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
 - h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
 - i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
 - j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
2. Institute of Electrical and Electronics Engineers (IEEE):
 - a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
 - b. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - c. C2, National Electrical Safety Code.
 - d. C37.23, Standard for Metal-Enclosed Bus.
 - e. C62.33, Standard Test Specifications for Varistor Surge-Protective Devices.

3. National Electrical Manufacturers Association (NEMA):
 - a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
4. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
5. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 70B, Recommended Practice for Electrical Equipment Maintenance.
 - c. 70E, Standard for Electrical Safety in the Workplace.
 - d. 101, Life Safety Code.
6. National Institute for Certification in Engineering Technologies (NICET).
7. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit 30 days prior to performing inspections or tests:
 - a. Schedule for performing inspection and tests.
 - b. List of references to be used for each test.
 - c. Sample copy of equipment and materials inspection form(s).
 - d. Sample copy of individual device test form.
 - e. Sample copy of individual system test form.
2. Energization Plan: Prior to initial energization of electrical distribution equipment; include the following:
 - a. Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
 - b. Staged sequence of initial energization of electrical equipment.
 - c. Lock-Out-Tag-Out plan for each stage of the progressive energization.
 - d. Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
4. Operation and Maintenance Data:
 - a. In accordance with Section 01 78 23, Operation and Maintenance Data.
 - b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.

5. Programmable Settings: At completion of Performance Demonstration Test, submit final hardcopy printout and electronic files on compact disc of as-left setpoints, programs, and device configuration files for:
 - a. Protective relays.
 - b. Intelligent overload relays.
 - c. Variable frequency drives.
 - d. Power metering devices.
 - e. Uninterruptible power supplies.
 - f. Electrical communications modules.

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

- A. Perform inspection and electrical tests after equipment listed herein has been installed.
- B. Perform tests with apparatus de-energized whenever feasible.

- C. Inspection and electrical tests on energized equipment shall be:
 - 1. Scheduled with Owner prior to de-energization.
 - 2. Minimized to avoid extended period of interruption to the operating plant equipment.
- D. Notify Owner at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Perform tests in accordance with requirements of Section 01 91 14, Equipment Testing and Facility Startup.
- B. Tests and inspections shall establish:
 - 1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
 - 2. Installation operates properly.
 - 3. Equipment is suitable for energization.
 - 4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.
- C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
- D. Set, test, and calibrate protective relays, circuit breakers, fuses, power monitoring meters, CTs, PTs, transducers and other applicable devices in accordance with values established by short circuit, coordination, and harmonics studies as specified in Section 26 05 70, Electrical Systems Analysis.
- E. Adjust mechanisms and moving parts of equipment for free mechanical movement.
- F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
- G. Verify nameplate data for conformance to Contract Documents and approved Submittals.

- H. Realign equipment not properly aligned and correct unlevelness.
- I. Properly anchor electrical equipment found to be inadequately anchored.
- J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.
- K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- L. Provide proper lubrication of applicable moving parts.
- M. Inform Engineer of working clearances not in accordance with NFPA 70.
- N. Investigate and repair or replace:
 - 1. Electrical items that fail tests.
 - 2. Active components not operating in accordance with manufacturer's instructions.
 - 3. Damaged electrical equipment.
- O. Electrical Enclosures:
 - 1. Remove foreign material and moisture from enclosure interior.
 - 2. Vacuum and wipe clean enclosure interior.
 - 3. Remove corrosion found on metal surfaces.
 - 4. Repair or replace, as determined by Engineer door and panel sections having dented surfaces.
 - 5. Repair or replace, as determined by Engineer poor fitting doors and panel sections.
 - 6. Repair or replace improperly operating latching, locking, or interlocking devices.
 - 7. Replace missing or damaged hardware.
 - 8. Finish:
 - a. Provide matching paint and touch up scratches and mars.
 - b. If required because of extensive damage, as determined by Engineer, refinish entire assembly.
- P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.
- Q. Replace transformer insulating oil not in compliance with ASTM D923.

3.02 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to Project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day.
 - a. Submit Voltage Field Test Report within 5 days of test.
4. Unbalance Corrections:
 - a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
 - b. Obtain written certification from responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.03 PANELBOARDS

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Perform visual and mechanical inspection for overcurrent protective devices.

B. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
 - b. Each phase of each bus section.
 - c. Phase-to-phase and phase-to-ground for 1 minute.
 - d. With breakers open.
 - e. With breakers closed.
 - f. Control wiring except that connected to solid state components.
 - g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Ground continuity test ground bus to system ground.

3.04 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.
9. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
 - 1) Winding-to-winding.
 - 2) Winding-to-ground.
 - b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
 - c. Results temperature corrected in accordance with NETA ATS, Table 100.14.

- d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
 - e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.05 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 4 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 specification.
 - 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 100.12, 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 neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 4 and Larger:

1. Insulation Resistance Tests:
 - a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
 - b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
 - c. Evaluate ohmic values by comparison with conductors of same length and type.
 - d. Investigate values less than 50 megohms.
2. Continuity test by ohmmeter method to ensure proper cable connections.

3.06 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.
7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
8. Perform mechanical operational test and verify mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
 - b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
 - c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
 - a. Contact resistance in microhms across each switch blade and fuse holder.
 - b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.07 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 100 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 100.12.

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-volt 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 100.1.
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. Alternatively, use NETA ATS, Table 100.7.
 - g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

3.08 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually check current, potential, and control transformers for:
 - a. Cracked insulation.
 - b. Broken leads or defective wiring.
 - c. Proper connections.
 - d. Adequate clearances between primary and secondary circuit wiring.

2. Verify Mechanically:
 - a. Grounding and shorting connections have good contact.
 - b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:
 - a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
 - b. Polarity test.
2. Potential Transformer Tests:
 - a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 100.9, for 1 minute on:
 - 1) Winding-to-winding.
 - 2) Winding-to-ground.
 - b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.
3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 100.5.

3.09 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.10 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control center, panelboard, switchboard, and switchgear assemblies for proper connection and tightness.
2. Ground bus connections in motor control center, panelboard, switchboard, 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 ohm(s).
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.
3. Neutral Bus Isolation:
 - a. Test each neutral bus individually with neutral bonding jumper removed at service entrance or separately derived system.
 - b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
 - c. Investigate values less than 50 megohms.

3.11 GROUND FAULT SYSTEMS

A. Inspection and testing limited to:

1. Zero sequence grounding systems.
2. Residual ground fault systems.

B. Visual and Manual Inspection:

1. Neutral main bonding connection to ensure:
 - a. Zero sequence sensing system is grounded ahead of neutral disconnect link.
 - b. Ground strap sensing system is grounded through sensing device.
 - c. Neutral ground conductor is solidly grounded.
2. Verify control power has adequate capacity for system.
3. Manually operate monitor panels for:
 - a. Trip test.
 - b. No trip test.
 - c. Nonautomatic rest.

4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.
5. Relay check for pickup and time under simulated ground fault conditions.
6. Verify nameplate identification by device operation.

C. Electrical Tests:

1. Test system neutral insulation resistance with neutral ground link removed; minimum 1 megohm.
2. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.
3. Test relay timing by injecting 300 percent of pick-up current or as specified by manufacturer. Relay operating time in accordance with manufacturer's time-current characteristic curves.
4. Test system operation at 55 percent rated control voltage, if applicable.
5. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.12 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 1/2 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, in excess of values in NETA ATS, Table 100.10.
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 100.1 for:
 - 1) Motors above 200 horsepower for 10-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 seconds 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.

3.13 LOW-VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check door and device interlocking system by:
 - a. Closure attempt of device when door is in OFF or OPEN position.
 - b. Opening attempt of door when device is in ON or CLOSED position.
8. Check key interlocking systems for:
 - a. Key captivity when device is in ON or CLOSED position.
 - b. Key removal when device is in OFF or OPEN position.
 - c. Closure attempt of device when key has been removed.
 - d. Correct number of keys in relationship to number of lock cylinders.
 - e. Existence of other keys capable of operating lock cylinders; destroy duplicate sets of keys.
9. Check nameplates for proper identification of:
 - a. Equipment title and tag number with latest one-line diagram.
 - b. Pushbuttons.
 - c. Control switches.

- d. Pilot lights.
- e. Control relays.
- f. Circuit breakers.
- g. Indicating meters.
- 10. Verify fuse and circuit breaker sizes and types conform to Contract Documents.
- 11. Verify current and potential transformer ratios conform to Contract Documents.
- 12. Check bus connections for high resistance by low-resistance ohmmeter and calibrated torque wrench applied to bolted joints.
- 13. Ohmic value to be zero.
 - a. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
- 14. Check operation and sequencing of electrical and mechanical interlock systems by:
 - a. Closure attempt for locked open devices.
 - b. Opening attempt for locked closed devices.
 - c. Key exchange to operate devices in OFF-NORMAL positions.
- 15. Verify performance of each control device and feature furnished as part of motor control center.
- 16. Control Wiring:
 - a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
 - b. Check for proper conductor lacing and bundling.
 - c. Check for proper conductor identification.
 - d. Check for proper conductor lugs and connections.
- 17. Exercise active components.
- 18. Inspect contactors for:
 - a. Correct mechanical operations.
 - b. Correct contact gap, wipe, alignment, and pressure.
 - c. Correct torque of connections.
- 19. Compare overload heater rating with full-load current for proper size.
- 20. Compare fuse, motor protector and circuit breaker with motor characteristics for proper size.
- 21. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

- 1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
 - b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
 - c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.

- d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
 - e. Test values to comply with NETA ATS, Table 100.1.
 2. Current Injection through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:
 - a. Trip time in accordance with manufacturer's published data.
 - b. Investigate values in excess of 120 seconds.
 3. Control Wiring Tests:
 - a. Apply secondary voltage to control power and potential circuits.
 - b. Check voltage levels at each point on terminal board and each device terminal.
 - c. Insulation resistance test at 1,000 volts dc on control wiring, except that connected to solid state components; 1 megohm minimum insulation resistance.
 4. Operational test by initiating control devices to affect proper operation.

3.14 LOW VOLTAGE SURGE ARRESTORS

A. Visual and Mechanical Inspection:

1. Adequate clearances between arrestors and enclosures.
2. Ground connections to ground bus.

B. Electrical Tests:

1. Varistor Type Arrestors:
 - a. Clamping voltage test.
 - b. Rated RMS voltage test.
 - c. Rated dc voltage test.
 - d. Varistor arrestor test values in accordance with IEEE C62.33, Section 4.4 and Section 4.9.

END OF SECTION

SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION 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 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. American Bearing Manufacturers Association (ABMA):
 - a. 9, Load Ratings and Fatigue Life for Ball Bearings.
 - b. 11, Load Ratings and Fatigue Life for Roller Bearings.
 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
 - b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
 - c. 841, Standard for Petroleum and Chemical Industry—Premium Efficiency Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp).
 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. C50.41, Polyphase Induction Motors for Power Generating Stations.
 - c. MG 1, Motors and Generators.
 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 5. Underwriters Laboratories (UL):
 - a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
 - b. 674, Standard for Safety for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
 - c. 2111, Standard for Safety for Overheating Protection for Motors.

1.03 DEFINITIONS

- A. CISD-TEFC: Chemical industry, severe-duty enclosure.
- B. DIP: Dust-ignition-proof enclosure.
- C. EXP: Explosion-proof enclosure.
- D. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.
- E. 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.
- F. ODP: Open drip-proof enclosure.
- G. TEFC: Totally enclosed, fan-cooled enclosure.
- H. TENV: Totally enclosed, nonventilated enclosure.
- I. WPI: Open weather protected enclosure, Type I.
- J. WPPI: Open weather protected enclosure, Type II.

1.04 SUBMITTALS

- A. Action Submittals:
 - 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 hp and larger.
 - e. Multispeed load classification (for example, variable torque).
 - f. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.
 - g. Guaranteed minimum full load efficiency and power factor.
 - 4. Enclosure type and mounting (such as, 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, ratings, and wiring diagram 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. Informational Submittals:

1. Factory test reports certified.
2. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
1. General Electric.
 2. Reliance Electric.
 3. Siemens Energy and Automation, Inc., Motors and Drives Division.
 4. Toshiba International Corp., Industrial Division.

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 drive motor, its driven equipment, and specified motor accessories.
- C. Meet requirements of NEMA MG 1.
- D. For motors used in hazardous (classified) locations, Class I, Division 1, Groups B, C, and D, and Class II, Division 1, Groups E, F, and G provide motors that conform to UL 674 and have an applied UL listing mark.
- E. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.
- F. Lifting lugs on motors weighing 100 pounds or more.

G. Operating Conditions:

1. Maximum ambient temperature not greater than 40 degrees C.
2. Motors shall be suitable for operating conditions without reduction being required in nameplate rated horsepower or exceeding 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 specification.
- B. Constant Speed Applications: Brake horsepower of driven equipment at any operating condition or at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.
- C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower at any operating condition or at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.

2.04 SERVICE FACTOR

- A. Inverter-duty Motors: 1.0 at rated ambient temperature, unless otherwise noted.
- B. Other Motors: 1.15 minimum at rated ambient temperature, unless otherwise noted.

2.05 VOLTAGE AND FREQUENCY RATING

- A. System Frequency: 60-Hz.
- B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specification:

Voltage Rating		
Size	Voltage	Phase
1/2 hp and smaller	115	1
3/4 hp and larger	460	3

- C. Suitable for full voltage starting.

- D. 50 hp and larger also suitable for reduced voltage starting with 65 percent 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 hp, 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 12.59.
 - b. Guaranteed minimum at full load in accordance with NEMA MG 1 Table 12-12, Full-load Efficiencies for NEMA Premium Efficiency Electric Motors Rated 600 Volts or Less (Random Wound), or as indicated in motor-driven equipment specification.
 - 2. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment specification.

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: 12 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 specification, 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.
- D. Motors With Form-Wound Coils: Locked coil bracing system in accordance with NEMA C50.41.

2.09 ENCLOSURES

- A. Enclosures to conform to NEMA MG 1.
- B. TEFC and TENV: Furnish with drain hole with porous drain/weather plug.
- C. Explosion-Proof (EXP):
 - 1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class I, 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 2111 and NFPA 70.
 - 4. Terminate thermostat leads in terminal box separate from main terminal box.
- D. Dust-Ignition-Proof (DIP):
 - 1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class II, Division 1, Group E.
 - 2. Integral thermostat opening on excessive motor temperature in accordance with UL 2111 and NFPA 70.
 - 3. Thermostat leads to terminate in a terminal box separate from main terminal box.
- E. Submersible: In accordance with Article Special Motors.
- F. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Article Special Motors.

2.10 TERMINAL (CONDUIT) BOXES

- A. Oversize main terminal boxes for 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, Section 1, Paragraph 4.19 and NFPA 70, Article 430:

Terminal Box Usable Values		
Voltage	Horsepower	Percentage
Below 600	15 through 125	500

Terminal Box Usable Values		
Voltage	Horsepower	Percentage
Below 600	150 through 300	275
Below 600	350 through 600	225

- E. Terminal for connection of equipment grounding wire in each terminal box.
- F. Coordinate motor terminal box conduit entries versus size and quantity of conduits shown on Drawings.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
2. 1 hp through 200 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
3. Above 200 hp: 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 ABMA 9 and ABMA 11.

B. Vertical Motors:

1. Thrust Bearings:
 - a. Antifriction bearing.
 - b. Manufacturer's standard lubrication 100 hp and smaller.
 - c. Oil lubricated 125 hp and larger.
 - d. Minimum 50,000 hours L-10 bearing life.
2. Guide Bearings:
 - a. Manufacturer's standard bearing type.
 - b. Manufacturer's standard lubrication 200 hp and smaller.
 - c. Oil lubricated 250 hp and larger.
 - d. Minimum 100,000 hours L-10 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.

E. Inverter Duty Rated Motors, Bearing Isolation: Motors larger than 5 hp shall have electrically isolated bearings to prevent stray current damage.

2.12 NOISE

A. Measured in accordance with NEMA MG 1.

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, Part 7.

2.14 EQUIPMENT FINISH

A. Protect Motor for Service Conditions:

1. ODP Enclosures: Indoor industrial atmospheres.
2. Other Enclosures: Outdoor industrial atmospheres, including moisture and direct sunlight exposure.

B. External Finish: Prime and finish coat manufacturer's standard.

C. 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, and attached with stainless steel screws.

B. Winding Thermal Protection:

1. Thermostats:
 - a. Motors for constant speed application 10 hp through 100 hp.
Motors for adjustable speed application 10 hp through 100 hp.
 - b. Bi-metal disk or rod type thermostats embedded in stator windings.

- c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature. (Provide manual reset at motor controller.)
 - d. Leads extending to separate terminal box for motors 100 hp and larger.
 - 2. Thermistors:
 - a. Motors for constant speed application 125 hp through 250 hp.
Motors for adjustable speed application 125 hp through 250 hp.
 - b. Thermistor embedded in each stator phase winding before winding dip and bake process.
 - c. In intimate contact with winding conductors.
 - d. Epoxy-potted, solid-state thermistor control module mounted in NEMA 250 Type 4 box on motor, by motor manufacturer, individual thermistor circuits factory-wired to control module.
 - e. Control module rated for 120V ac power supply.
 - f. Control module automatically reset contact for external use rated 120 V ac, 5 amps minimum, opening on abnormally high winding temperature. Provide manual reset at motor controller.
 - 3. Resistance Temperature Detector:
 - a. Motors for constant speed application 300 hp and larger, and motors for adjustable speed application 300 hp and larger.
 - b. 100-ohm platinum, three-wire, precision resistors with calibrated resistance-temperature characteristics.
 - c. Six (two each phase) positioned to detect highest winding temperature and located between coil sides in stator slots.
 - d. Compatible with monitoring instrumentation provided with motor controller and with adjustable speed control equipment.
 - e. Leads brought to separate motor terminal box.
- C. Bearing Temperature Protection:
- 1. On each bearing of horizontal motors 300 hp and larger.
 - 2. On the thrust bearing of each vertical motor 300 hp and larger.
 - 3. Bearing Temperature Detector:
 - a. 100-ohm precision resistors with calibrated resistance-temperature characteristics.
 - b. Compatible with monitoring instrumentation provided with motor controller and with adjustable speed control equipment.
 - c. Leads brought to separate motor terminal box.
- D. Vibration detection relay mounted in NEMA 250, Type 4X enclosure on side of motor.

E. Space Heaters:

1. Motors 10 hp and larger.
2. Provide winding space heaters with leads wired out to motor separate conduit or terminal box.
3. Provide extra hole or hub on motor terminal box as required.
4. Unless shown otherwise, heater shall be suitable for 120V ac supply, with wattage suitable for motor frame size.

F. Nameplates:

1. Raised or stamped letters on stainless steel or aluminum.
2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.
3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

G. Anchor Bolts: Provide meeting manufacturer's recommendations and of sufficient size and number for specified seismic condition.

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, and Fan Cover: Cast iron.
5. Ventilating Fan: Corrosion-resistant, nonsparking, 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.
- 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 motor-driven equipment specification.
- F. Inverter Duty Motor:
 1. Motor supplied power by adjustable voltage and adjustable frequency drives shall be inverter duty rated.
 2. Suitable for operation over entire speed range indicated.
 3. Provide forced ventilation where speed ratio is greater than published range for motor provided.
 4. When installed in Division 1 hazardous (classified) location shall be identified as acceptable for variable speed when used in Division 1 location.
 5. Shaft Grounding Device: Motors larger than 5 hp shall be provided with shaft grounding brush or conductive micro fiber shaft grounding ring. Shaft grounding device shall be solidly bonded to grounded motor frame per manufacturer's recommendations.
 - a. Manufacturers:
 - 1) Grounding Brush: Sohre Turbomachinery, Inc.
 - 2) Grounding Ring: EST-Aegis.
- G. Submersible Pump Motor:
 1. Manufacturers:
 - a. Reliance Electric.
 - b. ITT Flygt Corp.
 2. At 100 Percent Load:

Submersible Pump Motors		
Horsepower	Guaranteed Minimum Efficiency	Guaranteed Minimum Power Factor
5 through 10	80	82
10.1 through 50	85	82

Submersible Pump Motors		
Horsepower	Guaranteed Minimum Efficiency	Guaranteed Minimum Power Factor
5 through 10	80	82
50.1 through 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 I, 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 assembly, 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, 120V 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 120V ac supply.
 - c. Monitoring module with control power transformer, probe test switch and test light, and two independent 120V ac contacts, one opening and one closing when flux of moisture is detected.
10. Bearing Overtemperature Protection for Motors Larger than 100 hp:
 - a. Sensor on lower bearing housing monitoring bearing temperature.
 - b. Any monitoring relay necessary to provide 120V ac contact opening on bearing overtemperature.

11. Winding thermal protection, moisture detection, and bearing overtemperature specified above may be monitored by single device providing two independent 120V ac contacts, one closing and one opening on malfunction.
12. Connecting Cables:
 - a. Two separate cables, one containing power and grounding conductors, and the other containing 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.
 - d. UL 83 listed and sized in accordance with NFPA 70.

H. 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.
2. Routine (production) tests in accordance with NEMA MG 1. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
 - a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.59 and Paragraph 12.60.
 - b. For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
 - c. On motors of 100 hp and smaller, furnish certified copy of motor efficiency test report on an identical motor.
4. Additional Required Tests: Temperature rise at rated horsepower for motors 300.
5. Vibration (balance).
6. Provide certified test reports for all polyphase motors.

B. Test Report Forms:

1. Routine Tests: IEEE 112, Form A-1.
2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Table 12-12.

3. Efficiency and power factor by Test Method F, IEEE 112, Forms F-1, F-2, and F-3.
4. Temperature Test: IEEE 112, Form A-2.

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.

3.02 MANUFACTURER'S SERVICES

- A. Furnish manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 100 hp.
- B. Manufacturer's Certificate of Proper Installation.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronics Engineers (IEEE): C57.96, Guide for Loading Dry Type Transformers.
2. National Electrical Contractor's Association (NECA): 409, Recommended Practice for Installing and Maintaining Dry-Type Transformers.
3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. ST 20, Dry-Type Transformers for General Applications.
 - c. TP 1, Guide For Determining Energy Efficiency for Distribution Transformers.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL):
 - a. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
 - b. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - c. 1561, Standard for Dry-Type, General Purpose, and Power Transformers.

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Dimensions and weight.
3. Transformer nameplate data.
4. Schematic and connection diagrams.

B. Informational Submittals:

1. Test Report: Sound test certification for dry type power transformers (0 to 600-volt, primary).

PART 2 PRODUCTS

2.01 GENERAL

- A. UL 1561, NEMA ST 20, unless otherwise indicated.
- B. Dry-type, self-cooled, two-winding, with copper windings.
- C. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- D. Efficiency: Meet or exceed values in Table 4.2 of NEMA TP 1.
- E. Maximum Sound Level per NEMA ST 20:
 - 1. 40 decibels for 0 kVA to 9 kVA.
 - 2. 45 decibels for 10 kVA to 50 kVA.
 - 3. 50 decibels for 51 kVA to 150 kVA.
 - 4. 55 decibels for 151 kVA to 300 kVA.
 - 5. 60 decibels for 301 kVA to 500 kVA.
- F. Overload capability: Short-term overload per IEEE C57.96.
- G. Wall Bracket: For single-phase units, 7-1/2 kVA to 25 kVA, and for three-phase units, 15 kVA to 30 kVA.
- H. 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.
- I. Contractor shall provide higher insulation rating and/or increased capacity of transformer as necessary to ensure the transformer damage curves plot in the region of TCC protected by the overcurrent protective device for additional requirements, Reference Section 26 05 70, Electrical Systems Analysis.
- J. Manufacturers:
 - 1. General Electric Co.
 - 2. Square D Co.
 - 3. Siemens.

2.02 MINI-POWER CENTER (MPC)

- A. General: Transformer, primary and secondary main circuit breakers, and secondary panelboard section enclosed in NEMA 250, Type 4X, 316 stainless steel enclosure, or as shown.
- B. Transformer:
 - 1. Insulation Class and Temperature Rise: Manufacturer's standard.
 - 2. Core and Coil: Encapsulated.
 - 3. Windings: Copper.
 - 4. Full capacity, 2-1/2 percent voltage taps, two above and two below normal voltage.
 - 5. Primary Voltage: 480, single- or three-phase, as shown.
 - 6. Secondary Voltage: 208/120 volts, three-phase, four or 240/120 volts single-phase, three-wire, as shown.
- C. Panelboard: Full, UL 489, short-circuit current rated.
 - 1. Type: Thermal-magnetic, quick-make, quick-break, indicating, with noninterchangeable molded case, bolt-on circuit breakers.
 - 2. Bus: Tin plated copper.
 - 3. Number and Breaker Ampere Ratings: Refer to Panel Schedule.

2.03 GENERAL PURPOSE TRANSFORMER

- A. Insulation Class and Temperature Rise: Manufacturer's standard.
- B. Core and Coil:
 - 1. Encapsulated for single-phase units 1/2 kVA to 25 kVA and for three-phase units 3 kVA 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.
- C. Enclosure:
 - 1. Single-Phase, 3 kVA to 25 kVA: NEMA 250, Type 3R, nonventilated.
 - 2. Single-Phase, 37-1/2 kVA and Above: NEMA 250, Type 2, ventilated.
 - 3. Three-Phase, 3 kVA to 15 kVA: NEMA 250, Type 3R, nonventilated.
 - 4. Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.
 - 5. Outdoor Locations: NEMA 250, Type 3R.
 - 6. Corrosive Locations: NEMA 250, Type 3R stainless steel.

D. Voltage Taps:

1. Single-Phase, 3 kVA 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 kVA 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.

E. Impedance: 4.5 percent minimum on units 75 kVA and larger.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with NECA and manufacturer's instructions.
- B. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.
- C. Provide moisture-proof, flexible conduit for electrical connections.
- D. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.
- E. Provide wall brackets for single-phase units, 7-1/2 kVA to 25 kVA, and three-phase units, 15 kVA to 30 kVA.

END OF SECTION

SECTION 26 24 16 PANELBOARDS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronics Engineers (IEEE):
 - a. C62.1, Surge Arresters for Alternating Current Power Circuits.
 - b. C62.11, Standards for Metal-Oxide Surge Arrestors for AC Power Circuits.
2. National Electrical Contractor's Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. 289, Application Guide for Ground Fault Circuit Interrupters.
 - c. AB 1, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - d. KS 1, Enclosed Switches.
 - e. LA 1, Surge Arrestors.
 - f. PB 1, Panelboards.
 - g. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL):
 - a. 67, Standard for Panelboards.
 - b. 98, Standard for Enclosed and Dead-Front Switches.
 - c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
 - d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - e. 508, Standard for Industrial Control Equipment.
 - f. 870, Wireways, Auxiliary Gutters and Associated Fittings.
 - g. 943, Standard for Ground-Fault Circuit-Interrupters.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.

2. Manufacturer's shop drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.
3. Tabulation of features for each panelboard to include the following:
 - a. Protective devices with factory settings.
 - b. Provisions for future protective devices.
 - c. Space for future protective devices.
 - d. Voltage, frequency, and phase ratings.
 - e. Enclosure type.
 - f. Bus and terminal bar configurations and current ratings.
 - g. Provisions for circuit terminations with wire range.
 - h. Short circuit current rating of assembled panelboard at system voltage.
 - i. Features, characteristics, ratings, and factory settings of auxiliary components.
 - j. Wiring and schematic diagrams detailing control wiring, and differentiating between manufacturer-installed and field-installed wiring.

B. Informational Submittals:

1. Manufacturer's recommended installation instructions.

1.03 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled as defined in NEC Article 100.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
1. General Electric Co.
 2. Square D Co.
 3. Siemens.
- B. Panelboards shall be of the same manufacturer as equipment furnished under Section 26 24 19, Low-Voltage Motor Control.

2.02 GENERAL

- A. Provide low voltage panelboards for application at 600V or less in accordance with this Section including panelboards installed in other equipment specified in Section 26 24 19, Low-Voltage Motor Control.

- B. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.
- C. Wire Terminations:
 - 1. Panelboard assemblies, including protective devices, shall be suitable for use with 75 degrees C or greater wire insulation systems at NEC 75 degrees C conductor ampacity.
 - 2. In accordance with UL 486E.
- D. Load Current Ratings:
 - 1. Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.
 - 2. Where indicated “continuous”, “100 percent”, etc., selected components and protective devices shall be rated for continuous load current at value shown.
- E. Short Circuit Current Rating (SCCR): Integrated equipment short circuit rating for each panelboard assembly shall be no less than the indicated SCCR or the following:
 - 1. Minimum SCCR at 208Y/120 or 120/240 volts shall be 10,000 amperes rms symmetrical, unless greater is shown.
 - 2. Minimum SCCR at 480Y/277 volts shall amperes rms symmetrical, unless greater is shown.
- F. Overcurrent Protective Devices:
 - 1. In accordance with NEMA AB 1, NEMA KS 1, UL 98, and UL 489.
 - 2. Protective devices shall be adapted to panelboard installation.
 - a. Capable of device replacement without disturbing adjacent devices and without removing main bus.
 - b. Spaces: Cover openings with easily removable cover.
 - 3. Series-Connected Short Circuit Ratings: Devices shall be fully rated; series-connected ratings unacceptable.
- G. Circuit Breakers:
 - 1. General:
 - a. Less than 150 amps: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.

2. 150 amps and Larger: Insulated or molded case breakers with ambient insensitive solid-state trips and having current sensors and logic circuits integral in breaker frame.
3. Noninterchangeable: In accordance with NEC.
4. Bus Connection: Bolt-on circuit breakers in 480Y/277-volt, and bolt-on circuit breakers in 208Y/120 and 240/120-volt branch circuit panelboards.
5. Trip Mechanism:
 - a. Less than 150 amps: Individual permanent thermal and magnetic trip elements in each pole.
 - b. 150 amps and Larger: Solid-state current control with adjustable amp are setting, adjustable long-time delay, adjustable short-time trip and delay band, adjustable instantaneous trip.
 - c. Two and three pole, common trip.
 - d. Automatically opens all poles when overcurrent occurs on one pole.
 - e. Test button on cover.
 - f. Calibrated for 40 degrees C ambient, unless shown otherwise.
6. Unacceptable Substitution:
 - a. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
 - b. Do not use tandem or dual circuit breakers in normal single-pole spaces.
7. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).
 - a. Ground fault sensor shall be rated same as circuit breaker.
 - b. Push-to-test button.
 - c. Reset button.
8. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL listed for equipment ground fault protection).

H. Enclosures:

1. Provide as specified in Section 26 05 04, Basic Electrical Materials and Methods, unless otherwise shown.
2. Material: Stainless steel.

I. Bus:

1. Material: Tin-plated copper, full sized throughout length.
2. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

- J. Feeder Lugs: Main, feed-through, and neutral shall be replaceable, bolted mechanical or crimp compression type.
- K. Equipment Ground Terminal Bus: Tin-plated copper with suitably sized provisions for termination of ground conductors, and bonded to box.
 - 1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
 - 2. Provide individual termination points for all other grounding conductors such as feeder, grounding electrode, etc.
 - 3. Termination points shall be bolted crimp compression lugs for conductors 6 AWG and larger.
- L. Neutral Terminal Bus: Tin-plated copper with suitably sized provisions for termination of neutral conductors, and isolated from box.
 - 1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
 - 2. Provide individual termination points for all other neutral conductors.
 - 3. Termination points shall be bolted crimp compression lugs for conductors 6 AWG and larger.
 - 4. Oversize Neutral: Provide oversized neutral terminal bus as indicated.
- M. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.
- N. Special Features: Where indicated, provide the following features:
 - 1. Service Equipment Approval: Listed for use as service equipment for panelboards having service disconnecting means.
 - 2. Isolated Equipment Ground Terminal Bar:
 - a. Provide in addition to equipment ground terminal bar specified above.
 - b. Insulated from box.
 - c. Provide individual conductor termination points equal to quantity of breaker pole positions plus all feeder, subfeed, and feed-through isolated ground conductors.
 - 3. Controls:
 - a. Provide controls in accordance with UL 508.
 - b. Controls shall be Class I, 120V ac.
 - c. Control circuits shall be protected by fuse or circuit breaker.
 - 4. Magnetic Contactor:
 - a. Comply with Section 26 05 04, Basic Electrical Materials and Methods.
 - b. Provide with current rating, poles, and connections (mains or between split bussing) indicated.

- c. Contactor shall be mechanically held with 120V ac coil.
 - d. Contactor shall include at least one convertible (NO or NC) auxiliary contact and mechanically held contactors shall include coil clearing auxiliary contacts.
- 5. Control Transformer:
 - a. Provide for contactor, shunt trip, or other devices as required.
 - b. Capacity shall be 125 percent of maximum burden plus 100VA.
 - c. Mount in cabinet of panelboard.
 - d. Provide primary and secondary fused protection.
- 6. Extra Gutter Space: Dimensions and arrangement indicated.
- 7. Gutter Barrier: Arranged to isolate section of gutter as shown.
- 8. Subfeed: Protective device or lugs indicated, with additional terminals on neutral and ground bus to accommodate feeder.
- 9. Feed-Through Lugs: At opposite end of phase bus from mains, with additional terminals on neutral and ground buses, sized to accommodate feeders indicated.
- 10. Double Main Lugs: Furnish additional terminals on neutral and ground buses, sized to accommodate feeders indicated.
- 11. Surge Arresters:
 - a. In accordance with NEMA LA 1, IEEE C62.1, and IEEE C62.11.
 - b. Comply with Section 26 43 00, Surge Protective Devices (SPD) and Transient Voltage Suppression (TVSS).
 - c. Coordinate impulse sparkover voltage with system voltage.
 - d. Provide protective device within panelboard as disconnecting means and short circuit protection per manufacturer's recommendation.
 - e. Factory mounting within panelboard utilizing UL-recognized mounting device or SPD/TVSS shall be provided external to panelboard. Provide panelboard circuit breaker for SPD/TVSS.
- O. Protective Device Locking: Furnish provisions for handle padlocking for main and subfeed devices; also provide for branch devices where indicated.
- P. Multi-Section Panelboards: Where more than 42 poles are required or more than one section is otherwise indicated, provide multiple panelboards with separate fronts.
 - 1. Panelboard sections shall be individually installed and field interconnected to form a single electrical unit.
 - 2. Unless otherwise indicated, provide feed-through lugs on each section but last.
 - 3. Surface-mount panels shall be individually mounted and may be different sizes.
 - 4. Recessed-mount panels shall be individually mounted and the same size tub and flush cover.

5. Surface-mount multi-section panelboards may be comprised of sections of unequal heights.
6. Provide feed-through and main lugs in individual sections as required for field assembly of a complete multi-section panelboard.
7. Provide neutral and ground terminal bars in each section.
8. Front trim shall be secured to box with concealed trim clamps.
9. Surface-mount panelboard front trim shall have same dimensions as box.
10. Doors over 30 inches in height shall have multi-point latching.
11. Door lock shall be secure with flush catch and tumbler lock; all panelboards keyed alike, with two milled keys each lock.
12. Circuit Directory: Metal frame with transparent plastic face and enclosed card, mounted inside each panel door.
13. Hinged Front Cover (Door In Door): Entire front trim hinged to surface box with standard door within hinged trim cover.
14. Locking: Furnish devices with provisions for handle padlocking.
15. Load Connections: Wire lugs shall be mechanical or crimp compression type, removable/replaceable, and suitable for 75 degrees C rated conductors without derating switch nor conductor ampacity.
16. Provide a nameplate for each circuit, blanks for spares.

PART 3 EXECUTION

3.01 GENERAL

- A. Install in accordance with NECA 407, NEMA PB 1.1 and manufacturers' written installation instructions.
- B. Install securely, plumb, in-line and square with walls.
- C. Install top of cabinet trim 78 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 78 inches above the floor.
- D. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.
- E. Install filler plates in unused spaces.
- F. Wiring in Panel Gutters: Train conductors neatly in groups; bundle, and wrap with nylon wire ties.

END OF SECTION

SECTION 26 24 19
LOW-VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which shall be followed for this section:
1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
 2. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
 - b. ICS 1, Industrial Control and Systems: General Requirements.
 - c. ICS 2, Controllers, Contactors, and Overload Relays Rated 600 Volts.
 - d. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 4. Underwriters Laboratories, Inc. (UL):
 - a. 98, Enclosed and Dead-Front Switches.
 - b. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.

1.02 DEFINITIONS

- A. CT: Current Transformer.
- B. LCD: Liquid Crystal Display.
- C. N.C.: Normally Closed.
- D. N.O.: Normally Open.
- E. THD: Total Harmonic Distortion.
- F. VT: Voltage Transformer.

1.03 SUBMITTALS

- A. Action Submittals:
1. Descriptive information.
 2. Itemized Bill of Material.
 3. Dimensional drawings.
 4. Front Panel Elevations.

5. Conduit entrance locations.
6. Protective Devices: Copies of time-current characteristics.
7. 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 model number and relay setting.
 - f. Protective device trip settings.
 - g. Manufacturer's solid state starter switch or dip switch or program settings.
 - h. Attach above typed, tabulated data to a copy of starter manufacturer's overload heater or setting selection tables for starters provided.
8. Control diagrams.
9. One-line diagrams.
10. Schematic (elementary) diagrams.
11. Outline diagrams.

B. Informational Submittals: Manufacturer's installation instructions.

1.04 QUALITY ASSURANCE

- A. Provide products manufactured within scope of Underwriters Laboratories that conform to UL Standards and have applied UL Listing Mark.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
1. Eaton Electrical/Cutler-Hammer.
 2. GE Industrial Systems.
 3. Schneider Electric/Square D Services.
 4. Allen-Bradley.
 5. Siemens.

2.02 GENERAL

- A. Like Items of Equipment: End product of one manufacturer and same manufacturer as panelboard for standardization.
- B. Make adjustments 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.

- C. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.
- D. Control Transformer: None required when 120V is available from main feeder.
- E. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- F. Lifting lugs on equipment and devices weighing over 100 pounds.
- G. Anchor Bolts: Type 316 stainless steel, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.
- H. Operating Conditions:
 - 1. Ambient Temperature: Maximum as degrees C and direct sun exposure.
 - 2. Altitude: Ten feet above sea level.
 - 3. Equipment to be fully rated.
- I. Enclosures: In accordance with NEMA 250.
- J. Equipment Finish: Electrocoating process white applied to stainless steel enclosure to mitigate direct sun exposure.

2.03 SEPARATELY MOUNTED MOTOR CONTROL

- A. Combination Full-Voltage, Magnetic Starter:
 - 1. Rating: Horsepower rated at 600 volts, UL labeled for 22,000 amperes minimum at 200-240 volts short circuit capacity with overload protection.
 - 2. Single phase, nonreversing, full voltage.
 - 3. Control: STOP/START pushbutton as shown on Drawings.
 - 4. Disconnect Type: Motor circuit protector or Circuit breaker.
 - 5. Enclosure: NEMA 250, Type 4X stainless steel as shown on Drawings.
 - 6. Pilot Lights: Red-ON and Green-OFF; full voltage LED.
 - 7. Padlockable operating handle, capable of up to three locks.
- B. Solid State Motor Overload Protection:
 - 1. Inverse-time-limit characteristic.
 - 2. Phase loss, phase unbalanced and Class II ground fault protection.
 - 3. Current operated electronic circuitry with adjustable trip.
 - 4. Class 10/20/30 relay trip, switch selectable.
 - 5. N.O. auxiliary contact for remote monitoring.
 - 6. Manual reset.

7. Provide in each ungrounded phase.
8. Mount within starter unit.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install equipment in accordance with NEMA ICS 2.3, IEEE C2, NECA 402, Submittals, and manufacturer's written instructions and recommendations.
2. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
3. Install equipment plumb and in longitudinal alignment with pad or wall.
4. Coordinate terminal connections with installation of secondary feeders.
5. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.
6. Motor Data: Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
 - a. Motor served by tag number and equipment name.
 - b. Nameplate horsepower.
 - c. Motor code letter.
 - d. Full load amperes.
 - e. Service factor.
 - f. Installed overload relay heater catalog number.

B. Circuit Breakers:

1. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.
2. Adjust to approximately 11 times motor rated current.
3. Determine motor rated current from motor nameplate following installation.

C. Overload Relay: Select and install overload relay heaters and switch settings after actual nameplate full-load current rating of motor has been determined.

END OF SECTION

SECTION 26 27 26 WIRING DEVICES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. Federal Specifications (FS):
 - a. W-C-596G, General Specification for Connector, Electrical, Power.
 - b. W-S-896F, Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
3. Institute of Electrical and Electronic Engineers, Inc. (IEEE):
 - a. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits.
 - b. C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000V and less) AC Power Circuits.
4. National Electrical Contractors Association (NECA): 1, Standard Practice of Good Workmanship in Electrical Contracting.
5. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. FB 11, Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
 - c. WD 1, General Color Requirements for Wiring Devices.
 - d. WD 6, Wiring Devices – Dimensional Specifications.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories Inc. (UL):
 - a. 498, Standard for Safety for Attachment Plugs and Receptacles.
 - b. 508, Standard for Safety for Industrial Control Equipment.
 - c. 943, Standard for Safety for Ground-Fault Circuit-Interruption.
 - d. 1010, Standard for Safety for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
 - e. 1436, Standard for Safety for Outlet Circuit Testers and Similar Indicating Devices.
 - f. 1449, Standard for Safety for Surge Protective Devices (SPD).

1.02 SUBMITTALS

A. Action Submittals: Manufacturer's product data for wiring devices.

PART 2 PRODUCTS

2.01 SWITCHES

A. Switch, General Purpose:

1. NEMA WD 1 and FS W-S-896F.
2. Totally enclosed, ac type, with quiet tumbler switch and screw terminal.
3. Rivetless one-piece brass or copper alloy contact arm with silver alloy contact.
4. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
5. Rating: 20 amps, 120/277 volts.
6. Automatic grounding clip and integral grounding terminal on mounting strap.
7. Special Features: Provide the following features in comparable devices where indicated:
 - a. Three-way and four-way.
 - b. Rectangular (decorator) face.
8. Manufacturers and Products, Industrial Grade:
 - a. Cooper Arrow Hart; AH1220 Series.
 - b. Bryant; 4901 Series.
 - c. Hubbell; 1221 Series.
 - d. Leviton; 1221 Series.

B. Switch, Motor Rated:

1. Type: Two-pole or three-pole, manual motor starting/disconnect switch without overload protection.
2. UL 508 listed.
3. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts.
4. Minimum General Purpose Rating: 30 amperes, 600V ac.
5. Minimum Motor Ratings:
 - a. 2 horsepower for 120V ac, single-phase, two-pole.
 - b. 3 horsepower for 240V ac, single-phase, two-pole.
 - c. 15 horsepower for 480V ac, three-phase, three-pole.
6. Screw-type terminal.
7. Manufacturers and Products:
 - a. Cooper Arrow Hart.
 - b. Hubbell Bryant: HBL78 Series.
 - c. Leviton.

2.02 RECEPTACLES

A. Receptacle, General Purpose:

1. NEMA WD 1 and FS W-C-596G.
2. Duplex, two-pole, three-wire grounding type with screw type wire terminals.
3. Impact resistant nylon cover and body, with finger grooves in face, unless otherwise indicated.
4. One-piece mounting strap with integral ground contact (rivetless construction).
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, unless otherwise indicated.
7. Size: For 2-inch by 4-inch outlet box.
8. Special Features: Provide the following features in comparable devices where indicated:
 - a. Listed weather-resistant per NEC 406.8.
 - b. Listed tamper-resistant per NEC 406.11.
 - c. Isolated ground.
9. Industrial Grade Manufacturers and Products:
 - a. Cooper Arrow Hart; 5362 Series.
 - b. Hubbell Bryant; HBL5362 Series.
 - c. Leviton; 5362 Series.

B. Receptacle, Ground Fault Circuit Interrupter:

1. Meet requirements of general-purpose receptacle.
2. Listed Class A to UL 943, tripping at 5 mA.
3. Rectangular smooth face with push-to-test and reset buttons.
4. Listed weather-resistant per NEC 406.8.
5. Feed-through Capability: 20 amps.
6. Manufacturers and Products:
 - a. Hubbell Bryant; GFTR20 Series.
 - b. Cooper Arrow Hart WRVGF20 Series.
 - c. Leviton; 7899 Series.

C. Receptacle, Corrosion-Resistant:

1. Meet requirements of general-purpose receptacle.
2. Nickel coated metal parts.
3. Manufacturers and Products:
 - a. Hubbell Bryant; HBL53CM62 Series.
 - b. Leviton; 53CM-62 Series.
 - c. Cooper Arrow Hart; 5362CR Series.

D. Receptacle, Special-Purpose:

1. Rating and number of poles as indicated or required for anticipated purpose.
2. Where indicated provide matching plug with cord-grip features for each special-purpose receptacle.

2.03 DEVICE PLATES

A. Sectional type plate 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: Copper-free aluminum with gaskets.
2. Screw: Oval-head stainless steel.

E. Engraved:

1. Character Height: 1/8-inch.
2. Filler: Black.

F. Weatherproof:

1. Receptacle, Weatherproof Type 1:
 - a. Gasketed, cast-aluminum, with individual cap over each receptacle opening.
 - b. Mounting Screw and Cap Spring: Stainless steel.
 - c. Manufacturers and Products:
 - 1) Crouse-Hinds; Type WLRD-1.
 - 2) Appleton; Type FSK-WRD.

2. Receptacle, Weatherproof Type 2:
 - a. UL listed for wet location while in use.
 - b. Die cast metal cover.
 - c. Locking type.
 - d. Manufacturer and Product: TayMac; Type Multi-Mac.
3. Switch:
 - a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
 - b. Mounting Screw: Stainless steel.
 - c. Manufacturers and Products:
 - 1) Crouse-Hinds; DS-181 or DS-185.
 - 2) Appleton; FSK-1VTS or FSK-1VS.
- G. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel box.
- H. Sheet Steel: Formed sheet steel or Feraloy designed for installation on cast-metal box.

2.04 FINISHES

- A. Wiring device catalog numbers specified in this section do not designate device color. Unless otherwise indicated, or required by code, provide colors as specified below.
- B. Wiring Device:
 1. Other Areas: Gray.
 2. Isolated ground receptacle shall be orange.
- C. Special purpose and hazardous location devices may be manufacturer's standard color (black).
- D. Corrosion-resistant receptacle may be manufacturer's standard color (yellow).

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Comply with NECA 1.
- B. Coordination with Other Trades:
 1. Ensure device and its box are protected. Do not place wall finish materials over device box and do not cut holes for box with router that is guided by riding against outside of box.

2. Keep outlet box free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate raceway system, conductors, and cables.
3. Install device box in brick or block wall such that cover plate does not cross a joint, unless otherwise indicated. Where indicated or directed to cross joint, trowel joint flush with face of wall.
4. Install wiring device after wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted provided outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction or that show signs they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (150 mm) in length.
5. Use torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than 12 AWG are installed on 15-amp or 20-amp circuits, splice 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on device.
8. Device Plates:
 - a. Do not use oversized or extra deep plate.
 - b. Repair wall finishes and remount outlet box when standard device plate does not fit flush or does not cover rough wall opening.

3.02 SWITCH INSTALLATION

A. Switch, General Purpose:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switch such that toggle is in up position when switch is on.

B. Switch, Motor Rated:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position such that toggle is in up position when ON.
3. Install within sight of motor when used as disconnect switch.

C. Occupancy Sensor, Wall Switch: Install in accordance with manufacturer's instructions.

3.03 RECEPTACLE INSTALLATION

A. Duplex Receptacle:

1. Install with grounding slot down, except where horizontal mounting is shown, in which case install with neutral slot down.
2. Ground receptacle to box with grounding wire only.
3. Weatherproof Receptacle:
 - 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 Receptacle: Install in accordance with manufacturer's instructions.

3.04 DEVICE PLATE INSTALLATION

- A. Securely fasten to wiring device; ensure tight fit to box.
- B. Flush Mounted: Install with all four edges in continuous contact with finished wall surface without use of mat or similar material. Plaster fillings will not be acceptable.
- C. Surface Mounted: Plate shall not extend beyond sides of box, unless plate has no sharp corners or edges.

- D. Install with alignment tolerance to box of 1/16 inch.
- E. Engrave with designated title.
- F. Type (Unless Otherwise Shown):
 - 1. Office Areas: Plastic.
 - 2. Other Areas: Metal.
 - 3. Exterior:
 - a. Switch: Weatherproof.
 - b. Receptacle in Damp Location: Weatherproof Type 1.
 - c. Receptacle in Wet Location: Weatherproof Type 2.
- G. Interior:
 - 1. Flush Mounted Box: Metal.
 - 2. Surface Mounted, Aluminum Box:
 - a. General Purpose Areas: Stamped.
 - b. Other Areas: Cast.
 - 3. Surface Mounted, Nonmetallic Box: Manufacturer's standard.
 - 4. Receptacle Shown as Weatherproof on Drawings: Weatherproof Type 1.

3.05 IDENTIFICATION

- A. Use tape labels for identification of individual wall switches and receptacles in dry indoor locations.
 - 1. Degrease and clean device plate surface to receive tape labels.
 - 2. Use 3/16-inch Kroy black letters on white background, unless otherwise indicated.
 - 3. Identify panelboard and circuit number from which item is served on face of plate.
- B. Identify conductors with durable wire markers or tags inside outlet boxes where more than one circuit is present.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections, and prepare test reports.
- B. Test Instrument for 125-Volt 20-Amp Receptacle: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- C. Using test plug, verify device and its outlet box are securely mounted.
- D. Line Voltage Range: 105 volts to 132 volts.

- E. Percent Voltage Drop under 15-Amp Load: Less than 6 percent; 6 percent or higher is not acceptable.
- F. Ground Impedance: 2 ohms, maximum.
- G. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
- H. Tests shall be diagnostic, indicating damaged conductors, high resistance at circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

SECTION 26 41 00
FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Lightning Protection Institute (LPI): 175, Standard of Practice.
2. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 780, Standard for the Installation of Lightning Protection Systems.
3. Underwriters Laboratories, Inc. (UL):
 - a. 96, Standard for Lightning Protection Components.
 - b. 96A, Standard for Installation Requirements for Lightning Protection Systems.

1.02 DESIGN REQUIREMENTS

A. Provide lightning protection system design for the following structures:

1. Liquid Ammonium Sulfate Tank and associated equipment.
2. Recharge Well Field Panel, instruments and associated equipment.
3. Monitoring Well #1, Field Panel, Motor Starter, instruments and associated equipment.
4. Monitoring Well #2 Field Panel, Motor Starter, RTU and associated instruments and equipment.

B. Design lightning protection system to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.

1.03 SUBMITTALS

A. Action Submittals:

1. Drawings:
 - a. Lightning protection system layout.
 - b. Component locations.
 - c. Detailed plans.
2. Down conductor.
3. Connecting conductor.
4. Bond strap.
5. Air terminals.
6. Fittings.

7. Connectors.
8. Ground rods.

B. Informational Submittals:

1. Field test report.
2. Ground Witness Certification-Form LPI-175A.
3. Post-Installation Certification-Form LPI-175B.
4. UL 96 Master Label "C" Certification.

1.04 QUALITY ASSURANCE

- A. Designer: Lightning protection system design shall be prepared by a licensed registered Florida professional engineer. All submittals, preliminary, intermediate and final shall be signed and sealed by the professional engineer. No submittals will be approved which do not bear the engineer's signature and seal.
- B. System components shall be the product of a manufacturer regularly engaged in the manufacturing of lightning protection components in accordance with UL 96.
- C. Lightning protection system shall be installed under direct supervision of an LPI 175 Certified Master Installer.
- D. Inspection of final installation and grounding connection shall be performed by an LPI-certified inspector.
- E. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
- F. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
 1. Thompson Lightning.
 2. IPC Protection.

3. Erico Eritech Lightning Protection Systems.
4. VFC, Inc.

2.02 GENERAL

- A. Complete system shall bear UL 96 Master Label C.
- B. System Material: Aluminum, unless otherwise specified.
- C. Material shall comply in weight, size, and composition for the class of structure to be protected as established by NFPA 780.

2.03 COMPONENTS

- A. Air Terminal:
 1. Material: Solid aluminum with tapered or blunt points as required for application.
 2. Diameter: 5/8 inch.
 3. Length: Sufficient to extend minimum 10 inches above object being protected.
 4. UL 96 Label B applied to each terminal.
- B. Conductors:
 1. Lightning System Conductors: Bare medium hard-drawn stranded copper, or stranded aluminum as required for the application.
 2. Main Down Conductor: Smooth twist stranding, Class II.
 3. Connecting Conductor: Concentric stranding, Class II.
 4. Bonding Conductor: Flexible strap, minimum 3/4-inch wide by 1/8-inch thick.
 5. Main down and connecting conductors shall bear the UL 96 Label A, applied every 10 feet.
 6. Grounding Conductors: Stranded bare copper.
- C. Cable Fastener And Accessories: Capable of withstanding minimum pull of 100 pounds.
- D. Fittings:
 1. Heavy-duty.
 2. Bolts, Screws, and Related Hardware: Stainless steel.

E. Ground Rods:

1. Material: Copper-clad steel.
2. Diameter: 3/4 inch.
3. Length: 10 feet.

F. Grounding Connections:

1. Welds: Exothermic process.
2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
3. Hardware: Silicone bronze.

G. Cable Connections and Splicers:

1. Welds: Exothermic process.
2. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
3. Through-Roof Connectors: Straight or right angle with bronze and lead seal flashing washer.

H. Conduit: Schedule 40 PVC, as specified in Section 26 05 33, Raceway and Boxes.

PART 3 EXECUTION

3.01 GENERAL

- A. Workmanship to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780.
- B. Aluminum materials shall be used where required to meet the galvanic corrosion requirements of UL 96A.
- C. Provide pitchpockets or method compatible with roofing to waterproof roof penetrations.
- D. Install system in inconspicuous manner so components blend with building aesthetics.

3.02 EXAMINATION

- A. Verify conditions prior to installation. Actual conditions may require adjustments in air terminal and ground rod locations.

3.03 INSTALLATION

A. Air Terminals:

1. Supports: Brackets or braces.
2. Parapet Bracket Attachment: Lag or expansion bolts.
3. Secure base to roof surface with adhesive or pitch compatible with roofing bond.
4. Provide terminal flashing at roof penetrations.
5. Perimeter Terminals:
 - a. Maximum Spacing: 20 feet.
 - b. Maximum Distance From Outside Edge of Building: 2 feet.
6. Roof Ridge Terminals: Maximum spacing 20 feet.
7. Mid-Roof Terminals: Maximum spacing 50 feet.
8. Provide blunt point air terminals for applications exposed to personnel.

B. Conductors:

1. Conceal whenever practical.
2. Provide 1-inch PVC conduit in building walls or columns for main downleads and roof risers.
3. Support: Maximum spacing for exposed conductors.
 - a. Vertical: 3 foot.
 - b. Horizontal: 4 foot.
4. Maintain horizontal and vertical conductor courses free from dips or pockets.
5. Bends: Maximum 90 degrees, with minimum 8-inch radius.
6. Install air terminal conductors on the structural roof surface before roofing composition is applied.

C. Bonding:

1. Bond to Main Conductor System:
 - a. Roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
 - b. 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.
2. Bond each steel column or major framing members to grounding system.
3. Bond each main down conductor to grounding system.

D. Grounding System:

1. Grounding Conductor:
 - a. Completely encircle building structure.
 - b. Bury minimum 1 foot below finished grade.
 - c. Minimum 2 feet from foundation walls.
2. Interconnect ground rods by direct-buried copper cables.
3. Maximum Resistance: 5 ohms when connected to ground rods.
4. Connections:
 - a. Install ground cables continuous between connections.
 - b. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
 - c. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
 - d. Use bolted offset parapet bases or through-roof concealed base assemblies for air terminal connections.
 - e. Provide interconnections with electrical systems and all underground metal pipes.
 - f. Provide electric service arrestor ground wire to building water main.

3.04 FIELD QUALITY CONTROL

A. Field Testing:

1. Isolate lightning protection system from other ground conditions while performing tests.
2. Resistance: Test ground resistance of grounding system by the fall-of-potential method.
 - a. Test Resistance to Ground: Maximum 5 ohms.
 - b. Install additional ground rods as required to obtain maximum allowable resistance.
3. Test Report:
 - a. Description of equipment tested.
 - b. Description of test.
 - c. Test results.
 - d. Conclusions and recommendations.
 - e. Appendix, including appropriate test forms.
 - f. Identification of test equipment used.
 - g. Signature of responsible test organization authority.

END OF SECTION

SECTION 26 43 00
SURGE PROTECTION DEVICES (SPD) AND
TRANSIENT VOLTAGE SUPPRESSION (TVSS)

PART 1 GENERAL

1.01 SUBMITTALS

- A. Submit product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.
- B. Submit manufacturer's UL certified test data and nameplate data for each SPD/TVSS.
- C. Submit electrical single-line diagram showing location of each SPD/TVSS.

1.02 QUALITY ASSURANCE

- A. UL Compliance and Labeling:
 - 1. For power and signal circuits, SPD/TVSS devices shall comply with UL 1449 and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units that are listed and labeled by UL.
 - 2. For telephone circuit protection, SPD/TVSS devices shall comply with UL 497A.
- B. ANSI Compliance: Use SPD/TVSS devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

PART 2 PRODUCTS

2.01 GENERAL

- A. All SPD/TVSS devices for power circuits, provided under this section, shall be the product of a single manufacturer.
- B. SPD/TVSS devices shall be capable of performance at ambient temperatures between minus 40 degrees C and 60 degrees C, at relative humidity ranging from 0 percent to 95 percent, and at altitudes ranging from sea level to 12,000 feet.
- C. SPD/TVSS devices shall be fused to disconnect the suppressor from the electrical source should the suppressor fail. The fusing shall allow full surge handling capabilities and to afford safety protection from thermal overloads and short circuits.

- D. Design SPD/TVSS devices for the specific type and voltage of the electrical service. Single-phase and three-phase wye-configured systems shall have L-N, L-G, and N-G protection. Grounded delta-configured systems shall have L-L and L-G protection.
- E. Power Filter: The SPD/TVSS shall include a high frequency extended range power filter complimentary listed to UL 1283 as an electromagnetic interference filter.

2.02 MANUFACTURER

- A. Innovative Technology, VanGuard Series.
- B. Advanced Protection Technologies, Inc.
- C. General Electric.

2.03 MAIN DISTRIBUTION SPD/TVSS

- A. Provide SPD/TVSS meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category C.
- B. Surge current capacity shall be not less than the following:
 - 1. L-N Capacity: 200 kA.
 - 2. L-G Capacity: 120 kA.
 - 3. N-G Capacity: 120 kA.
- C. Suppressor housing shall be in an enclosure that has the same NEMA rating as the equipment it protects and painted to match.
- D. UL 1449 maximum suppression voltage shall not be more than:

System Voltage	Phase	L-L or L-N Suppression Voltage
120	1	400
208Y/120	3	400
240	3	800
480Y/277	3	800

- E. Nominal Discharge Current: 20 kA.

2.04 PANELBOARD SPD/TVSS

- A. Provide SPD/TVSS meeting IEEE C62.41.1 and IEEE C62.41.2 Location Category B.
- B. Surge current capacity shall be not less than the following:
 - 1. L-L Capacity: 80 kA.
 - 2. L-N Capacity: 80 kA.
 - 3. L-G Capacity: 80 kA.
 - 4. N-G Capacity: 80 kA.
- C. Suppressor shall be in an enclosure that has the same NEMA rating as the panel it protects or the SPD/TVSS may be integral to a panelboard.
- D. UL 1449 maximum clamp voltage shall not be more than:

System Voltage	Phase	L-L or L-N Clamp Voltage
120	1	400
208Y/120	3	400
240	3	800
480Y/277	3	800

- E. Nominal Discharge Current: 20 kA.

2.05 ANNUNCIATION

- A. Provide unit or separately mounted LED-type indication lights to show the normal and failed status of each module. Provide one normally open and one normally closed contacts which operate when the unit fails.

2.06 SURGE COUNTER

- A. Provide each SPD/TVSS rated above 100 kA with a counter displaying the number of voltage transients that have occurred on the unit input. The counter shall be battery backed and retain the count through system power outages.

2.07 PAIRED CABLE DATA LINE INTERIOR SUPPRESSORS

- A. Provide units meeting IEEE C62.41, Location Category A.
- B. Use bi-polar 1,500-watt silicon avalanche diodes between the protected conductor and earth ground.

- C. Provide units with a maximum single impulse current rating of 80 amperes (10 by 1,000 microsecond-waveform).
- D. Breakdown voltage shall not exceed 36 volts.

2.08 PAIRED CABLE DATA LINE EXTERIOR SUPPRESSORS

- A. Provide units meeting IEEE C62.41, Location Category A.
- B. Suppressors shall be a hybrid design with a minimum of three stages, utilizing solid-state components and operating bi-directionally.
- C. Suppressors shall meet or exceed the following criteria:
 - 1. Maximum single impulse current rating of 10,000 amperes (8 by 20 microsecond-waveform).
 - 2. Pulse Life Rating: 3,000 amperes (8 by 20 microsecond-waveform): 2,000 occurrences.
 - 3. Maximum clamping voltage at 10,000 amperes (8 by 20 microsecond current waveform), shall not exceed the peak of the normal applied signal voltage by 200 percent.

PART 3 EXECUTION

3.01 APPLICATION REQUIREMENTS

- A. Install SPD/TVSS when indicated on the Drawings and:
 - 1. Main Distribution SPD/TVSS in or near each low-voltage switchgear (load center).
 - 2. Main Distribution SPD/TVSS in or near each motor control center.
 - 3. Panelboard SPD/TVSS In or near each distribution panelboard unless otherwise indicated.
- B. Electronic Equipment Paired Cable Conductors: Install data line suppressors at the low voltage input and output of each piece of equipment, including telephone cable entrance.
 - 1. Use secondary protectors on lines that do not exit the structure.
 - 2. Use primary protectors on lines that exit and enter the structure.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install suppressors according to manufacturer's recommendations.

- B. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with all conductors laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.
- C. Connecting wires shall be as short as possible with gently twisted conductors, tied together, to prevent separation. Connecting wires shall not exceed 24 inches in length at any point.
- D. Field installed conductors shall be the same as specified for building wire, not smaller than No. 8 AWG and not larger than No. 4 AWG. Device leads shall not be longer than the length recommended by the manufacturer, unless specifically reviewed and approved by the manufacturer.

END OF SECTION

SECTION 26 56 00 EXTERIOR LIGHTING

PART 1 PRODUCTS

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - c. A572/A572A, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 - d. A588/A588M, Standard Specification for High-Strength Low-Alloy Structural Steel, with 50 ksi [345 MPa] Minimum Yield Point to 4-in. [100-mm] Thick.
 - e. A595/A595M, Standard Specification for Steel Tubes, Low-Carbon or High-Strength Low-Alloy, Tapered for Structural Use.
 - f. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - g. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - h. D6576, Standard Specification for Flexible Cellular Rubber Chemically Blown.
2. Illuminating Engineering Society of North America (IESNA): HB-9, Lighting Handbook.
3. The Institute of Electrical and Electronics Engineers, Inc. (IEEE): C2, National Electrical Safety Code.
4. Military Specification (MIL): DTL-83420M, Wire Rope, Flexible, for Aircraft Control, General Specification for.
5. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. ICS 6, Industrial Control and Systems: Enclosures.
6. National Energy Policy Act.
7. National Fire Protection Association (NFPA): 70, National Electrical Code.

8. Underwriters Laboratories, Inc. (UL):
 - a. 595, Standard for Safety Marine-Type Electric Lighting Fixtures.
9. U.S. Environmental Protection Agency and U.S. Department of Energy: Energy Star.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Exterior Luminaires:
 - 1) Catalog data sheets and pictures.
 - 2) Luminaire material, finish, metal gauge, and dimensions.
 - 3) IESNA classification and isolux diagram.
 - 4) Distribution data according to classification type as defined in IESNA HB-9.
 - 5) Fastening details.
 - 6) For light poles, submit wind loading, complete dimensions, pole deflection with fixture attached, finish, and catalog sheet.
 - 7) For concrete poles, include section and details to indicate quantities and position of prestressing steel, spiral steel, inserts, and through holes, initial prestressing steel tension, and concrete strengths at release and at 28 days.
 - 8) Lens material, pattern, and thickness.
 - 9) Data indicating lumens per watt efficiency and color rendition index of light source.
 - b. Lamps:
 - 1) Voltage.
 - 2) Approximate life (in hours).
 - 3) Approximate initial lumens.
 - 4) Lamp type and base.
 - 5) Color.
 - c. Ballasts:
 - 1) Type.
 - 2) Wiring diagram.
 - 3) Nominal watts and input watts.
 - 4) Input voltage and power factor.
 - 5) Starting current, line current, and restrike current values.
 - 6) Sound rating.
 - 7) Temperature rating.
 - 8) Efficiency ratings.
 - 9) Low temperature characteristics.
 - d. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

2. Samples: Submit sample of luminaire if requested by Engineer. Fixture shall be operational from a 120V ac outlet.

B. Informational Submittals:

1. Manufacturer's printed installation instructions.
2. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

B. Standard Products:

1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship.
2. Products shall have been in satisfactory commercial or industrial use for 2 years prior to Bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
3. Material and Equipment Manufacturing Date: Products manufactured more than 3 years prior to date of delivery to Site shall not be used.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Concrete Poles:

1. Do not store poles on ground.
2. Support poles so they are at least 1 foot above ground level and growing vegetation.
3. Ship poles with bolt circle template, base cover, handhold cover, and shaft cap or tenon.

PART 2 PRODUCTS

2.01 LUMINAIRES

A. General:

1. Specific requirements relative to the Work of this section are located in Luminaire Schedule on Drawings.
2. Component Access: Accessible and replaceable without removing luminaire from its mounting.

B. Exterior Installations:

1. UL Labeled: "SUITABLE FOR OUTDOOR LOCATIONS."
2. Ballast: Removable, prewired.

C. Marine Environments:

1. UL Labeled: "MARINE, OUTSIDE TYPE."
2. Housing: Copper-free, aluminum in accordance with UL 595.
3. Manufacturers:
 - a. General Electric Company.
 - b. Osram Sylvania.
 - c. Phillips Lighting Company.

2.02 POLES

A. General:

1. Design for wind load as specified in Section 01 61 00, Common Product Requirements, while supporting luminaires and other appurtenances. The effective projected areas (EPA) of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole.
2. Poles 40 feet and shorter shall be one piece construction.
3. Pole Height: As indicated on Luminaire Schedule.
4. Handhole:
 - a. Poles shall have oval-shaped handhole having a minimum clear opening of 2.5 inches by 5 inches.
 - b. Cover shall be secured by stainless steel captive screws.
5. Scratched, stained, chipped, or damaged poles shall not be installed.

B. Concrete Poles:

1. Cross-sectional shape shall be square.
2. Steel Reinforcing:
 - a. Prestressed concrete pole shafts shall be reinforced with steel prestressing members.
 - b. Design shall provide internal longitudinal loading by either pretensioning or post tensioning of longitudinal reinforcing members.
3. Tensioned Reinforcing:
 - a. Primary reinforcement steel used for a prestressed concrete pole shaft shall be tensioned between 60 percent to 70 percent of its ultimate strength.
 - b. Amount of reinforcement shall be such that when reinforcement is tensioned to 70 percent of its ultimate strength, the total resultant tensile force does not exceed the minimum section compressive strength of the concrete.
4. Coating and Sleeves for Reinforcing Members:
 - a. Where minimum internal coverage cannot be maintained next to required core openings, such as handhole and wiring inlet, reinforcing shall be protected with a vaporproof noncorrosive sleeve over the length without the 1/2-inch concrete coverage.
 - b. Each steel reinforcing member which is to be post-tensioned shall have a nonmigrating slipper coating applied prior to the addition of concrete to ensure uniformity of stress throughout length of such member.
5. Strength Requirement:
 - a. Naturally cured to achieve a 28-day compressive strength of 7,000 psi.
 - b. Do not subject to severe temperature changes during curing period.
6. Shaft Preparation:
 - a. Completed prestressed concrete pole shaft shall have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost, and shall be clean, smooth, and free of surface voids and internal honeycombing.
 - b. Shall not be installed for at least 15 days after manufacture.

2.03 BRACKETS AND SUPPORTS

A. Features:

1. Not less than 1-1/4-inch aluminum secured to pole.
2. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical.

3. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated.
4. Special mountings or brackets shall be as indicated on Drawings and shall be of metal which will not promote galvanic reaction with luminaire head.

2.04 EQUIPMENT IDENTIFICATION

- A. Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; nameplate of distributing agent will not be acceptable.
- B. Markings shall be clear and located to be readily visible to service personnel.

2.05 FACTORY FINISH

- A. Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Electrical installations shall conform to IEEE C2 and requirements specified herein.
- B. Pole Setting:
 1. Depth shall be as determined by Contractor for equipment proposed for use but not less than 6 feet.
 2. Soil Setting: Depths shall apply where pole holes are in soil, sand, or gravel or any combination of these.
 3. Setting on Sloping Ground: On sloping ground, measure depth of hole from low side of hole.
 4. Backfill: Tamp pole backfill for the full depth of hole and mound excess fill around pole.
 5. Dig holes large enough to permit the proper use of tampers to the full depth of the hole.
 6. Place backfill in the hole in 6-inch maximum layers and thoroughly tamp.
 7. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.
- C. Concrete Poles: Install according to pole manufacturer's instructions.

- D. Grounding: Ground noncurrent-carrying parts of equipment including luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 26 05 26, Grounding. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

1. Belowgrade Wiring:

a. Excavating and Backfill:

- 1) Trenches for electrical conduit and wiring shall be of sufficient width to permit proper handling and installation of pipe and fittings.
- 2) Trenches containing conduit for line voltage wiring must have a minimum cover of at least 30 inches.
- 3) Backfill shall be thoroughly compacted up to original grade level 90 percent of the modified Proctor density.

b. Pulling:

- 1) Sizing of the required pull boxes shall be determined using Section 26 05 33, Raceway and Boxes.
- 2) Keep interior of conduit free from dirt and debris.

c. Underground Conduit: Install per Section 26 05 33, Raceway and Boxes.

d. Pull Boxes and Junction Boxes:

- 1) Install per Section 26 05 33, Raceway and Boxes.
- 2) Boxes shall remain accessible at all times.

3.02 FIELD QUALITY CONTROL

- A. Upon completion of installation, verify equipment is properly installed, connected, and adjusted. Conduct an operating test to show equipment operates in accordance with the requirements of this section.
- B. Coordinate lighting and controls installation and testing with commissioning as specified in Section 01 91 14, Equipment Testing and Facility Startup.

3.03 CLEANING

- A. Remove labels and markings, except UL listing mark.
- B. Wipe luminaries inside and out to remove construction dust.
- C. Clean luminaire plastic lenses with antistatic cleaners only.
- D. Touchup painted surfaces of luminaries and poles with matching paint ordered from manufacturer.
- E. Replace defective lamps at time of Substantial Completion.

END OF SECTION

**SECTION 31 10 00
SITE CLEARING**

PART 1 GENERAL

1.01 DEFINITIONS

- A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.
- C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.
- D. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 SCHEDULING AND SEQUENCING

- A. Prepare Site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Clear, grub areas actually needed for Site improvements within limits shown or specified.
- B. Do not injure or deface vegetation that is not designated for removal.

3.02 LIMITS

- A. As follows, but not to extend beyond Project limits.
 - 1. Excavation 5 feet beyond top of cut slopes.
 - 2. Fill:
 - a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
 - 3. Structures: 15 feet outside of new structures.
 - 4. Roadways: Clearing and grubbing: 30 feet from centerline.
 - 5. Other Areas: As shown.

- B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 TEMPORARY REMOVAL OF INTERFERING PLANTINGS

- A. Remove and store shrubs and trees that are not designated for removal but do interfere with construction or could be damaged by construction activities.
- B. Photograph and document location, orientation, and condition of each plant prior to its removal. Record sufficient information to uniquely identify each plant removed and to assure accurate replacement.

3.04 CLEARING

- A. Clear areas within limits shown or specified.
- B. Fell trees so that they fall away from facilities and vegetation not designated for removal.
- C. Cut stumps not designated for grubbing to within 6 inches of ground surface.
- D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.05 GRUBBING

- A. Grub areas within limits shown or specified.

3.06 DISPOSAL

- A. Clearing and Grubbing Debris:
 - 1. Dispose of debris offsite.
 - 2. Burning of debris onsite will not be allowed.
 - 3. Woody debris may be chipped. Chips may be sold to Contractor's benefit or used for landscaping onsite as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Maximum dimensions of chipped material used onsite shall be 1/4 inch by 2 inches. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
 - 4. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

END OF SECTION

SECTION 31 23 13 SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³)).
 - b. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - c. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - d. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

- A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.
- B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.
- C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.
- D. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.
- E. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.03 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Sections 31 10 00, Site Clearing; and 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

- A. Notify Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.
- B. Bring subgrade to proper grade and cross-section and uniformly compact surface.
- C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.
- D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

- A. Under Earthfill: Compact upper 12 inches to minimum of 90 percent relative compaction as determined in accordance with ASTM D1557.
- B. Under Pavement Structure, Floor Slabs On Grade, or Granular Fill Under Structures: Proof-roll the subgrade with at least 15 overlapping passes, using a vibratory roller having a minimum dynamic force of 10 tons. After proof-rolling, compact the upper 12 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

3.03 MOISTURE CONDITIONING

- A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.
- B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

- A. The Contractor shall retain an independent soil testing company to determine in-place density and moisture content.
- B. One test per every 2,000 square feet of prepared subgrade, or minimum of one test per structure or facility.
- C. Test in accordance with ASTM D1556 or ASTM D6938.

3.05 CORRECTION

- A. Soft or Loose Subgrade:
 - 1. Adjust moisture content and recompact, or
 - 2. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.
- B. Unsuitable Material: Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

END OF SECTION

SECTION 31 23 16 EXCAVATION

PART 1 GENERAL

1.01 QUALITY ASSURANCE

- A. Provide adequate survey control to avoid unauthorized overexcavation.
- B. Monitor potential adverse impacts on adjacent facilities and completed work.

1.02 WEATHER LIMITATIONS

- A. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.03 SEQUENCING AND SCHEDULING

- A. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.
- B. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering, prior to initiating excavation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.
- B. Do not overexcavate without written authorization of Engineer.
- C. Conduct excavation in accordance with OSHA Standards 29CFR Part 1926.650 Subpart P. Trenching and Excavation regulations and requirements.

3.02 UNCLASSIFIED EXCAVATION

- A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
 - a. Less than 4-inch Outside Diameter or Width: 18 inches.
 - b. Greater than 4-inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.04 EMBANKMENT AND CUT SLOPES

- A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown.
- B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.
- C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.05 STOCKPILING EXCAVATED MATERIAL

- A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.
- B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.
- C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.
- D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

- E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.06 DISPOSAL OF SPOIL

- A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.
- B. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION

**SECTION 31 23 19.01
DEWATERING**

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Dewatering and Water Control Plan.
2. Contingency Plan.
3. Discharge permits.
4. Water Level Elevations: Submit same day measured.
5. Settlement Benchmark: Submit weekly record.

B. Coordinate dewatering and water control submittal with the excavation support submittals.

1.02 DEWATERING AND WATER CONTROL PLAN

A. Prepared by a licensed Professional Engineer in the State of Florida, having a minimum of 10 years of professional experience in the design and construction of dewatering systems.

B. At least 30 days prior to the start of construction, Contractor shall submit the proposed dewatering and water control plan. The dewatering and water control plan shall include, as a minimum:

1. Shop Drawings.
2. Descriptions of proposed groundwater and surface water control facilities including, but not limited to equipment, methods, standby equipment and power supply, means of measuring inflow to excavations, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
3. Drawings showing locations, dimensions, and relationships of elements of each system, including but not limited to location of piezometers and monitoring wells, surface water control elements, location for disposing removed water.
4. Design calculations, signed and sealed by a Professional Engineer, demonstrating adequacy of proposed dewatering systems and components.
5. The design shall include provisions for monitoring and recording total daily volume (gallons), and instantaneous flow rate (gallons per minute).

- C. If system is modified during installation or operation revise or amend and resubmit Dewatering and Water Control Plan.

1.03 DESIGN AND PERFORMANCE RESPONSIBILITY

- A. Contractor shall obtain permits and comply with all requirements of agencies having jurisdiction.
- B. The Contractor shall be solely responsible for the proper design and execution of methods for dewatering and controlling surface water and ground water.
- C. Contractor shall be solely responsible for damage to properties, buildings or structures, utility installations, and work that may result from dewatering or surface water control operations.
- D. Any design review and field monitoring activities by the Engineer shall not relieve the Contractor of his/her responsibilities for the work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

3.02 SURFACE WATER CONTROL

- A. Intercept surface water and divert it away from excavations through the use of diversion ditches, dikes, pipes, or other approved means.
- B. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

- A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

- B. Dewatering operations shall be conducted in a manner that does not cause loss or ground or disturbance to the soil that supports overlying or adjacent utilities or structures.
- C. Dewatering systems shall include wells or well points, and other equipment and appurtenances installed sufficiently below lowest point of excavation, or to maintain specified water elevation.
- D. Design and Operate Dewatering Systems:
 - 1. To prevent loss of ground as water is removed.
 - 2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
 - 3. To relieve artesian pressures and resultant uplift of excavation bottom.
- E. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.
- F. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.
- G. If method of dewatering does not properly dewater the trench or excavation as specified, install groundwater observation wells and do not proceed with any work until the readings obtained from the observation wells indicate that the groundwater has been lowered a minimum of 2 feet below the bottom of the final excavation.
- H. Remove dewatering system only when groundwater control is no longer required and as approved by the Engineer.

3.04 MONITORING WELLS

- A. Monitoring Groundwater Levels: Install and monitor observation wells at locations selected by Engineer. Measure water levels observed in each observation well at frequency stated in Contractor's Dewatering Plan and whenever system or component failures are discovered.
- B. After groundwater level observation wells are no longer needed for monitoring groundwater levels, remove observation wells.

3.05 SETTLEMENT

- A. Monitoring Dewatering-Induced Settlement: Establish monuments for monitoring settlement at adjacent facility locations selected by Engineer. Monitor vertical movement of each settlement monument, relative to remote benchmark selected by Engineer, at least weekly.

3.06 MONITORING FLOWS

- A. Monitor volume of water pumped per calendar day from excavations, as Work progresses. Also monitor volume of water introduced each day into excavations for performance of Work. Monitor flows using measuring devices acceptable to Engineer.

3.07 DISPOSAL OF WATER

- A. Obtain discharge permit for water disposal from authorities having jurisdiction.
- B. All water discharged from the dewatering system shall be treated to remove solids and sediment prior to discharge.
- C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

3.08 PROTECTION OF PROPERTY

- A. Make assessment of potential for dewatering induced settlement. If necessary, provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.
- B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

END OF SECTION

SECTION 31 23 23 FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
 - b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - c. D75, Standard Practice for Sampling Aggregates.
 - d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - g. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, excavation to grade, and subgrade preparation.

- D. Completed Course: A course or layer that is ready for next layer or next phase of Work.
- E. Lift: Loose (uncompacted) layer of material.
- F. Geosynthetics: Geotextiles, geogrids, or geomembranes.
- G. Well-Graded:
 - 1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
 - 2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
 - 3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.
- H. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
 - 1. 1 foot outside outermost edge at base of foundations or slabs.
 - 2. 1 foot outside outermost edge at surface of roadways or shoulder.
 - 3. 0.5 foot outside exterior at spring line of pipes or culverts.
- I. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.
- J. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.
- K. Imported Material: Materials obtained from sources offsite, suitable for specified use.
- L. Structural Fill: Fill materials as required under structures, pavements, and other facilities.
- M. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

1.03 SUBMITTALS

- A. Informational Submittals: Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Section 31 10 00, Site Clearing; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.
- B. Backfill against concrete structures only after concrete has attained 28 day compressive strength, specified in Section 03 30 10, Cast-in-Place Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.
- C. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

- A. Gradation Tests: By Contractors testing laboratory, as necessary to locate acceptable sources of imported material.

2.02 EARTHFILL

- A. Excavated material from required excavations free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.
- B. Provide imported material of equivalent quality, if required to accomplish Work.

2.03 GRANULAR FILL

- A. 1-inch minus crushed gravel or crushed rock.
- B. Free from dirt, clay balls, and organic material.

- C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.04 WATER FOR MOISTURE CONDITIONING

- A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

PART 3 EXECUTION

3.01 GENERAL

- A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.
- C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.
- D. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
 - 1. Fill or backfill to an elevation 2 feet above top of item to be laid.
 - 2. Excavate trench for installation of item.
 - 3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
 - 4. Install item.
 - 5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.
- E. Tolerances:
 - 1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
 - 2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.
- F. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

- A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 98 percent relative compaction as determined in accordance with ASTM D1557.
- B. Other Areas: Backfill with earthfill to lines and grades shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.

3.03 FILL

- A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:
 1. Allow for 4-inch thickness of topsoil where required.
 2. Maximum 8-inch thick lifts.
 3. Place and compact fill across full width of embankment.
 4. Compact to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.
 5. Dress completed embankment with allowance for crest surfacing, and slope protection, where applicable.

3.04 SITE TESTING

- A. Gradation:
 1. One sample from each 500 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications or the approved samples.
 2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
 3. Remove material placed in Work that does not meet Specification requirements.
- B. In-Place Density Tests: In accordance with ASTM D1556 or ASTM D6938. During placement of materials, test as follows:
 1. Granular Fill and Earthfill: One test for every 2,000 square feet of each lift; or one test per lift, whichever requires more lifts.

3.05 REPLACING OVEREXCAVATED MATERIAL

- A. Replace excavation carried below grade lines shown or established by Engineer as follows:
1. Beneath Footings: Granular fill.
 2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
 3. Beneath Slabs-On-Grade: Granular fill.
 4. Trenches:
 - a. Unauthorized Overexcavation: Granular Fill.
 - b. Authorized Overexcavation: Granular Fill.
 5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
 - a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
 - b. Steep Slopes (Steeper than 3:1):
 - 1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
 - 2) Backfilling overexcavated areas is prohibited, unless in Engineer's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

END OF SECTION

SECTION 31 23 23.15 TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
 - a. C33/C33M, Standard Specification for Concrete Aggregates.
 - b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
 - d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - e. C150/C150M, Standard Specification for Portland Cement.
 - f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - g. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - h. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
 - i. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - j. D3776, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
 - k. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - l. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - m. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - n. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
 - p. D4991, Standard Test Method for Leakage Testing of Empty Rigid Containers by Vacuum Method.
 - q. D5034, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)

3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

- A. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.
- B. Imported Material: Material obtained by Contractor from source(s) offsite.
- C. Lift: Loose (uncompacted) layer of material.
- D. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.
- E. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.
- F. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.
- G. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.03 SUBMITTALS

- A. Action Submittals:
 1. Shop Drawings: Manufacturer's descriptive literature for marking tapes.
- B. Informational Submittals:
 1. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
 2. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 MARKING TAPE

A. Nondetectable:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 5 mils.
3. Width: 6 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
 - a. Reef Industries; Terra Tape.
 - b. Mutual Industries; Non-detectable Tape.
 - c. Presco; Non-detectable Tape.

B. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: 6 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
7. Manufacturers and Products:
 - a. Reef Industries; Terra Tape, Sentry Line Detectable.
 - b. Mutual Industries; Detectable Tape.
 - c. Presco; Detectable Tape.

C. Color: In accordance with APWA Uniform Color Code.

Color*	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
*As specified in NEMA Z535.1, Safety Color Code.	

2.02 TRENCH STABILIZATION MATERIAL

- A. Granular Fill: As specified in Section 31 23 23, Fill and Backfill.

2.03 BEDDING MATERIAL AND PIPE ZONE MATERIAL

- A. Granular Fill: As specified in Section 31 23 23, Fill and Backfill.

2.04 EARTH BACKFILL

- A. Earthfill: As specified in Section 31 23 23, Fill and Backfill.

2.05 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.
- B. Materials:
 - 1. Cement: ASTM C150/C150M, Type I or Type II.
 - 2. Aggregate: ASTM C33/C33M, Size 7.
 - 3. Fly Ash (Pozzolan): Class C fly ash in accordance with ASTM C618, except as modified herein:
 - 4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.06 SOURCE QUALITY CONTROL

- A. Contractor's testing laboratory to perform gradation analysis in accordance with ASTM C136.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

- A. Water Control:
 - 1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water. As specified in Section 31 23 19.01, Dewatering.
 - 2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
 - 3. Provide continuous water control until trench backfill is complete.
- B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

- A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.
- B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 TRENCH STABILIZATION MATERIAL INSTALLATION

- A. Rebuild trench bottom with trench stabilization material.
- B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.
- C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.04 BEDDING

- A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.
- B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.
- C. Hand grade and compact each lift to provide a firm, unyielding surface.
- D. Minimum Thickness: As follows.
 - 1. Pipe 15 Inches and Smaller: 4 inches.
 - 2. Pipe 18 Inches to 36 Inches: 6 inches.
 - 3. Pipe 42 Inches and Larger: 8 inches.
 - 4. Conduit: 4 inches.
 - 5. Direct-Buried Cable: 4 inches.
 - 6. Duct Banks: 4 inches.
- E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.
- F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

- G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.05 BACKFILL PIPE ZONE

- A. Upper limit of pipe zone shall not be less than following:
 - 1. Pipe: 12 inches, unless shown otherwise.
 - 2. Conduit: 3 inches, unless shown otherwise.
 - 3. Direct-Buried Cable: 3 inches, unless shown otherwise.
 - 4. Duct Bank: 3 inches, unless shown otherwise.
- B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.
- C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
 - 1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
 - 2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.
- D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.
- E. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor only over area between sides of pipe and trench walls.

3.06 MARKING TAPE INSTALLATION

- A. Continuously install marking tape along centerline of buried piping, on top of last lift of pipe zone material. Coordinate with piping installation drawings.
 - 1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.
 - 2. Nondetectable Marking Tape: Install with metallic piping.

3.07 BACKFILL ABOVE PIPE ZONE

- A. General:
 - 1. Process excavated material to meet specified gradation requirements.
 - 2. Adjust moisture content as necessary to obtain specified compaction.

3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Backfill areas to be grassed:

1. Place in lifts not exceeding thickness of 8 inches.
2. Mechanically compact each lift to a minimum of 90 percent relative compaction (ASTM D1557).

C. Backfill for Areas Under Facilities and Asphalt or Portland Cement Concrete Paving:

1. Backfill trench above pipe zone with granular fill in lifts not to exceed 6 inches. Compact each lift to a minimum of 98 percent relative compaction (ASTM D1557) prior to placing succeeding lifts.

D. Controlled Low Strength Material:

1. Discharge from truck mounted drum type mixer into trench.
2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.

3.08 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.
- B. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.
- C. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.09 SITE TESTING

A. Gradation:

1. One sample from each 150 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.

2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
 3. Remove material placed in Work that does not meet Specification Requirements.
- B. In-Place Density Tests: In accordance with ASTM D1556 or ASTM D6938. During placement of materials, test as follows:
1. Granular fill and pipe zone fill: One test for every 300 feet of each lift; or one test per lift, whichever requires more tests.

3.10 SETTLEMENT OF BACKFILL

- A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

**SECTION 31 41 00
SHEETING AND SHORING**

PART 1 GENERAL

1.01 SCOPE

- A. Work under this section consists of furnishing all labor, tools, equipment and materials necessary for providing secure and stable trench excavation.

1.02 QUALITY ASSURANCE

- A. Provide surveys to monitor movements of critical structures.
- B. Conform to the requirements of the OSHA Standards and Interpretations: "29 CFR Part 1926.650 Subpart P — Excavation, Trenching, and Shoring," and all other applicable laws, regulations, rules, and codes.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Trench box sizes for each pipe and utility excavation with structural capacity of retaining soil types as described in OSHA's 29 CFR Part 1926 Subpart P.

PART 3 EXECUTION

3.01 GENERAL

- A. Contractor is responsible for design, provide, and maintain shoring, sheeting, and bracing system as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed the Work.
- B. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he/she may order additional supports placed at the expense of the Contractor. Compliance with such order shall not relieve the Contractor from his/her responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.
- C. Shoring system shall provide suitable room for installing pipe, structures and appurtenances.

- D. When movable trench bracing such as trench boxes, movable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the screened gravel backfill.
 - 1. When installing rigid pipe (R.C., V.C., A.C., etc), any portion of the box extending below mid-diameter shall be raised above this point prior to moving the box ahead to install the next pipe. This is to prevent the separation of installed pipe joints due to movement of the box.
 - 2. When installing flexible pipe (PVC, etc), trench boxes, movable sheeting, shoring, or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, movable sheeting, shoring or plates are moved, screened gravel shall be placed to fill any voids created and the screened gravel and backfill shall be recompact to provide uniform side support for the pipe.

3.02 REMOVAL OF EXCAVATION SUPPORT

- A. Remove excavation support in a manner that will maintain support as excavation is backfilled.
- B. Do not begin to remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.
- C. Remove excavation support in a manner that does not leave voids in the backfill. Immediately backfill all voids left or caused by withdrawal of temporary excavation support systems with gravel or sand by tamping with tools specifically adapted for that purpose.

3.03 TRENCHES

- A. For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements of applicable state and local construction safety orders, and federal requirements.
- B. All excavation, trenching, and related sheeting, bracing, etc, shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P) and State requirements. Where conflict between OSHA and State regulations exists, the more stringent requirements shall apply.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSES

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):
 - a. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18-in) Drop.
 - b. Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction (Standard Specifications).

1.02 DEFINITIONS

- A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.
- B. Completed Lift: Compacted with uniform cross-section thickness.
- C. Standard Specifications: When referenced in this section, shall mean the Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction, current edition.

1.03 SUBMITTALS

- A. Informational Submittals:
 1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.
 2. Certified results of in-place density tests from independent testing agency.

PART 2 PRODUCTS

2.01 BASE COURSE

- A. As specified in Section 911 of the Standard Specifications.

2.02 SOURCE QUALITY CONTROL

- A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.
- B. Final approval of aggregate material will be based on test results of installed materials.
- C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. As specified in Section 31 23 13, Subgrade Preparation.
- B. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.
- C. Do not place base course or surfacing materials on soft, muddy subgrade.

3.02 EQUIPMENT

- A. In accordance with Sections 200 and 300 of the Standard Specifications.

3.03 HAULING AND SPREADING

- A. In accordance with Sections 200 and 300 of the Standard Specifications.

3.04 CONSTRUCTION OF COURSES

- A. Construction of Courses: In accordance with Sections 200 and 300 of the Standard Specifications.

3.05 SURFACE TOLERANCES

- A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.
- B. Finished Surface of Limerock Base Course: Within plus or minus 0.05 foot of grade shown at any individual point.

3.06 CLEANING

- A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

**SECTION 32 12 16
ASPHALT PAVING**

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):
 - a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
 - b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
 - c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
 - d. M140, Standard Specification for Emulsified Asphalt.
 - e. M208, Standard Specification for Cationic Emulsified Asphalt.
 - f. T166, Standard Method of Test for Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens.
 - g. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
 - h. T230, Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures.
 - i. T245, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
 - j. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus.
 - k. T247, Standard Method of Test for Preparation of Test Specimens of Bituminous Mixtures by Means of California Kneading Compactor.
 - l. T283, Standard Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage.
 - m. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate (Method A).
2. Asphalt Institute (AI):
 - a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
 - b. Superpave Series No. 2 (SP-2), Superpave Mix Design.

3. ASTM International (ASTM):
 - a. D2041, Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
 - b. D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - c. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
 - d. D5821, Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
 - e. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

1.02 DEFINITIONS

- A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.
- B. RAP: Reclaimed asphalt pavement.
- C. Standard Specifications: Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

1.03 DESIGN REQUIREMENTS

- A. Prepare asphalt concrete mix design, meeting the following design criteria, tolerances, and other requirements of Section 334 of the Standard Specifications.

1.04 SUBMITTALS

- A. Informational Submittals:
 1. Asphalt Concrete Mix Formula:
 - a. Submit minimum of 15 days prior to start of production.
 - b. Submittal to include the following information:
 - 1) Properties as stated in Section 334 of the Standard Specifications.
 2. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services, for the following materials:
 - a. Aggregate: Gradation, source test results as defined in Section 334 of the Standard Specifications.
 - b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
 - c. Prime Coat: Type and grade of asphalt.
 - d. Tack Coat: Type and grade of asphalt.
 - e. Additives.
 - f. Mix: Conforms to job-mix formula.

3. Statement of qualification for independent testing laboratory.
4. Test Results:
 - a. Mix design.
 - b. Asphalt concrete core.
 - c. Gradation and asphalt content of uncompacted mix.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

1.06 ENVIRONMENTAL REQUIREMENTS

- ##### A. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

- ##### A. Prime Coat: Cut-back asphalt, conform to Section 300 of the Standard Specifications.
- ##### B. Tack Coat: Emulsified asphalt, conform to Section 300 of the Standard Specifications.

2.02 ASPHALT CONCRETE MIX

A. General:

1. Mix formula shall not be modified except with written approval of Engineer.
2. Source Changes:
 - a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
 - b. Make adjustments in gradation or asphalt content as necessary to meet design criteria.

- ##### B. Asphalt Concrete: As specified in the Drawings in accordance with Section 334 of the Standard Specifications.

- C. Composition: Hot-plant mix of aggregate, mineral filler if required, and paving grade asphalt cement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of mix formula.
- D. Aggregate:
 - 1. General: As specified in Section 334 of the Standard Specifications.
- E. Mineral Filler: In accordance with Section 334 of the Standard Specifications.
- F. Asphalt Cement: Paving Grade as specified in Section 334 of the Standard Specifications.

PART 3 EXECUTION

3.01 GENERAL

- A. Traffic Control: Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

3.02 LINE AND GRADE

- A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.
- B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 APPLICATION EQUIPMENT

- A. In accordance with Section 320 of the Standard Specifications.

3.04 PREPARATION

- A. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.
- B. Existing Roadway:
 - 1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
 - 2. Remove existing material to a minimum depth of 25 millimeters (1 inch).
 - 3. Paint edges of meet line with tack coat prior to placing new pavement.
- C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.05 PAVEMENT APPLICATION

- A. General: Place asphalt concrete mixture on approved, prepared base in conformance with Section 330 of the Standard Specifications.
- B. Prime Coat:
 - 1. Heat cut-back asphalt as specified in Section 330 of the Standard Specifications, prior to application.
 - 2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
 - 3. Do not apply when moisture content of upper 75 millimeters (3 inches) of base exceeds optimum moisture content of base, or if free moisture is present.
 - 4. Remove or redistribute excess material.
 - 5. Allow a minimum of 5 full days for curing of primed surface before placing asphalt concrete.
- C. Tack Coat:
 - 1. Prepare material, as specified in Section 330 of the Standard Specifications, prior to application.
 - 2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
 - 3. Do not apply more tack coat than necessary for the day's paving operation.
 - 4. Touch up missed or lightly coated surfaces and remove excess material.
- D. Pavement Mix:
 - 1. Prior to Paving:
 - a. Sweep primed surface free of dirt, dust, or other foreign matter.
 - b. Patch holes in primed surface with asphalt concrete pavement mix.
 - c. Blot excess prime material with sand.
 - 2. Place asphalt concrete pavement mix as specified on the Drawings.
 - 3. Total Compacted Thickness: As shown.
 - 4. Apply such that meet lines are straight and edges are vertical.
 - 5. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
 - 6. Joints:
 - a. Offset edge of each layer a minimum of 150 millimeters (6 inches) so joints are not directly over those in underlying layer.
 - b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
 - c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.

7. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
8. After placement of pavement, seal meet line by painting a minimum of 150 millimeters (6 inches) on each side of joint with cut-back or emulsified asphalt. Cover immediately with sand.

E. Compaction: In accordance with Section 330 of the Standard Specifications.

F. Tolerances:

1. General: In accordance with Section 330 of the Standard Specifications.

3.06 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Application:

1. Patch Thickness: 75 millimeters (3 inches) or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 350 to 525 Newtons per linear centimeter (200 to 300 pounds per linear inch). Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 6 millimeters (1/4 inch) or minus 0 millimeter when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.07 FIELD QUALITY CONTROL

- A. General: Provide services of approved certified independent testing laboratory to conduct tests.
- B. Field Density Tests:
 - 1. Perform tests from cores or sawed samples in accordance with AASHTO T230 and AASHTO T166.
 - 2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
 - 3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.
- C. Testing Frequency:
 - 1. Quality Control Tests:
 - a. Asphalt Content, Aggregate Gradation: Once per every 400 mg (500 tons) of mix or once every 4 hours, whichever is greater.
 - b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 900 mg (1,000 tons) or once every 8 hours, whichever is greater.
 - 2. Density Tests: Once every 450 mg (500 tons) of mix or once every 4 hours, whichever is greater.

END OF SECTION

SECTION 32 31 13 CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
 - b. A313/A313M, Standard Specification for Stainless Steel Spring Wire.
 - c. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
 - d. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
 - e. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
 - f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - g. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
 - h. A824, Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use with Chain Link Fence.
 - i. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - j. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - k. C150, Standard Specification for Portland Cement.
 - l. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.
 - m. F552, Standard Terminology Relating to Chain Link Fencing.
 - n. F567, Standard Practice for Installation of Chain-Link Fence.
 - o. F626, Standard Specification for Fence Fittings.
 - p. F900, Standard Specification for Industrial and Commercial Swing Gates.
 - q. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
 - r. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

- s. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.
- t. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.

1.02 DEFINITIONS

- A. Terms as defined in ASTM F552.

1.03 SUBMITTALS

- A. Action Submittals:

- 1. Shop Drawings:
 - a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.
 - 1) Fence, gate posts, rails, and fittings.
 - 2) Chain link fabric.
 - 3) Gates and hardware.
- 2. Test Reports: Field test result for compliance of installation of chain link fence, gates.

- B. Informational Submittals:

- 1. Manufacturer's recommended installation instructions.
- 2. Evidence of Supplier and installer qualifications.

1.04 QUALITY ASSURANCE

- A. Design, supply of equipment and components, installation, and on-call service shall be product of individual company with record of installations meeting requirements specified.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.06 SCHEDULING AND SEQUENCING

- A. Complete necessary Site preparation and grading before installing chain link fence and gates.

- B. Interruption of Existing Utility Service: Notify owner of utility 72 hours prior to interruption of utility services. Do not proceed with interruption of utility service without written permission from utility owner.

1.07 SPECIAL GUARANTEE

- A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of the following items found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.
 - 1. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Deflection of fence fabric beyond limits.

PART 2 PRODUCTS

2.01 GENERAL

- A. Match style, finish, and color of each fence component with that of other fence components.

2.02 CHAIN LINK FENCE FABRIC

- A. Galvanized fabric conforming to ASTM A392, Type II, Class 1, 1.2 ounces per square foot; galvanized after weaving.
- B. Height: 72 inches, unless otherwise shown.
- C. Core Wire Gauge: No. 9.
- D. Pattern: 2-inch diamond-mesh.
- E. Diamond Count: Manufacturer's standard and consistent for fabric furnished of same height.
- F. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.
- G. Wires of Twisted Selvages:
 - 1. Twisted in a closed helix three full turns.
 - 2. Cut at an angle to provide sharp barbs that extend minimum 1/4 inch beyond twist.

2.03 POSTS

A. General:

1. Strength and Stiffness Requirements: ASTM F1043, heavy industrial fence except as modified in this section.
2. Round Steel Pipe, Schedule 40: ASTM F1083.
3. Roll-Formed Steel Shapes: Roll-formed from ASTM A1011/A1011M, Grade 45, High-Strength Low-Alloy steel.
4. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 34 inches.
5. Protective Coatings:
 - a. Zinc Coating: ASTM F1043, Type A external and internal coating.

B. Line Posts:

1. Round Steel Pipe:
 - a. Outside Diameter: 2.375 inches.
 - b. Weight: 3.65 pounds per foot.

C. End, Corner, Angle, and Pull Posts:

1. Round Steel Pipe:
 - a. Outside Diameter: 2.875 inches.
 - b. Weight: 5.79 pounds per foot.

D. Posts for Removable Fence Panels: As specified for end, corner, angle, and pull posts.

E. Posts for Swing Gates 8 Feet High and Under:

1. ASTM F900.
2. Round Steel Pipe:
 - a. Outside Diameter: 2.875 inches.
 - b. Weight: 4.64 pounds per foot.

2.04 TOP AND BRACE RAILS

A. Galvanized Round Steel Pipe:

1. ASTM F1083.
2. Outside Diameter: 1.66 inches.
3. Weight: 2.27 pounds per foot.

- B. Protective Coatings: As specified for posts.
- C. Strength and Stiffness Requirements: ASTM F1043, top rail, heavy industrial fence.

2.05 FENCE FITTINGS

- A. General: In conformance with ASTM F626, except as modified by this article.
- B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.
- C. Tension and Brace Bands: Vinyl-clad.
- D. Tension Bars:
 - 1. One-piece vinyl-clad.
 - 2. Length not less than 2 inches shorter than full height of chain link fabric.
 - 3. Provide one bar for each gate and end post, and two for each corner and pull post.
- E. Truss Rod Assembly: 3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- F. Tie Wires, Clips, and Fasteners: According to ASTM F626.

2.06 TENSION WIRE

- A. Zinc-coated steel marcelled tension wire conforming to ASTM A824, Type II, Class 2.

2.07 GATES

- A. General:
 - 1. Gate Operation: Opened and closed easily by one person.
 - 2. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.
 - 3. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.
 - 4. Gate Fabric Height: Same as for adjacent fence height.
 - 5. Welded Steel Joints: Paint with zinc-based paint.
 - 6. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
 - 7. Latches: Arranged for padlocking so padlock will be accessible from both sides of gate.

B. Swing Gates: Comply with ASTM F900 for single swing gate types.

1. Leaf Width: As shown.
2. Hinges: Offset type, malleable iron.
 - a. Furnished with large bearing surfaces for clamping in position.
 - b. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and not twist or turn under action of gate.
3. Latches: Plunger bar arranged to engage stop, except single gates of openings less than 10 feet wide may each have forked latch.
4. Gate Stops: Mushroom type or flush plate with anchors, suitable for setting in concrete.
5. Locking Device and Padlock Eyes: Integral part of latch, requiring one padlock for locking both leaves of double gate.
6. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in open position until manually released.

2.08 CONCRETE

- A. Provide as specified in Section 03 30 00, Cast-in-Place Concrete.

2.09 FENCE GROUNDING

- A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
1. Material above Finished Grade: Copper.
 2. Material on or below Finished Grade: Copper.
 3. Bonding Jumpers: Braided copper tape, 1-inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
- B. Connectors and Grounding Rods: Comply with UL 467.
1. Connectors for Below-Grade Use: Exothermic welded type.
 2. Grounding Rods: Copper-clad steel.

PART 3 EXECUTION

3.01 GENERAL

- A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.

- B. Provide necessary hardware for a complete fence and gate installation.
- C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

3.02 PREPARATION

- A. Clear area on either side of fence to the extent specified in Section 31 10 00, Site Clearing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.
- B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.
- C. Embedment Coating: Coat portion of galvanized or aluminum-coated steel posts that will be embedded in concrete as specified in Section 09 90 00, Painting and Coating. Extend coating 1 inch above top of concrete.

3.03 POST SETTING

- A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.
- B. Posthole Depth:
 - 1. Minimum 3 feet below finished grade.
 - 2. 2 inches deeper than post embedment depth below finish grade.
- C. Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.
- D. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.
- E. Before concrete sets, crown and finish top of concrete to readily shed water.

- F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
- G. Line Posts: Space line posts uniformly at 10 feet on centers between terminal end, corner, and gate posts.

3.04 POST BRACING

- A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.
 - 1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.05 TOP RAILS

- A. Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into rail end attached to posts or posts caps fabricated to receive rail at terminal posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.06 TENSION WIRE

- A. Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.
- B. Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

3.07 CHAIN LINK FABRIC

- A. Do not install fabric until concrete has cured minimum 7 days.
- B. Apply fabric to outside of enclosing framework. Pull fabric taut to provide a smooth and uniform appearance free from sag, without permanently distorting fabric diamond or reducing fabric height. Tie fabric to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

- C. Splicing shall be accomplished according to ASTM F1916 by weaving a single picket into the ends of the rolls to be joined.
- D. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated.
- E. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches on center.
- F. Tie Wires: Fasten ties to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends of tie wire three full twists, and cut off protruding ends to preclude untwisting by hand.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches on center and to brace and top rails at 24 inches on center.

3.08 GATES

- A. Install gates according to manufacturer's written instructions, level, plumb and secure for full opening without interference. Attach fabric and hardware to gate using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary so gates operate satisfactorily from open or closed position.

3.09 ELECTRICAL GROUNDING

- A. Ground fences at a maximum interval of 1,000 feet in accordance with applicable requirements of IEEE C2, National Electrical Safety Code.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.
- C. Grounding Method: At each grounding location, drive a grounding rod vertically until top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

3.10 FIELD QUALITY CONTROL

- A. Post and Fabric Testing: Test fabric tension and line post rigidity according to ASTM F1916.

B. Gate Tests:

1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.
2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.
3. Confirm that latches and locks engage accurately and securely without forcing and binding.

3.11 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, to train Owner's personnel to adjust, operate, and maintain gates.

3.12 CLEANUP

- A. Remove excess fencing materials and other debris from Site.

END OF SECTION

**SECTION 32 92 00
TURF AND GRASSES**

PART 1 GENERAL

1.01 DEFINITIONS

- A. Maintenance Period: Begin maintenance immediately after each area is planted (seed, sod) and continue for a period of 8 weeks after all planting under this section is completed.
- B. Standard Specifications: Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.
- C. Satisfactory Stand: Grass or section of grass of 10,000 square feet or larger that has:
 - 1. No bare spots larger than 3 square feet.
 - 2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
 - 3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.02 SUBMITTALS

- A. Action Submittals: Product labels/data sheets.
- B. Informational Submittals:
 - 1. Certification of sod; include source and harvest date of sod, and sod seed mix.
 - 2. Description of required maintenance activities and activity frequency.

1.03 DELIVERY, STORAGE, AND PROTECTION

- A. Sod:
 - 1. Do not harvest if sod is excessively dry or wet to the extent survival may be adversely affected.
 - 2. Harvest and deliver sod only after laying bed is prepared for sodding.
 - 3. Roll or stack to prevent yellowing.
 - 4. Deliver and lay within 24 hours of harvesting.
 - 5. Keep moist and covered to protect from drying from time of harvesting until laid.

1.04 WEATHER RESTRICTIONS

- A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 SEQUENCING AND SCHEDULING

- A. Complete Work under this section within 3 days following completion of soil preparation.
- B. Notify Engineer at least 3 days in advance of:
 - 1. Each material delivery.
 - 2. Start of planting activity.
- C. Planting Season: Those times of year that are normal for such Work as determined by accepted local practice.

1.06 MAINTENANCE SERVICE

- A. Contractor: Perform maintenance operations during maintenance period to include:
 - 1. Watering: Keep surface moist.
 - 2. Washouts: Repair by filling with soil, fertilizing, seeding, and mulching.
 - 3. Mulch: Replace wherever and whenever washed or blown away.
 - 4. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
 - 5. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
 - 6. Reseed/replant entire area if satisfactory stand does not develop by July 1 of the following year.

PART 2 PRODUCTS

2.01 FERTILIZER

- A. In accordance with Section 982 of the Standard Specifications.
- B. Application Rates: Determined by the manufacturer.
- C. Mix:
 - 1. Nitrogen: 12.
 - 2. Phosphoric Acid: 4.
 - 3. Potash: 8.

4. At least 50 percent of the phosphoric acid shall be from normal superphosphate or an equivalent source, which will provide a minimum of two units of sulphur.

2.02 SOD

- A. All sod shall be Bahia grass in accordance with Section 981 of the Standard Specifications. Sod shall be a minimum of 1-1/4-inch thick including a 3/4-inch thick layer of roots and topsoil.
- B. Strongly rooted pads, capable of supporting own weight and retaining size and shape when suspended vertically from a firm grasp on upper 10 percent of pad.
 1. Age: Not less than 10 months or more than 30 months.
 2. Condition: Healthy, green, moist; free of diseases, nematodes and insects, and of undesirable grassy and broadleaf weeds. Yellow sod, or broken pads, or torn or uneven ends will not be accepted.

2.03 WEED BARRIER

- A. 6 mils (0.006 inch) black polyethylene sheet.

PART 3 EXECUTION

3.01 PREPARATION

- A. Grade areas to smooth, even surface with loose, uniformly fine texture.
 1. Roll and rake, remove ridges, fill depressions to meet finish grades.
 2. Limit such Work to areas to be planted within immediate future.
 3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.
- B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.
- C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER

- A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.

3.03 SODDING

- A. Lay sod to form solid mass with tightly fitted joints; butt ends and sides, do not overlap.
 - 1. Stagger strips to offset joints in adjacent courses.
 - 2. Work from boards to avoid damage to subgrade or sod.
 - 3. Tamp or roll lightly to ensure contact with subgrade; work sifted soil into minor cracks between pieces of sod, remove excess to avoid smothering adjacent grass.
 - 4. Complete sod surface true to finished grade, even, and firm.
- B. Fasten sod on slopes to prevent slippage with wooden pins 6 inches long driven through sod into subgrade, until flush with top of sod. Install at sufficiently close intervals to securely hold sod.
- C. Water sod with fine spray immediately after planting. During first week, water daily or more frequently to maintain moist soil to depth of 4 inches.
- D. Apply top dress fertilizer at rate of 1 pound per 1,000 square feet.

3.04 FIELD QUALITY CONTROL

- A. 8 weeks after sodding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.
- B. If a satisfactory stand has not been established, Engineer will make another determination after written notice from Contractor following the next growing season.

END OF SECTION

SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
 - a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
 - c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. Florida Building Code, Fifth Edition (2015).
5. International Code Council (ICC):
6. International Building Code (IBC).
7. International Mechanical Code (IMC).
8. Manufacturers' Standardization Society (MSS):
 - a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
 - b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, hanger, guide, component, and anchor for piping. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

2. Calculations for each type of pipe support, attachment and anchor.
3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
2. Maintenance information on piping support system.

1.04 QUALIFICATIONS

- A. Piping support systems of pipes 24 inches or larger shall be designed and Shop Drawings prepared and sealed by a registered professional engineer in the state where the Work is to be installed.

1.05 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Wind loads in accordance with governing codes and as shown on Structural General Drawings.
3. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
 - a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
 - b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.

- C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.
- D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

PART 2 PRODUCTS

2.01 GENERAL

- A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.
- B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.
- C. Materials: In accordance with Table 1 and Table 2, attached as Supplements at end of section.

2.02 WALL BRACKETS, SUPPORTS, AND GUIDES

- A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):
 - 1. Anvil; Figure 199, 3,000-pound rating.
 - 2. B-Line; Figure B3067, 3,000-pound rating.
- B. Adjustable "J" hanger MSS SP 58, Type 5:
 - 1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
 - 2. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.
- C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches.
- D. Channel Type:
 - 1. Unistrut.
 - 2. Anvil; Power-Strut.
 - 3. B-Line; Strut System.
 - 4. Aickinstrut (FRP).

2.03 PIPE SADDLES

- A. Provide 90-degree to 120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchor bolts.
 - 1. In accordance with Standard Detail 4005-515.
 - 2. Sizes 20 inches through 60 inches, Piping Technology & Products, Inc.; Fig. 2000.
- B. Saddle Supports, Pedestal Type:
 - 1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
 - 2. Nonadjustable Saddle: MSS SP, Type 37 with U-bolt.
 - a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
 - b. B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.
 - 3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
 - a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
 - b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

2.04 CHANNEL TYPE SUPPORT SYSTEMS

- A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.
- B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.
- C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.
- D. Manufacturers and Products:
 - 1. B-Line; Strut System.
 - 2. Unistrut.
 - 3. Anvil; Power-Strut.
 - 4. Aickinstrut (FRP System).
 - 5. Enduro-Durostrut (FRP Systems).

2.05 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

2.06 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.07 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.
2. Bolt Length (Extension Above Top of Nut):
 - a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
 - b. Maximum Length: No more than a full nut depth above top of nut.

B. Dielectric Barriers:

1. Plastic coated hangers, isolation cushion, or tape.
2. Manufacturer and Products:
 - a. B-Line; B1999 Vibra Cushion.
 - b. B-Line; Iso Pipe, Isolation Tape.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Support piping connections to equipment by pipe support and not by equipment.
3. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
4. Support no pipe from pipe above it.
5. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.

6. Do not use adhesive anchors for attachment of supports to ceiling or walls.
7. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
8. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Piping Supported from Floors:
 - a. Saddle Supports:
 - 1) Pedestal Type, elbow and flange.
 - 2) Provide minimum 1-1/2-inch grout beneath baseplate.
 - b. Floor Mounted Channel Supports:
 - 1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
 - 2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
 - 3) Attach pipe to channel with clips or pipe clamps.
 - c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

- C. Saddles for Steel or Concrete Pipe: Provide 90-degree to 120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

D. Accessories:

1. Dielectric Barrier:
 - a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
 - b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

- A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

3.03 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Table 1: Nonchemical Areas.
2. Table 2: Chemical Areas.

END OF SECTION

Table 1 Nonchemical Areas	
Exposure Conditions	Support Material
All areas other than liquid ammonium sulfate storage area	Type 304 Stainless steel

Table 2 Chemical Areas		
Exposure Conditions	Support for Direct Exposure	Support for Remote Exposure
Liquid Ammonium Sulfate	Type 316 Stainless Steel	Type 316 Stainless Steel

SECTION 40 27 00 PROCESS PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:
1. Air Force: A-A-58092, Tape, Antiseize, Polytetrafluorethylene.
 2. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges.
 3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
 4. American Society of Mechanical Engineers (ASME):
 - a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
 - b. B1.20.1, Pipe Threads, General Purpose (Inch).
 - c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
 - d. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
 - e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
 - f. B16.9, Factory-Made Wrought Buttwelding Fittings.
 - g. B16.11, Forged Fittings, Socket-Welding and Threaded.
 - h. B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
 - i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
 - j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.
 - l. B16.25, Buttwelding Ends.
 - m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
 - n. B31.1, Power Piping.
 - o. B31.3, Process Piping.
 - p. B31.9, Building Services Piping.
 - q. B36.10M, Welded and Seamless Wrought Steel Pipe.
 5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personal Qualification and Certification in Nondestructive Testing.

6. American Water Works Association (AWWA):
 - a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
 - b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
 - d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - f. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
 - g. C153/A21.53, Ductile-Iron Compact Fittings.
 - h. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
 - i. C606, Grooved and Shouldered Joints.
7. American Welding Society (AWS):
 - a. Brazing Handbook.
 - b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
 - c. D1.1/D1.1M, Structural Welding Code - Steel.
 - d. QC1, Standard for AWS Certification of Welding Inspectors.
8. ASTM International (ASTM):
 - a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
 - d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - f. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
 - g. A139/A139M, Standard Specification for Electro-Fusion (Arc)–Welded Steel Pipe (NPS 4 Inches and Over).
 - h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
 - j. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

- k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
- l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
- m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- n. A197/A197M, Standard Specification for Cupola Malleable Iron.
- o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
- p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- q. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- r. A276, Standard Specification for Stainless Steel Bars and Shapes.
- s. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- t. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- u. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- v. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
- w. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
- x. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- y. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
- aa. A536, Standard Specification for Ductile Iron Castings.
- bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- cc. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
- dd. A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
- ee. A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.

- ff. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
- gg. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
- hh. B32, Standard Specification for Solder Metal.
- ii. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
- jj. B61, Standard Specification for Steam or Valve Bronze Castings.
- kk. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- ll. B75/B75M, Standard Specification for Seamless Copper Tube.
- mm. B88, Standard Specification for Seamless Copper Water Tube.
- nn. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
- oo. B462, Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
- pp. B464, Standard Specification for Welded UNS N08020 Alloy Pipe.
- qq. B474, Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe.
- rr. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
- ss. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
- tt. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
- uu. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
- vv. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
- ww. D1330, Standard Specification for Rubber Sheet Gaskets.
- xx. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- yy. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- zz. D2000, Standard Classification System for Rubber Products in Automotive Applications.

- aaa. D2310, Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- bbb. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- ccc. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- ddd. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- eee. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- fff. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
- ggg. D2996, Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- hhh. D3222, Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
- iii. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- jjj. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
- kkk. D4894, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.
- lll. D4895, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion.
- mmm. F423, Standard Specification for Polytetrafluoroethylene (PTFE) Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges.
- nnn. F436, Standard Specification for Hardened Steel Washers.
- ooo. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- ppp. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- qqq. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
- rrr. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
- sss. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- ttt. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

9. FM Global (FM).
10. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-43, Wrought and Fabricated Butt-Welding Fittings for Low-Pressure, Corrosion Resistant Applications.
11. NSF International (NSF):
 - a. ANSI 61: Drinking Water System Components - Health Effects.
 - b. ANSI 372: Drinking Water System Components - Lead Content.
12. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
13. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of:
 - a. Liquid surface or within 2 feet above top of liquid surface.]
 - b. Top of tank wall or under tank cover.

1.03 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
3. Thrust Restraints:
 - a. Design for test pressure shown in Piping Schedule.
 - b. Restrain all pressure pipes.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Fabricated Piping:
 - a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
 - b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.

2. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
3. Pipe Corrosion Protection: Product data.

B. Informational Submittals:

1. Flanged Pipe and Fittings: Manufacturer's product data sheets for gaskets including torquing requirements and bolt tightening procedures.
2. Pipe coating applicator certification.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Division 1, General Requirements Specifications, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPING

- A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as.

B. Diameters Shown:

1. Standardized Products: Nominal size.
2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.
3. Cement-Lined Steel Pipe: Lining inside diameter.

2.03 JOINTS

A. Flanged Joints:

1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.
2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

B. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

C. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
2. Thrust rated to 250 psi minimum.
3. Rated operating deflection not less than:
 - a. 3 degrees for sizes through 12 inches.
 - b. 2 degrees for sizes 14 inches through 16 inches.
 - c. 1.5 degrees for sizes 18 inches through 24 inches.
 - d. 1 degree for sizes 30 inches through 48 inches.
4. UL and FM approved.

D. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
 - a. Pipeline Products Corp.
 - b. Fernco Joint Sealer Co.

2.04 GASKET LUBRICANT

- A. Lubricant shall be supplied by pipe manufacturer and no substitute or “or-equal” will be allowed.

2.05 DOUBLE WALL CONTAINMENT PIPING SYSTEM

- A. For double contained piping use schedule 40 PVC conduits with long radius sweeps. Install a pull box for any runs that have more than 270-degree changes of direction.

- B. Pull through one solid piece of Chemfluor 367, scientific grade fluoropolymer tubing, by Saint-Gobain Performance Plastics. Tubing shall be one continuous piece throughout the full run from the chemical feed pumps to the injection point.
- C. Tubing connections shall be flared. Use PVDF FlareLINK fittings from Fit-LINE.

2.06 PIPE CORROSION PROTECTION

- A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.
- B. Heat Shrink Wrap:
 - 1. Type: Cross-linked polyolefin wrap or sleeve with mastic sealant.
 - 2. Manufacturer and Product: Raychem; WPC or TPS.
- C. Polyethylene Encasement (Bagging):
 - 1. Encasement Tube: Black polyethylene encasement tube, 8 mils minimum thickness, conforming to AWWA C105/A21.5, free of gels, streaks, pinholes, foreign matter, undispersed raw materials, and visible defects such as tears, blisters, and thinning at folds.
 - 2. Securing Tape: Thermoplastic tape, 8 mils minimum thickness, 1 inch wide, pressure sensitive adhesive face capable of bonding to metal, bituminous coating, and polyethylene encasement tube.
- D. Insulating Flanges, Couplings, and Unions:
 - 1. Materials:
 - a. In accordance with applicable piping material specified in Pipe Data Sheet. Complete assembly shall have ASME B31.3 working pressure rating equal to or higher than that of joint and pipeline.
 - b. Galvanically compatible with piping.
 - c. Resistant for intended exposure, operating temperatures, and products in pipeline.
 - 2. Union Type, 2 Inches and Smaller:
 - a. Screwed or solder-joint.
 - b. O-ring sealed with molded and bonded insulation to body.
 - 3. Flange Type, 2-1/2 Inches and Larger:
 - a. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
 - b. Bolt insulating sleeves shall be provided full length between insulating washers.
 - c. Ensure fit-up of components of insulated flange assembly to provide a complete functioning installation.

- d. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves.
- e. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of required washers, flanges, and gasket.
- 4. Flange Insulating Kits:
 - a. Gaskets: Full-face, Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
 - b. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA LI-1, G-10 grade).
 - c. Insulating Washers: Fiberglass-reinforced epoxy (NEMA LI-1, G-10 grade).
 - d. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
 - 1) Flange Diameters 36 Inches or Less: Provide two washers per bolt.
- 5. Manufacturers and Products:
 - a. Dielectric Flanges and Unions:
 - 1) PSI, Houston, TX.
 - 2) Advance Products and Systems, Lafayette, LA.

2.07 THRUST TIES

- A. Buried Ductile Iron Pipe and Fittings: Unless restraint is otherwise specified or shown, conform to NFPA 24. Tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

2.08 VENT AND DRAIN VALVES

- A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.
- B. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.09 FABRICATION

- A. Mark each pipe length on outside with the following:
 - 1. Size or diameter and class.
 - 2. Manufacturer's identification and pipe serial number.
 - 3. Location number on laying drawing.
 - 4. Date of manufacture.

- B. Code markings according to approved Shop Drawings.
- C. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

2.10 FINISHES

- A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.
- B. Galvanizing:
 - 1. Hot-dip applied, meeting requirements of ASTM A153/A153M.
 - 2. Electroplated zinc or cadmium plating is unacceptable.
 - 3. Stainless steel components may be substituted where galvanizing is specified.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.
- B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

- A. See Piping Schedule and Section 09 90 00, Painting and Coating, for additional requirements.
- B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.
- C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
- D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

3.03 WELDING

- A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.3 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.
- B. Weld Identification: Keep paper record of which welder welded each joint.
- C. Pipe End Preparation:
 - 1. Machine Shaping: Preferred.
 - 2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
 - 3. Beveled Ends for Butt Welding: ASME B16.25.
- D. Surfaces:
 - 1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
 - 2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
 - 3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.
- E. Alignment and Spacing:
 - 1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
 - 2. Root Opening of Joint: As stated in qualified welding procedure.
 - 3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1 inch, whichever is greater.
- F. Climatic Conditions: Do not perform welding if there is impingement of any rain, snow, sleet, or wind exceeding 5 mph on the weld area, or if ambient temperature is below 32 degrees F.
- G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.
- H. Surface Defects: Chip or grind out those affecting soundness of weld.
- I. Weld Quality: Meet requirements of governing welding codes.

3.04 INSTALLATION—GENERAL

- A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
- B. Remove foreign objects prior to assembly and installation.
- C. Flanged Joints:
 - 1. Install perpendicular to pipe centerline.
 - 2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
 - 3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
 - 4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
 - 5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
 - 6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
 - 7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
 - 8. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
 - 9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
 - 10. Manufacturer: Same as pipe manufacturer.
- D. Threaded and Coupled Joints:
 - 1. Conform to ASME B1.20.1.
 - 2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
 - 3. Countersink pipe ends, ream and clean chips and burrs after threading.
 - 4. Make connections with not more than three threads exposed.
 - 5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.
- E. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

F. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

G. Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
2. Dressing Cut Ends:
 - a. General: As required for the type of joint to be made.
 - b. Rubber Gasketed Joints: Remove sharp edges or projections.
 - c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
 - d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

3.05 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. From Adjacent Work: Minimum 2 inches from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.06 INSTALLATION—BURIED PIPE

A. Joints:

1. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown.

B. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.

8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
 - a. Shorter pipe lengths.
 - b. Special mitered joints.
 - c. Standard or special fabricated bends.
10. After joint has been made, check pipe alignment and grade.
11. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
12. Prevent uplift and floating of pipe prior to backfilling.

C. PVC, CPVC, or HDPE Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

1. Deflection from Horizontal Line, Except PVC, CPVC, or HDPE: Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4 inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.07 INSTALLATION—CONCRETE ENCASED

- A. Provide reinforced concrete pipe encasement where shown on Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs, and other structures shall be concrete encased. See details on Drawings for encasement requirements.
- B. Where concrete encased piping crosses structure construction and expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.08 PIPE CORROSION PROTECTION

A. Ductile Iron Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule.
2. Buried: Wrap with polyethylene bagging.
3. Submerged or Embedded: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF/ANSI 61 approved epoxy.

B. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

C. Piping Accessories:

1. Exposed:
 - a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.
 - b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
2. Buried:
 - a. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating.
 - b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
 - c. Flexible Couplings and Similar Items: Wrap with heat shrink wrap.
 - d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.
 - e. Cement-Coated Pipelines: Cement coat appurtenances, same as pipe.

D. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer's instructions.

E. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.

F. Heat Shrink Wrap: Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

G. Insulating Flanges, Couplings, and Unions:

1. Applications:
 - a. Dissimilar metal piping connections, including connection between ductile iron and stainless steel.
 - b. Where required for electrically insulated connection.
2. Pipe Installation:
 - a. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
 - b. Align and install insulating joints as shown on the Drawings and according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.09 THRUST RESTRAINT

A. Location:

1. Buried Piping: At all joints in piping.
2. Exposed Piping: At all joints in piping.

B. Thrust Ties:

1. Steel Pipe: Attach with lugs fabricated in accordance with details shown on Drawings.
2. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
3. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through coupling sleeve or use dismantling joints.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping:
Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or mechanical joint anchor gland follower.

3.10 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.11 BRANCH CONNECTIONS

- A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.
- B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.
- C. Threaded Pipe Tap Connections:
 - 1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
 - 2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
 - 3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.12 VENTS AND DRAINS

- A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines as shown.

3.13 FIELD FINISHING

- A. Notify Engineer at least 3 days prior to start of surface preparation or coating application work.
- B. As specified in Section 09 90 00, Painting and Coating.

3.14 PIPE IDENTIFICATION

- A. As specified in Section 09 90 00, Painting and Coating.

3.15 FIELD QUALITY CONTROL

- A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.

3.16 CLEANING

- A. Following assembly and testing, and prior to final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

- B. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.
- C. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.17 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are a part of this Specification:

- 1. Piping Schedule Legend.
- 2. Piping Schedule.
- 3. Data Sheets.

Number	Title
40 27 00.01	Cement-Mortar Lined Ductile Iron Pipe and Fittings
40 27 00.08	Stainless Steel Pipe and Fittings—General Service
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings

END OF SECTION

PIPING SCHEDULE LEGEND**SERVICE**

DR	Drain
LAS	Liquid Ammonium Sulfate
OF	Overflow
PW	Potable Water
RW	Reuse Water
SA	Sample
V	Vents

EXPOSURE

ALL	All
BUR	Buried
EXP	Exposed
SUB	Submerged
ENC	Concrete Encased

MATERIAL

CLDI	Cement-Lined Ductile Iron
DWCP	Double Wall Containment Pipe
PVC	Polyvinyl Chloride
SST	Stainless Steel

JOINT TYPE

FL	Flanged
PRJ	Proprietary Restrained
S	Screwed
W	Welded (including solvent and fusion)

PRESSURE TEST

G	Gravity Service: Test pressure is not shown on gravity services. Test to highest liquid level that pipe can be subject to.
H	Hydrostatic
NA	Not Applicable

Piping Schedule										
Service	Legend	Size(s) (In.) ¹	Exposure	Piping Material	Specification Section	Joint Type	Coating ²	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color and Label	Remarks
Drain	DR	All	All	PVC	40 27 00.10	W	System No.25	G		
Liquid Ammonium Sulfate	LAS	All	All	PVC	40 27 00.10	W	System No.25	H/100		Upstream of Metering Pump Skids, on Pump Skids, and upstream of pipe to tubing transition points shown on drawings
		All	All	DCWP	40 27 00 Paragraph 2.05	Solvent weld conduit/ tubing fittings	NA	H/100		Downstream of pipe to tubing transition points shown on drawings
Overflow	OF	All	All	PVC	40 27 00.10	W	System No. 25	NA		
Potable Water	PW	All	All	PVC	40 27 00.10	W	System No. 25	H/150		
Reuse Water	RW	All	EXP	CLDI	40 27 00.01	F	System No. 4	H/150	Purple	
		All	BUR	CLDI	40 27 00.01	PRJ		H/150	NA	
Sample	SA	All	All	PVC	40 27 00.10	W, S	System No. 25	H/150		
Vents	V	All	All	PVC	40 27 00.10	F,W	System No. 25	NA		

Piping Schedule										
Service	Legend	Size(s) (In.) ¹	Exposure	Piping Material	Specification Section	Joint Type	Coating ²	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color and Label	Remarks
Drain	DR	All	All	PVC	40 27 00.10	W	System No.25	G		
¹ “>” Greater Than “<” Less Than “<=” Less Than or Equal To “>=” Greater Than or Equal To “All” All Sizes ² Coating system number as specified in Section 09 90 00, Painting and Coating, and as specified in Article Pipe Corrosion Protection.										

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	Description
General	<p>Materials in contact with potable water shall conform to NSF 61 acceptance.</p> <p>Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of the specified diameters, dimensions, and standards for a period of not less than 10 years.</p> <p>Testing of pipe required by AWWA A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).</p>
Pipe	<p>Buried Liquid Service Using Proprietary Restrained Joints: AWWA C111/A21.11, and AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron.</p> <p>Buried Air Service Using Proprietary Restrained Joints: AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron.</p> <p>Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.</p>
Lining	<p>Cement-mortar: AWWA C104/A21.4.</p> <p>Glass: Completely fused above 1,400 degrees F, 6 mils to 10 mils thick, defects which expose base metal not greater than 0.01 percent of total lined surface, hardness greater than 5 on the Mohs scale, lining bonded sufficiently to withstand a metal strain of 0.001 inch/inch without damage to the glass lining, finished lined pipe not to deviate more than 0.0125 inch per foot of length from a centerline perpendicular to the flange face or square end of the pipe. Fast Fabricators, Inc., Ferrock MEH-32; Ceramic Coating Co., SL-31; VITCO Corp., SG-14.</p>

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	Description
Fittings	<p>Lined and coated same as pipe.</p> <p>Proprietary Restrained: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, ductile iron, 250 psi minimum working pressure. Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell or fitting sizes smaller than 16 inches may be mechanical joint, restrained by anchor gland followers, ductile iron anchor type, wedge action, with break-off tightening bolts. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall be not less than 1/2 degree for 42-inch and larger pipe. Clow Corp., American Cast Iron Pipe Co., U.S. Pipe. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted.</p> <p>Grooved End: AWWA C606 and AWWA C110/A21.10, ductile iron, 250 psi minimum working pressure; Victaulic.</p> <p>Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.</p>
Joints	<p>Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex.</p> <p>Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic.</p> <p>Flange: Class 125 flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed.</p> <p>Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.</p>
Couplings	<p>Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.</p> <p>Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.</p>

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	Description
Bolting	<p>Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard.</p> <p>Class 125 Flat-Faced Flange: ASTM A307, Grade A carbon steel hex head bolts, ASTM A563, Grade A carbon steel hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p>
Gaskets	<p>General: Gaskets in contact with potable water shall be NSF 61 certified.</p> <p>Proprietary Restrained Joints; Water and Sewage Service: Rubber conforming to AWWA C111/A21.11.</p> <p>Flanged, Water, Sewage and Hot Air Services: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000 4CA 415 A25 B35 C32 EA14 F19.</p> <p>Full face for Class 125 flat-faced flanges, flat-ring type for Class 250 raised-face flanges. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.</p> <p>Gasket pressure rating to equal or exceed the system hydrostatic test pressure.</p>
Joint Lubricant	Manufacturer's standard.

END OF SECTION

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Pipe	2-1/2" & smaller 3" thru 6" 8" & larger	Schedule 40S: ASTM A312/A312M, Type 316 seamless, pickled and passivated. Schedule 10S: ASTM A312, "as-welded" grade, Type 316L, pickled and passivated. Schedule 5S: ASTM A312, "as-welded" grade, Type 316L, pickled and passivated.
Tubing	All	ASTM A269, Type 316 stainless steel, seamless, fully annealed hydraulic tubing, 0.065-inch wall thickness minimum.
Joints	1-1/2" & smaller 2" & larger	Threaded or flanged at equipment as required or shown. Butt-welded or flanged at valves and equipment.
Tubing Joints	All	Flareless compression fitting
Fittings	1-1/2" & smaller 2" & 2-1/2" 3" & larger	Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F316 or cast Class 150, ASTM A351/A351M, Grade CF8/304, CF8M/316. Butt Welded: ASTM A403/A403M, Grade WP316L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise. Butt-Welded: ASTM A403/A403M Grade 316L conforming to MSS SP 43, "as-welded" grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
Tubing Fittings	All	Flareless Compression Type Forged: ASTM A182/A182M, Grade F316, Parker-Hannifin Ferulok, Flodar BA Series.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Branch Connections	1-1/2" & smaller	Tee or reducing tee in conformance with fittings above.
	2" & larger	Butt-welding tee or reducing tee in accordance with fittings above.
Tubing Branch Connections	All	Compression type tees or reducing tees in accordance with Tubing Fittings above.
Flanges	All	<p>Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside.</p> <p>Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150 or Class 300 Van Stone Type with stainless steel stub ends, ASTM A240 Type 316L "as-welded grade", conforming to MSS SP 43, wall thickness same as pipe.</p> <p>Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.</p>
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Bolting	All	<p>Forged Flanges: Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p> <p>Van Stone Flanges and anywhere mating flange on equipment is cast iron and gasket is flat ring: Carbon steel ASTM A307 Grade B hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p> <p>Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts and ASTM A194/A194M, Grade 8M hex nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.</p>
Gaskets	All Flanges	<p>Flanged, Water, Hot Air, Fuel Gas and Sewage Services: 1/8 inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade.</p> <p>Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.</p>
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE Teflon tape.

END OF SECTION

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	Size	Description
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	Size	Description
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
 - b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
2. American Water Works Association (AWWA):
 - a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
 - b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
 - c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
 - f. Manual M11, Steel Pipe—A Guide for Design and Installation.
3. ASTM International (ASTM):
 - a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
5. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).
2. Metal Bellows Field Finishing:
 - a. Manufacturer's recommended weld procedures for joining welded carbon steel piping to stainless steel bellows.

- b. Welder qualifications for joining welded carbon steel piping to stainless steel bellows.
 - c. Product data for field-applied System No. 4, high temperature, epoxy lining and coating in accordance with Section 09 90 00, Painting and Coating.
- 3. Chemical Injectors:
 - a. Type, size, quantity, materials, and model number of each.
 - b. Sketch of each showing major parts, main pipe, and dimensions.
 - c. Details and model number of each support system and component.
 - d. Details and model of connects (for example, service saddle, weld-o-let).

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.
- B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.
- C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 CONNECTORS

- A. Quick Connect Couplings for Chemical Services:
 - 1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
 - 2. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the service by manufacturer.
 - 3. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.
 - 4. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.

5. Pressure Rating: 125 psi, minimum, at 70 degrees F.
6. Manufacturers and Products:
 - a. OPW; Kamlok.
 - b. Ryan Herco; 1300 Series.

2.03 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 psi.
3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on Drawings.
5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flanged Coupling Adapter:

1. Anchor studs penetrating pipe is not allowed.
2. Manufacturers and Products:
 - a. Ductile Iron Pipe:
 - 1) Dresser Piping Specialties; Style 128.
 - 2) Smith-Blair, Inc.; Style 911.

C. Restrained Flange Adapter:

1. Pressure Rating:
 - a. Minimum Working Pressure Rating: Not less than 150 psi.
 - b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
2. Thrust Restraint:
 - a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
 - b. Products employing set screws that bear directly on pipe will not be acceptable.
3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.
 - a. 1500.
 - b. Proco Products, Inc.; Series 251.

2.04 SERVICE SADDLES

A. Double-Strap Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Taps: Iron pipe threads.
4. Materials:
 - a. Body: Malleable or ductile iron.
 - b. Straps: Galvanized steel.
 - c. Hex Nuts and Washers: Steel.
 - d. Seal: Rubber.
5. Manufacturers and Products:
 - a. Smith-Blair; Series 313 or 366.
 - b. Dresser; Style 91.

2.05 PIPE SLEEVES

A. Molded Polyethylene Pipe Sleeve:

1. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.
2. Provided with end caps for support during concrete placement.
3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal.

B. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication:
 - a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
 - b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.06 CHEMICAL INJECTOR SYSTEM

A. Chemical Injectors:

1. Type, size, quantity, and materials as shown on Drawings and Standard Details.
2. Manufacturer: SAF-T-FLO.

B. Support System:

1. Stainless steel Unistrut or FRP Aickenstrut.
2. Materials compatible with chemical service and subject to Engineer approval.

C. Connectors: Stainless steel service saddle or weld-o-let, as shown on Drawings.

2.07 MISCELLANEOUS SPECIALTIES

A. Strainers, Plastic Piping Systems, 4 Inches and Smaller:

1. Type: Y-pattern PVC body, 150 psi nonschock rated, with screwed PVC cap and Viton seals.
2. End Connections: Screwed or solvent weld, 2 inches and smaller. Class 150 ANSI flanged, 2-1/2 inches and larger.
3. Screen: Heavy-gauge PVC, 1/32-inch mesh, minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturer: Hayward.

B. Emergency Showers and Eyewashes:

1. SSH-1, Safety Shower/Eyewash Combination (All Stainless Steel):
 - a. Model: Haws Drinking Faucet Co.; Model 8330.
 - b. Shower: Stainless steel deluge.
 - c. Eyewash: Stainless steel aerated eye/face wash and stainless steel bowl.
 - d. Valve: Stay open.
 - e. Support: Freestanding, 1-1/4-inch stainless steel pipe standard, stanchion, and floor flange.
 - f. Stainless steel scald protection bleed valve, Model SP157A.
 - g. Flow Switch: Sense flow in the inlet pipeline and switch a set of contacts when the flow is positive. Bronze body, 1-1/2 inches, single-pole, double-throw, 120V, 5 amps; Magnetrol F50, NEMA 4X or equal.
 - h. Provide insulation and jacket where safety shower is exposed to direct sunlight.

2. Manufacturers:
 - a. Haws.
 - b. Western.
 - c. Guardian.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

- A. General:
 1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.
 2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.
- B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.
- C. Flexible Joints at Concrete Structures:
 1. Install 18 inches or less from face of structures; joint may be flush with face.
 2. Install a second flexible joint, whether or not shown.
 - a. Pipe Diameter 18 Inches and Smaller: Within 18 inches of first joint.
 - b. Pipe Diameter Larger than 18 Inches: Within two to three pipe diameter of first joint.

3.03 PIPING TRANSITION

- A. Applications:
 1. Provide complete closure assembly where pipes meet other pipes or structures.
 2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
 3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown.
 4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.

5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
2. Concrete Closures:
 - a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
 - b. Clean pipe surface before placing closure collars.
 - c. Wet nonmetallic pipe thoroughly prior to pouring collars.
 - d. Prevent concrete from entering pipe.
 - e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.
 - f. Make entire collar in one placement.
 - g. After concrete has reached initial set, cure by covering with well-moistened earth.

3.04 SERVICE SADDLES

- A. Ferrous Metal Piping (except stainless steel): Double-strap iron.
- B. Plastic Piping: Nylon-coated iron.

3.05 OUTLET/TAPPING SADDLE

- A. Install in accordance with manufacturer's written instructions.

3.06 COUPLINGS

- A. General:
 1. Install in accordance with manufacturer's written instructions.
 2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
 3. Do not remove pipe coating. If damaged, repair before joint is made.
 4. Application:
 - a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
 - b. Concrete Encased Couplings: Flexible coupling.

3.07 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

- A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.
- B. Product Applications Unless Shown Otherwise:
 - 1. Nonmetallic Piping: Teflon bellows connector.
 - 2. Copper Piping: Flexible metal hose connector.
 - 3. Compressor and Blower Discharge: Metal bellows connector.
 - 4. All Other Piping: Elastomer bellows connector.
- C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.08 PIPE SLEEVES

- A. Application:
 - 1. As specified in Section 40 27 00, Process Piping—General.
 - 2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.
 - 3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
 - 4. Alternatively, Molded Polyethylene Pipe Sleeve as specified may be applied.
- B. Installation:
 - 1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
 - 2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

3.09 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

- A. Applications:
 - 1. Watertight and Below Ground Penetrations:
 - a. Wall pipes with thrust collars.
 - b. Provide taps for stud bolts in flanges to be set flush with wall face.
 - 2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
 - 3. Existing Walls: Rotary drilled holes.
 - 4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09 90 00, Painting and Coating.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.10 CHEMICAL INJECTOR SYSTEM

- A. Install in accordance with manufacturer's instructions.

3.11 MISCELLANEOUS SPECIALTIES

- A. Emergency showers and eyewashes:

1. System Shutoff Valves:
 - a. Shutoff valves shall give visual indication of position (open or closed).
 - b. Shutoff valves shall be lockable valves and locked in open position.
2. Each safety shower, eyewash, combination safety shower/eyewash shall have red safety signoff tag. After completing requirements listed below, Contractor and Owner shall sign red safety signoff tag. Requirements are as follows:
 - a. Visually check safety shower/eyewash piping for leaks.
 - b. Verify that upon operation, stay-open valves remain open.
 - c. Showerheads to be between 82 inches and 96 inches above standing surface.
 - d. Shower spray pattern, when valve is full open, shall be a minimum 20 inches in diameter at 60 inches above standing surface.
 - e. Water arcs from eyewash spray heads must cross. Test with eyewash gauge; Haws Drinking Faucet Co., Model 9015.
 - f. Minimum flow rates for safety showers shall be 20 gpm.
 - g. Minimum flow rates for eyewashes shall be 3 gpm.

END OF SECTION

SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Gas Association (AGA): 3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.
2. American National Standards Institute (ANSI): Z21.15, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
3. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - b. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi.
4. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
5. American Water Works Association (AWWA):
 - a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - b. C500, Metal-Seated Gate Valves for Water Supply Service.
 - c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
 - d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
 - e. C509, Resilient-Seated Gate Valves for Water Supply Service.
 - f. C510, Double Check Valve Backflow Prevention Assembly.
 - g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
 - h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
 - i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
 - j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
 - k. C542, Electric Motor Actuators for Valves and Slide Gates.
 - l. C550, Protective Interior Coatings for Valves and Hydrants.
 - m. C606, Grooved and Shouldered Joints.
 - n. C800, Underground Service Line Valves and Fittings.

6. ASTM International (ASTM):
 - a. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - e. B61, Standard Specification for Steam or Valve Bronze Castings.
 - f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
 - h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
 - i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
 - j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
 - k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
 - l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
 - m. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
 - n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
7. Canadian Standards Association, Inc. (CSA): 9.1, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
8. Chlorine Institute (CI): Pamphlet 6, Piping Systems for Dry Chlorine.
9. FM Global (FM).
10. Food and Drug Administration (FDA).
11. International Association of Plumbing and Mechanical Officials (IAPMO).
12. Manufacturers Standardization Society (MSS):
 - a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
 - b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
 - c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
 - d. SP-88, Diaphragm Valves.
 - e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

13. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
14. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
15. Underwriters Laboratories (UL).
16. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Power and control wiring diagrams, including terminals and numbers.
 - d. For each power actuator provided, manufacturer's standard data sheet, with application specific features and options clearly identified.
 - e. Sizing calculations for open-close/throttle and modulating valves.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, for:
 - a. Electric actuators; full compliance with AWWA C542.
 - b. Butterfly valves; full compliance with AWWA C504.
2. Tests and inspection data.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
4. Manufacturer's Certificate of Proper Installation.

PART 2 PRODUCTS

2.01 GENERAL

- A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.
- B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

- C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.
- D. Valve ends to suit adjacent piping.
- E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.
- F. Size operators and actuators to operate valve for full range of pressures and velocities.
- G. Valve to open by turning counterclockwise, unless otherwise specified.
- H. Factory mount operator, actuator, and accessories.
- I. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SCHEDULE

- A. Additional requirements relative to this section are shown on Electric Motor Actuated Valve Schedule and Self-Regulated Valve Schedule located at the end of this section.

2.03 MATERIALS

- A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.
 - 1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
 - 2. Stainless steel Alloy 18-8 may be substituted for bronze.

B. Valve materials in contact with or intended for drinking water service to meet the following requirements:

1. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
2. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.

2.04 FACTORY FINISHING

A. General:

1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.
3. Material in contact with potable water shall conform to NSF/ANSI 61.
4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be "safety yellow."

B. Where epoxy lining and coating are specified, factory finishing shall be as follows:

1. In accordance with AWWA C550.
2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as "fusion" or "fusion bonded" epoxy.
3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.05 VALVES

A. Gate Valves:

1. Type V135 Resilient Seated Ductile Iron Gate Valve 3 Inches to 36 Inches:
 - a. Ductile iron body, resilient seat, bronze stem and stem nut, mechanical joint ends, nonrising stem, in accordance with AWWA C515, minimum design working water pressure 200 psig, full port, fusion epoxy coated inside and outside per AWWA C550.
 - b. Manufacturers and Products:
 - 1) American Flow Control; Series 2500.
 - 2) M&H; Style 7000 and C515 Large RW Valves.

B. Ball Valves:

1. Type V306 Stainless Steel Ball Valve 2 Inches and Smaller:
 - a. Two-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end piece, NPT threaded ends, ASTM A276 Type 316 stainless steel ball, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 1,000 psig CWP, complies with MSS SP-110.
 - b. Manufacturers and Products:
 - 1) Conbraco Apollo; 76F-100 Series.
 - 2) Nibco; T-585-S6-R-66-LL.
2. Type V330 PVC Ball Valve 4 Inches and Smaller:
 - a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Provide pressure relief hole drilled on low pressure side of ball for ammonium sulfate services.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru-Bloc.
 - 2) ASAHI/America; Type 21.

C. Butterfly Valves:

1. General:
 - a. In full compliance with AWWA C504 and following requirements:
 - 1) Suitable for throttling operations and infrequent operation after periods of inactivity.
 - 2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
 - 3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
 - 4) No travel stops for disc on interior of body.
 - 5) Self-adjusting V-type or O-ring shaft seals.
 - 6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
 - 7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.

- 8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
- 9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.
- 2. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
 - a. AWWA C504, Class 150B.
 - b. Short body type, flanged ends.
 - c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, EPDM rubber seat bonded or molded in body only, and stainless steel seating surface.
 - d. Provide epoxy lining and coating in compliance with AWWA C550.
 - e. Manufacturers and Products:
 - 1) Pratt; Model 2FII or Triton XR-70.
 - 2) DeZurik; AWWA Valve.
- 3. Type V520 Solid Polyvinyl Chloride Butterfly Valve 1-1/2 Inches to 8 Inches:
 - a. Wafer body type, pressure rated 150 psi at 70 degrees F CWP, solid ASTM D1784, Type I, Grade 1, PVC body and contoured PVC or polypropylene valve disc, stainless steel valve stem, Viton seat, lever operator.
 - b. Manufacturers and Products:
 - 1) ASAHI/America; Type 57.
 - 2) Spears.

D. Check and Flap Valves:

- 1. Type V608 Swing Check Valve 2 Inches to 24 Inches:
 - a. AWWA C508, 125-pound flanged ends, cast-iron body, bronze body seat, bronze mounted cast-iron clapper with rubber facing, stainless steel hinge shaft.
 - b. Valves, 2 inches through 12 inches rated 175-pound WWP and 14 inches through 24 inches rated 150-pound WWP. Valves to be fitted with adjustable outside lever and weight. Increasing-pattern body valve may be used where increased outlet piping size is shown.
 - c. Manufacturers and Products:
 - 1) M&H Valve; Style 59, 159, or 259.
 - 2) Mueller Co.; No. A-2600 Series.
- 2. Type V630 PVC Ball Check Valve 4 Inches and Smaller:
 - a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 150 psi at 73 degrees F, and Viton seat and seal.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru Union.
 - 2) ASAHI/America.
 - 3) Spears; True Union.

3. Type V640 Double Check Valve Backflow Prevention Assembly
3/4 Inch to 10 Inches:
 - a. Two resilient seated check valves, two outside screw and yoke resilient-seated isolation valves, test cocks, in accordance with AWWA C510, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
 - b. Manufacturers and Products:
 - 1) FEBCO; Model 850.
 - 2) Danfoss Flomatic; Model DCVE/DCV.
 - 3) Watts; Series 007/709.

E. Self-Regulated Automatic Valves:

1. Type V720 PVC Pressure Relief, By-Pass Relief, Back-Pressure Regulator, Back-Pressure, Anti-Siphon Valve 1/2 Inch to 2 Inches:
 - a. Direct acting diaphragm, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
 - b. PVC body, Teflon or Viton diaphragm, PVC or Teflon piston, high-density polyethylene or stainless steel adjusting bolt and locknut, stainless steel or coated steel spring, stainless steel fasteners.
 - c. Designed to open when upstream pressure reaches setpoint; set pressure adjustable from 10 psi to 100 psi, minimum.
 - d. Manufacturers and Products:
 - 1) Plast-O-Matic; Series RVDT.
 - 2) Griffco; Series BPV.
 - 3) Primary Fluid Systems; TOP Valve.
2. Type V740 Air and Vacuum Valve 1/2 Inch to 16 Inches:
 - a. 1/2-inch through 3-inch NPT inlets and outlets, 4-inch and larger ASME B16.1 Class 125 flanged inlet with plain outlet and protective hood.
 - b. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.
 - c. Manufacturers and Products:
 - 1) APCO Valve and Primer Corp.; Series 140 or 150.
 - 2) Val-Matic Valve; Series 100.
3. Type V744 Air Release Valve 1/2 Inch to 2 Inches:
 - a. Suitable for water service, automatically exhaust small amounts of entrained air that accumulates in a system. In CLOSED position, seat against resilient seat to prevent water leakage.
 - b. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, NPT threaded inlet and outlet, built and tested to AWWA C512.

- c. Manufacturers and Products:
 - 1) APCO Valve and Primer Corp.; Series 50, 200, and 200A.
 - 2) Val-Matic Valve; Series 15A to 45.6.

2.06 OPERATORS AND ACTUATORS

A. Manual Operators:

- 1. General:
 - a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
 - b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
 - c. Operator self-locking type or equipped with self-locking device.
 - d. Position indicator on quarter-turn valves.
 - e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.
- 2. Exposed Operator:
 - a. Galvanized and painted handwheel.
 - b. Cranks on gear type operator.
 - c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
 - d. Valve handles to take a padlock, and wheels a chain and padlock.
- 3. Buried Operator:
 - a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
 - b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
 - c. Buried valves shall have extension stems, bonnets, and valve boxes.

B. Electric Operators, 120 Volts:

- 1. General:
 - a. Unit shall be low profile to reduce amount of required space and weigh 15 pounds or less.

- b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of the valve.
 - c. Provide operator mounting bracket to mount operator to valve providing minimal torque to piping system when operating.
- 2. Operator Operation, General:
 - a. Suitable for full 90-degree rotation of quarter-turn valves.
 - b. Manually override handwheel.
 - c. Mechanical valve position indication.
- 3. Electronic Control:
 - a. Torque Limiting Switches: Two single pole, double throw mechanical switches. Switches operate at any point in valve travel.
 - b. Jammed-valve detection and protection.
 - c. Motor over-temperature detection and protection.
 - d. Travel limit switches, single pole double throw.
 - e. Remote Indication and Control:
 - 1) Relay contact that closes when valve is capable of being controlled remotely (L-O-R switch in REMOTE) for connection to and monitoring by plant control system.
 - 2) Limit switch that closes when valve is fully OPENED for connection to and monitoring by plant control system.
 - 3) Limit switch that closes when valve is fully CLOSED for connection to and monitoring by plant control system.
 - f. Modulating (M) Service:
 - 1) Operator rated for continuous duty with servo shall be rated for 100 percent modulating operation.
 - 2) Operator shall modulate based on an externally applied 4 mA to 20 mA dc signal.
 - 3) Operator shall be equipped with an electronic servo module for valve modulation.
 - a) Module shall provide serial communications with provided cable for setup of valve operation.
 - g. Local Indication and Control:
 - 1) Integral mechanical valve POSITION indication, 0 percent to 100 percent OPENED.
 - 2) Integral OPENED and CLOSED indication lights.
 - 3) Integral LOCAL-OFF-REMOTE (L-O-R).
 - 4) Integral OPEN momentary switch which causes valve to stroke towards OPENED, as long as OPEN switch is held, while L-O-R switch is in LOCAL.
 - 5) Integral CLOSE momentary switch which causes valve to stroke towards CLOSED, as long as CLOSED switch is held, while L-O-R switch is in LOCAL.
 - 6) Position valve proportionally 0 to 100 percent OPEN with external 4 mA to 20 mA dc signal while in REMOTE.

- h. Remote Indication and Control:
 - 1) Relay contact that closes when valve is capable of being controlled remotely (L-O-R switch in REMOTE) for connection to and monitoring by plant control system.
 - 2) Limit switch that closes when valve is fully OPENED for connection to and monitoring by plant control system.
 - 3) Limit switch that closes when valve is fully CLOSED for connection to and monitoring by plant control system.
 - 4) Current Position Transmitter, 4 mA to 20 mA dc signal in proportion to 0 percent to 100 percent OPENED, with 0.5 percent accuracy and 0.5 percent repeatability, capable of driving a 750-ohm load, for connection to and monitoring by Plant Control System.
- 4. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.
- 5. Manufacturer and Product: Rotork; EIM; or equal.

2.07 ACCESSORIES

- A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each electric actuated valve operator, bearing valve tag number shown on Electric Actuated Valve Schedule.
- B. Limit Switch:
 - 1. Factory installed NEMA 4X limit switch by actuator manufacturer.
 - 2. SPST, rated at 5 amps, 120 volts ac.
- C. T-Handled Operating Wrench:
 - 1. One each galvanized operating wrenches, 4 feet long.
 - 2. Manufacturers and Products:
 - a. Mueller; No. A-24610.
 - b. Clow No.; F-2520.
- D. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.
- E. Cast-Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 5-1/4-inch ID shaft.
 - 1. Box: Cast iron with minimum depth of 9 inches.
 - 2. Lid: Cast iron, minimum depth 3 inches nonlocking type, marked DRAIN.
 - 3. Extensions: Cast iron.

4. Two-piece box and lid for valves 4 inches through 12 inches, three-piece box and lid for valves larger than 12 inches with base sized for valve.
5. Valve extension stem for valves with operating nuts 3 feet or greater below finish grade.
6. Manufacturers and Products:
 - a. East Jordan Iron Works; Cast-Iron Valve Boxes.
 - b. Bingham & Taylor; Cast-Iron Valve Boxes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

D. Valve Installation and Orientation:

1. General:
 - a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
 - b. Install valves in location for easy access for routine operation and maintenance.
 - c. Install valves per manufacturer's recommendations.
2. Gate, Globe, and Ball Valves:
 - a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
 - b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.
3. Butterfly Valves:
 - a. Unless otherwise restricted or shown on Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.

- b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
 - c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
 - d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
 - e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.
4. Check Valves:
- a. Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.
 - b. Install valve in vertical flow (up) piping only for gas services.
 - c. Install swing check valve with shaft in horizontal position.
 - d. Install double disc swing check valve to be perpendicular to flow pattern when discs are open.
- E. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.
- F. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

3.02 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.
- C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.
- E. Set, verify, and record set pressures for relief and regulating valves.
- F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.
- G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.03 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are part of this Specification.
1. Electric Actuated Valve Schedule.
 2. Self-Regulated Valve Schedule.

END OF SECTION

Electric Actuated Valve Schedule									
Tag Number	Valve Type	Actuator Power Supply	Valve Size (inches)	Process Fluid	Maximum Operating Flow (gpm)	Maximum ΔP (psi)	Service	Travel Time (Seconds)	Control Feature Modifications/Supplements
580FCV-01-01	V500	120 volt, single phase	24	RW	11,000	100	M	60	C, G
<p>Service: O/C = Open-Close, T = Throttling, M = Modulating</p> <p>Control Feature Modifications/Supplements:</p> <p>A = Actuator shall open valve upon loss of signal.</p> <p>B = Actuator shall close valve upon loss of signal.</p> <p>C = Actuator shall remain in last position upon loss of signal.</p> <p>D = Local OPEN-CLOSE momentary pushbuttons that must be continuously depressed to initiate/maintain valve travel; travel stops when pushbutton is released or when end of travel limit is reached.</p> <p>E = Remote OPEN-CLOSE maintained dry contacts; travel stops when remote contact opens, or when end of travel limit is reached.</p> <p>F = Three 24-volt dc interposing relays for remote OPEN-STOP-CLOSE control. Relays powered externally, thereby permitting valve control from greater distances.</p> <p>G = Motor and control enclosure(s) NEMA 250, Type 4 with 120-volt space heaters.</p> <p>H = Motor and control enclosure(s) NEMA 250, Type 6 (IP 68) with 120-volt space heaters.</p> <p>I = Motor and control enclosure(s) NEMA 250, Type 7 with 120-volt space heaters.</p> <p>J = Valve position output converter that generates isolated 4 mA to 20 mA dc signal in proportion to valve position, and is capable of driving into loads of up to 500 ohms at 24 volts dc.</p> <p>K = 120-volt secondary control power transformer.</p> <p>L = Externally operable power disconnect switch.</p>									

Self-Regulated Valve Schedule							
Tag No.	Valve Type No.	Size (inches)	Inlet* Pressure	Outlet* Pressure	Maximum psig	Flow (gpm)	Fluid
005-ARV-01	V744	1	110	0	110	600	RW
005-ARV-02	V744	1	110	0	110	600	RW
570-PRV-01-01	V720	1/2	10	0	10	1	LAS
578-PCV-02-01	V720	1/2	100	0	0	1	LAS
578-PCV-02-02	V720	1/2	100	0	0	1	LAS
578-PCV-02-03	V720	1/2	100	0	0	1	LAS
578-PCV-02-04	V720	1/2	100	0	0	1	LAS
580-ARV-0101	V744	2	110	0	110	11,000	RW
580-AVRV-0301	V740	6	100	0	100	11,000	RW
*Inlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.							

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan:
 - a. Submit prior to testing and include at least the information that follows.
 - 1) Testing dates.
 - 2) Piping systems and section(s) to be tested.
 - 3) Test type.
 - 4) Method of isolation.
 - 5) Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

- A. Notify Engineer in writing 10 days in advance of testing. Perform testing in presence of Engineer.**
- B. Pressure Piping:**
1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
 2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
 3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
 4. New Piping Connected to Existing Piping:
 - a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
 5. Items that do not require testing include: tank overflows to atmospheric vented drains, tank atmospheric vents.
 6. Test Pressure: As indicated on Piping Schedule.

- C. Test section may be filled with water and allowed to stand under low pressure prior to testing.
- D. Gravity Piping:
 - 1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
 - 2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.
 - 3. Pipe 42 Inches Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

- A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.
- B. Exposed Piping:
 - 1. Perform testing on installed piping prior to application of insulation.
 - 2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
 - 3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
 - 4. Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
 - 5. Examine joints and connections for leakage.
 - 6. Correct visible leakage and retest as specified.
 - 7. Leave pipe full of water after repair of leaks.
- C. Buried Piping:
 - 1. Test after backfilling has been completed.
 - 2. Expel air from piping system during filling.
 - 3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
 - 4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
 - 5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

6. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{148,000}$$

where:

- L = Allowable leakage, in gallons per hour.
- S = Length of pipe tested, in feet.
- D = Nominal diameter of pipe, in inches.
- P = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.03 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
 - a. Leaks (type, location).
 - b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

**SECTION 40 90 00
INSTRUMENTATION AND CONTROL
FOR PROCESS SYSTEMS**

PART 1 GENERAL

1.01 SUMMARY

- A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:
 - 1. Section 40 91 00, Instrumentation and Control Components.
 - 2. Section 40 95 60, Telemetry Subsystem.

- B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.
 - 1. Process instrumentation including primary elements, transmitters, control devices, and control panels.
 - 2. Modify existing panel SP-08 and its PLC to interface with signals provided as part of this Project.
 - 3. Interface I/O points defined in the supplementary I/O list and Drawings to:
 - a. Existing PLC, SP-01-PLC-01, in existing panel SP-01.
 - b. Existing PLC, SP-02-PLC-01, in existing panel SP-02.
 - c. Existing PLC, SP-08-PLC-01, in existing panel SP-08.
 - 4. Wire all control devices, including equipment within control panels, as shown on the Drawings.
 - 5. Provide a complete RTU, tower and antenna assembly. Integrate this assembly into the existing DFS system-wide SCADA system.
 - 6. Applications Software (Programming and Configuring):
 - a. PLC and HMI software in accordance with Owner's standards.
 - b. PLC: Provided by PICS Contractor for the three existing PLCs described above. Existing PLCs are Allen-Bradley SLC 5/05.
 - c. HMI: Provided by the PICS Contractor for existing HMI(s) associated with the existing Citect SCADA System.
 - d. DFS controller and HMI: New DFS RTU, existing Master DFS RTU, and data transfer to existing Citect SCADA System.
 - 1) Implement the data transfer via an existing Modbus communication link.
 - e. All Other Standard and Applications Software: Programming provided by the PICS Contractor.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section and other PIC subsections:
1. American National Standards Institute (ANSI).
 2. ASTM International (ASTM):
 - a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - d. B32, Standard Specification for Solder Metal.
 - e. B88, Standard Specification for Seamless Copper Water Tube.
 3. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
 4. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 5. International Society of Automation (ISA):
 - a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
 - b. S5.1, Instrumentation Symbols and Identification.
 - c. S5.4, Instrument Loop Diagrams.
 - d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
 - e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
 6. International Conference on Energy Conversion and Application (ICECA).
 7. National Electrical Code (NEC).
 8. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. ICS 1, Industrial Control and Systems General Requirements.
 9. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
 10. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.03 DEFINITIONS

A. Abbreviations:

1. DCU: Distributed Control Unit.
2. FDT: Factory Demonstration Test.
3. HMI: Human-Machine Interface.
4. HVAC: Heating, Ventilating, and Air Conditioning.
5. I&C: Instrumentation and Control.
6. I/O: Input and Output.
7. O&M: Operation and Maintenance.
8. P&ID: Process and Instrument Diagram.
9. PC: Personal Computer.
10. PIC: Process Instrumentation and Control.
11. PICS: PIC System.
12. PLC: Programmable Logic Controller.
13. RTU: Remote Terminal Unit.
14. SCADA: Supervisory Control and Data Acquisition.
15. SLDC: Single Loop Digital Controller.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: Eight hours of actual instruction time.

D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.

1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc.); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
3. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, DCUs, SLDC, and fieldbus devices.

- E. Application Software: Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:
 - 1. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
 - 2. Programming in any programming or scripting language.
- F. Rising/Falling: Define action of discrete devices about their setpoint.
 - 1. Rising: Contacts close when an increasing process variable rises through setpoint.
 - 2. Falling: Contacts close when a decreasing process variable falls through setpoint.
- G. Signal Types:
 - 1. Analog Signal, Current Type:
 - a. 4 to 20 mA dc signals conforming to ISA S50.1.
 - b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
 - 1) Transmitter Type: Number 2, two-wire.
 - 2) Transmitter Load Resistance Capacity: Class L.
 - 3) Fully isolated transmitters and receivers.
 - 2. Analog Signal, Voltage Type: 1 to 5 volts dc within panel where common high precision dropping resistor is used.
 - 3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
 - 4. Pulse Frequency Signals:
 - a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
 - b. Pulses generated by contact closures or solid state switches.
 - c. Power source less than 30V dc.
 - 5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Complete detailed design of PIC components and PIC drawings, including panel wiring diagrams, loop wiring diagrams, and interconnecting wiring diagrams.
 - 2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.

3. PIC design as shown and specified includes:
 - a. Functional requirements, performance requirements, and component Specifications.
 - b. P&IDs, block diagrams, and network diagrams.
4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

B. Use a qualified PIC System Integrator for at least the following work:

1. For PIC Equipment and Ancillaries:
 - a. Completing detail design.
 - b. Submittals.
 - c. Equipment, enclosures, and ancillaries.
 - d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
 - e. Verify readiness for operation.
 - f. Verify correctness of final power and signal connections (lugging and connecting).
 - g. Adjusting and calibrating.
 - h. Starting up.
 - i. Testing and coordination of testing.
 - j. Training.
2. Verify following Work not by PIC System Integrator is provided:
 - a. Correct type, size, and number of signal wires with their raceways.
 - b. Correct electrical power circuits and raceways.
 - c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
 - d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. NonPIC Equipment Directly Connected to PIC Equipment:
 - a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
 - b. Coordinate with Contractor to allow required interface and operation with PIC.
 - c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
 - d. Test to demonstrate required interface and operation with PIC.
 - e. Examples of items in this category, but not limited to the following:
 - 1) Valve operators, position switches, and controls.
 - 2) Chemical feed pump and feeder speed/stroke controls.

- 3) Automatic samplers.
- 4) Motor control centers.
- 5) Adjustable speed and adjustable frequency drive systems.
- f. Examples of items not in this category:
 - 1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
 - 2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

1.05 SUBMITTALS

A. General:

- 1. Submit proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
- 2. Partial Submittals not in accordance with Project Schedule will not be accepted.
- 3. Submittal Format:
 - a. Hard Copy: Required for all submittals.
 - b. Electronic Copies: Required, unless otherwise noted for specific items.
 - 1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
 - 2) Documents created specifically for Project:
 - a) Text and Graphics: Microsoft Word.
 - b) Lists: Microsoft Excel, unless otherwise noted for specific items.
 - c) Drawings: MicroStation.
- 4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
- 5. Legends and Abbreviation Lists:
 - a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
 - b. Use identical abbreviations in PIC subsections.
 - c. Submit updated versions as they occur.
- 6. Activity Completion:
 - a. Action Submittals: Completed when reviewed and approved.
 - b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Action Submittals:

1. Bill of Materials: List of required equipment.
 - a. Group equipment items by enclosure and field, and within an enclosure, as follows:
 - 1) PIC Components: By component identification code.
 - 2) Other Equipment: By equipment type.
 - b. Data Included:
 - 1) Equipment tag number.
 - 2) Description.
 - 3) Manufacturer, complete model number and all options not defined by model number.
 - 4) Quantity supplied.
 - 5) Component identification code where applicable.
 - 6) For panels, include panel reference number and name plate inscription.
 - c. Formats: Hard copy and Microsoft Excel.
2. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
 - a. Catalog information, marked to identify proposed items and options.
 - b. Descriptive literature.
 - c. External power and signal connections.
 - d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
3. Instrument List:
 - a. Engineer will provide an initial Instrument List in Microsoft Excel. Data from this may be used as starting point for creating final Instrument List and Component Data Sheets.
 - b. Applicable fields to be completed include, but are not limited to:

Instrument List Characteristics	
Item	Initially Completed By
Tag Number	Engineer
Loop Number	Engineer
Description	Engineer
Manufacturer and complete model number	Contractor
Size and scale range	Engineer
Setpoints	Engineer

Instrument List Characteristics	
Item	Initially Completed By
Reference P&IDs, Electrical, Mechanical, Interconnection Drawings and Installation Details Drawings	Engineer
Instrument detail number	Engineer

- c. Submit updated version of Instrument List.
- d. Electronic Copies: Microsoft Excel.
- 4. Component Data Sheets: Data sheets for I&C components.
 - a. Format:
 - 1) Similar to ISA TR20.00.01.
 - 2) Microsoft Excel, one component per data sheet.
 - 3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
 - b. Content: Specific features and configuration data for each component, including but not limited to:
 - 1) Tag Number.
 - 2) Component type identification code and description.
 - 3) Location or service.
 - 4) Service conditions.
 - 5) Manufacturer and complete model number.
 - 6) Size and scale range.
 - 7) Setpoints.
 - 8) Materials of construction.
 - 9) Options included.
 - 10) Power requirements.
 - 11) Signal interfaces.
 - 12) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
 - c. Electronic Copies: Microsoft Excel.
- 5. Sizing and Selection Calculations:
 - a. Primary Elements:
 - 1) Complete calculations plus process data used. Example for Flow Elements:
 - a) Minimum and maximum values, permanent head loss, and assumptions made.
 - b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
 - c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.

6. Panel Construction Drawings:
 - a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
 - b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
 - c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
 - d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
 - e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
 - f. Submit electronic copies of Drawings.
7. Panel Wiring Diagrams:
 - a. Show wiring modifications to existing panel(s). Obtain existing panel Record Drawings from Owner. Show the wiring modifications on these Drawings.
 - b. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
 - c. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.
 - d. Diagram Type:
 - 1) Ladder diagrams where applicable in a format similar to those shown on Drawings. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
 - 2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.
 - e. Item Identification: Identify each item with attributes listed.
 - 1) Wires: Wire number and color. Cable number if part of multiconductor cable.
 - 2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
 - 3) Components:
 - a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
 - b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).

- 4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
- 5) Relay Coils:
 - a) Tag number and its function.
 - b) On right side of run where coil is located, list contact location by ladder number and sheet number.
Underline normally closed contacts.
- 6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
- 7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.
- f. Show each circuit individually. No “typical” diagrams or “typical” wire lists will be allowed.
- g. Ground wires, surge protectors, and connections.
- h. Wire and Cable Names: Show names and wire color for circuits entering and leaving a panel. Refer to Division 26, Electrical.
8. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
 - a. Conform to the minimum requirements of ISA S5.4.
 - b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
 - c. Show loop components within a panel and identify each component, component terminals, and panel terminals.
 - d. If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:
 - 1) Show the first component connected to within the panel or device that is not provided under this section and its subsections.
 - 2) Identify the component by tag and description.
 - 3) Identify panel and component terminal numbers.
 - e. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
 - f. Divide each loop diagram into areas for panel face, back-of-panel, field and PLC One Drawing Per Loop: Show each loop individually. No “typical” loop diagrams will be allowed.
 - g. Show:
 - 1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
 - 2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.

- 3) Tabular summary on each analog loop diagram:
 - a) Transmitting Instruments: Output capability.
 - b) Receiving Instruments: Input impedance.
 - c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
 - d) Total loop impedance.
 - e) Reserve output capacity.
- 4) Circuit and raceway schedule names.
9. Communications and Digital Networks Diagrams:
 - a. Scope: Includes connections to telephone system, Ethernet network, remote I/O, and fieldbus (for example, Modbus, Profibus, Foundation Fieldbus, Device Net, etc.).
 - b. Format: Network schematic diagrams for each different type of network.
 - c. Show:
 - 1) Interconnected devices, both passive and active.
 - 2) Device names and numbers.
 - 3) Terminal numbers.
 - 4) Communication Media: Type of cable.
 - 5) Connection Type: Type of connector.
 - 6) Node and device address numbers.
 - 7) Wire and cable numbers and colors.
10. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
 - a. Required voltages, currents, and phases(s).
 - b. Maximum heat dissipations Btu per hour.
 - c. Calculations.
 - d. Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures defined in paragraph 2.05, Service Conditions.
11. Panel Plumbing Diagrams: For each panel containing piping and tubing. Show type and size for:
 - a. Pipes and Tubes: Thickness, pressure rating, and materials.
 - b. Components: Valves, regulators, and filters.
 - c. Connections to panel-mounted devices.
 - d. Panel interface connections.
 - e. Submit electronic copies of Drawings.
12. Installation Details: Include modifications or further details required and define installation of I&C components.
13. Spares, expendables, and test equipment.
14. Electronic Copies: Microsoft Excel.
15. PLC I/O List: Submit I/O assignment, including Drawing number, Tag number, PLC number, I/O function and description, and Rack/Slot/Point.
16. Color schedule for control panels.

17. PLC Software Submittals:

- a. Complete set of standard user's manuals for PLCs. Include all aspects of programming, documenting, and use of the PLC equipment.
- b. Detailed design description of the PLC programs. This submittal will be reviewed by the Owner and Engineer, and shall include:
 - 1) Control Diagram Description: A written overview description of each control program. These descriptions shall lead the user through the major program subsections. Descriptions shall generally describe the programming methods and techniques used to implement the functional requirements of this Specification and the distribution of these programs within the PLC hardware.
 - 2) Logic Diagram Listings: Each element (input, output, or special function block) shall have a 15-character minimum description. Logic runs (or equivalent) shall have comments that describe the run functions. Provide an average of one 60-character comment line per run. Provide complete ladder diagram logic listings.
 - 3) Variable data memory storage record, indicating memory location, and description of the variable data; i.e., tag number, timer number, counter number.
 - 4) Data Exchange: Block definitions for the data exchange between the PLC and HMI.

18. Applications Software Documentation:

- a. Complete configuration documentation for microprocessor based programmable devices.
- b. For each device, include program listings and function block diagrams, as appropriate, showing:
 - 1) Functional blocks or modules used.
 - 2) Configuration, calibration, and tuning parameters.
 - 3) Descriptive annotations.
- c. Refer to PIC subsections for additional requirements.

C. Informational Submittals:

1. Statements of Qualification:

- a. PIC System Integrator.
- b. PIC System Integrator's site representative.
- c. Resume for each PIC System Integrator's onsite startup and testing team member (engineers, technicians, and software/configuring personnel).

2. Operation and Maintenance Data: In accordance with Section 01730, Operation and Maintenance Data, and in addition the following:
 - a. General:
 - 1) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
 - 2) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.
 - b. Final versions of Legend and Abbreviation Lists.
 - c. Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.
 - d. Provide the following items as defined under heading Action Submittals:
 - 1) Bill of materials.
 - 2) Catalog cuts.
 - 3) Instrument list.
 - 4) Component data sheets.
 - 5) Detailed Wiring Diagrams: As-built drawings.
 - a) Panel wiring diagrams.
 - b) Loop diagrams.
 - c) Interconnecting wiring diagrams.
 - 6) Panel plumbing diagrams.
 - 7) Applications software documentation.
 - e. Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:
 - 1) Content for Each O&M Manual:
 - a) Table of Contents.
 - b) Operations procedures.
 - c) Installation requirements and procedures.
 - d) Maintenance requirements and procedures.
 - e) Troubleshooting procedures.
 - f) Calibration procedures.
 - g) Internal schematic and wiring diagrams.
 - h) Component and I/O Module Calibration Sheets from field quality control calibrations.
 - 2) Provide PDF file with linked index to all manuals.
 - f. List of spares, expendables, test equipment and tools provided.
 - g. List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.
3. Provide Manufacturer's Certificate of Proper Installation where specified.

4. Testing Related Submittals:
 - a. Functional Test:
 - 1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - 2) Final Test Procedures: Proposed test procedures, forms, and checklists.
 - 3) Test Documentation:
 - a) Copy of signed-off test results.
 - b) Completed component calibration sheets.
 - b. Performance Test:
 - 1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - 2) Final Test Procedures: Proposed test procedures, forms, and checklists.
 - 3) Test Documentation: Copy of signed-off test results.
5. Owner Training Plan: Submit plan that details the training requirements as specified in Paragraph 3.05 Training.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. PIC System Integrator: Minimum of 5 years' experience providing, integrating, installing, and starting up similar systems as required for this Project.
2. PIC System Integrator's Site Representative: Minimum of 5 years' experience installing systems similar to PIC required for this Project.

B. PIC Coordination Meetings:

1. General: Refer to Section 01200, Project Meetings, for PIC coordination meetings.
2. Training Coordination Meeting:
 - a. Timing: Following Engineer review of preliminary training plan.
 - b. Purpose:
 - 1) Resolve required changes to proposed training plan.
 - 2) Identify specific Owner personnel to attend training.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Section 01620, Storage and Protection.
- B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

- C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.
- D. Cover panels and other elements that are exposed to dusty construction environments.

1.08 SEQUENCING AND SCHEDULING

- A. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:
 - 1. Shop Drawing Reviews by Engineer:
 - a. Prerequisite: Engineer in accordance with Progress Schedule.
 - b. Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01340, Shop Drawings, Project Data and Samples.
 - 2. Test Prerequisite: Associated test procedures Submittals completed.
 - 3. Training Prerequisite: Associated training plan Submittal completed.
 - 4. Performance Test Prerequisite: Functional Test completed and facility started up.
- B. Coordinate all software integration with concurrent or preceding projects. Do not download software or alter network configurations until work has been completed or approved by PICS contractor on any concurrent project by others.

1.09 MAINTENANCE

- A. Telephone Support: As specified in PIC subsections.
- B. Software Subscription: As specified in PIC subsections.

1.10 EXTRA MATERIALS

- A. As specified in PIC subsections.
- B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

C. Spare Parts:

Description	Percent of Each Type and Size Used	No Less Than
dc power supplies	20	2
Fuses	20	5
Relays	20	3
Terminal Blocks	10	10
Hand Switches, Pushbuttons and Lights	10	1
Surge Suppressors, Type 1	10	1
Surge Suppressors, Type 2	10	2
Surge Suppressors, Type 3	10	1
Surge Suppressors, Type 4	10	1
Electrode, A105 ORP	10	1
Probe, A140 Ammonium-Nitrate	10	1

D. Expendables: For following items provide manufacturer's recommended 2-year supply, unless otherwise noted.

1. Spray pump filter adhesive; Hoffman Model A-FLTAD. One pint per panel with air filters.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide PIC functions shown on Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software whether indicated or not, necessary to effect required system and loop performance.
- B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.
 1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes.
 2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.

C. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
2. Implement same or similar functions in same or similar manner. For example control logic, sequence controls, and display layouts.

2.02 I&C COMPONENTS

- A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.
- B. Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article Supplements. Furnish equipment that is necessary to achieve required loop performance.
- C. Control Panels: Reference Control Panel Schedule in Article Supplements.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

- A. None for this project. PLCs are existing.
- B. Reference PLC I/O List Equipment List, which is a Supplement to this section.

2.04 FIELD BUS, NETWORK, AND HMI COMPONENTS

- A. None for this Project. Components are existing.
- B. Reference PIC subsections.

2.05 SERVICE CONDITIONS

- A. Standard Service Conditions: The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:
 1. Computer Room, Air Conditioned:
 - a. Temperature: 60 degrees F to 80 degrees F.
 - b. Relative Humidity: 40 percent to 60 percent.
 - c. NEC Classification: Nonhazardous.
 2. Inside, Air Conditioned:
 - a. Temperature:
 - 1) Normal: 60 degrees F to 80 degrees F.
 - 2) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.

- b. Relative Humidity:
 - 1) Normal: 10 percent (winter) to 70 percent (summer).
 - 2) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
 - c. NEC Classification: Nonhazardous.
 - 3. Inside:
 - a. Temperature: 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 10 percent to 100 percent.
 - c. NEC Classification: Nonhazardous.
 - 4. Inside, Hazardous:
 - a. Temperature: Minus 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 10 percent to 100 percent.
 - c. NEC Classification: Class 1, Division 1, Group D.
 - 5. Outside:
 - a. Temperature: Minus 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 10 percent to 100 percent rain.
 - c. NEC Classification: Nonhazardous.
 - 6. Outside, Hazardous:
 - a. Temperature Minus 20 degrees F to 104 degrees F.
 - b. Relative Humidity: 0 to 100 percent.
 - c. NEC Classification: Class 1, Division 1, Group D.
- B. Standard Service Conditions for Panels and Consoles: Unless otherwise noted, in Instrument List and Control Panel Schedule located in Article Supplements at End of Section, design equipment for continuous operation in these environments:
 - 1. Freestanding Panel and Consoles:
 - a. Inside, Air Conditioned: NEMA 1.
 - b. Inside: NEMA 12.
 - 2. Smaller Panels and Assemblies (that are not freestanding):
 - a. Inside, Air Conditioned: NEMA 12.
 - b. All Other Locations: NEMA 4X.
 - 3. Field Elements: Outside.
- C. Special Environmental Requirements: Design following panels for continuous operation in environments listed.

2.06 NAMEPLATES AND TAGS

- A. Panel Nameplates: Enclosure identification located on enclosure face.
 - 1. Location and Inscription: As shown on Drawings.
 - 2. Materials: Laminated plastic attached to panel with stainless steel screws.
 - 3. Letters: 1/2-inch high, white on black background, unless otherwise noted.
- B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.
 - 1. Location and Inscription: As shown on panel drawing.
 - 2. Materials: Adhesive-backed, laminated plastic.
 - 3. Letters: 3/16-inch high, white on black background, unless otherwise noted.
- C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.
 - 1. Inscription: Component tag number.
 - 2. Materials: Adhesive-backed, laminated plastic.
 - 3. Letters: 3/16-inch high, white on black background, unless otherwise noted.
- D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.
 - 1. Inscription:
 - a. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
 - b. Refer to table under Paragraph Standard Light Colors and Inscriptions.
 - c. Refer to P&IDs on Drawings.
 - 2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
 - 3. Letters: Black on gray or white background.
- E. Service Legends: Component identification nameplate located on face of component.
 - 1. Inscription: As shown on panel drawing.
 - 2. Materials: Adhesive-backed, laminated plastic.
 - 3. Letters: 3/16-inch high, white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16-inch high, imposed.
4. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.

2.07 MECHANICAL SYSTEM COMPONENTS

- A. Reference Section 40 91 00, Instrumentation and Control Components.

2.08 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

- A. Shown on Drawings, in panel control diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.
- B. Supplemented by Loop Specifications that describe requirements not obvious on P&IDs or panel control diagrams.
- C. Supplemented by standard functional requirements in PIC subsections.

2.09 LOOP SPECIFICATIONS

- A. See Article Supplements located at End of Section.
- B. Organization: By unit process and loop number.
- C. Loop Subheadings:
1. Hardwired Special Functions: Clarifies functional performance of loop, including abstract of interlocks for hard wired logic, for example in MCCs and control panels.
 2. PLC Special Functions: Specifies nonstandard PLC functions. When required for clarification, additional definition is shown by logic diagrams or sequence diagrams on Drawings.
 3. HMI Special Functions: Specifies nonstandard HMI functions.

2.10 ELECTRICAL REQUIREMENTS

- A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.
- B. Wiring External to PIC Equipment:
1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
 2. Other Wiring and Cable: As specified in Section 26 05 05, Conductors.

- C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.
- D. Wires within Enclosures:
 - 1. ac Circuits:
 - a. Type: 600-volt, Type MTW stranded copper.
 - b. Size: For current to be carried, but not less than No. 18 AWG.
 - 2. Analog Signal Circuits:
 - a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
 - b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Beldon No. 1121A.
 - c. Size: No. 18 AWG, minimum.
 - 3. Other dc Circuits.
 - a. Type: 600-volt, Type MTW stranded copper.
 - b. Size: For current carried, but not less than No. 18 AWG.
 - 4. Special Signal Circuits: Use manufacturer's standard cables.
 - 5. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Machine printed, heat shrink.
 - b. Manufacturers:
 - 1) Brady Perma Sleeve.
 - 2) Tyco Electronics.
- E. Terminate and identify wires entering or leaving enclosures as follows:
 - 1. Analog and discrete signal, terminate at numbered terminal blocks.
 - 2. Special signals terminated using manufacturer's standard connectors.
 - 3. Identify wiring in accordance with requirements in Section 26 05 05, Conductors.
- F. Terminal Blocks for Enclosures:
 - 1. Quantity:
 - a. Accommodate present and spare indicated needs.
 - b. Wire spare PLC I/O points to terminal blocks.
 - c. One wire per terminal for field wires entering enclosures.
 - d. Maximum of two wires per terminal for No. 18 AWG wire for internal enclosure wiring.
 - e. Spare Terminals: 20 percent of connected terminals, but not less than 5 per terminal block, unless otherwise shown on Drawings.
 - 2. Terminal Block Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.

G. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
 - a. Locate signal ground at dc power supply for loop.
 - b. Use to ground wire shields for loop.
 - c. Group and ground wire shields in following locations: at dc power supply location.
4. Ground terminal block rails to ground bus.

H. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

I. Intrinsic Safety System Installation:

1. Comply with NEC Article 504, Intrinsically Safe Systems.
2. Install intrinsically safe circuits in a separate wire way that:
 - a. Is separated from non-intrinsically safe circuits as specified by NEC.
 - b. Is colored light blue and has message "Intrinsically Safe Circuits Only" on raceway cover every 6 inches.

J. Wiring Interface: Terminate and identify wiring entering or leaving enclosures.

1. Analog and Discrete Signal Wires: Terminate at numbered terminal blocks as shown on the wiring diagrams.
2. Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer's standard connectors for the device to which the signals terminate.

K. Electrical Transient Protection:

1. General: Function: Protect elements of PIC System against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
2. Show Surge Suppressors on Shop Drawings.

3. Furnish, install, coordinate, and inspect grounding of surge suppressors at:
 - a. Connection of ac power to PICS System equipment including panels, consoles, assemblies, and field-mounted analog transmitters and receivers.
 - b. For analog and other signals, as shown on the P&IDs, where SS-X means "Surge Suppressor, Type X".
4. Products: Surge suppressors shall conform to the requirements of the Surge Suppressor Products Table, which is a Supplement to this section.
5. Install and ground surge suppressors as per manufacturer's instructions and applicable standard details.

2.11 PANEL FABRICATION AND MODIFICATION

A. General:

1. Nominal Panel Dimensions: As noted on Control Panel Schedule.
2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
3. Fabricate panels, install instruments and wire, and plumb at PIC System Integrator's facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.
4. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.
5. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Modifications to Existing Panels SP-01, SP-02, SP-08:

1. General: Interface new signals furnished as part of this project with existing panels SP-01, SP-02 and SP-08 as well as their PLCs. Based on best available information, there are sufficient spare I/O points to accept these new signals. Work includes, but is not limited to:
 - a. Providing new wiring circuits within panel SP-08, including ancillaries such as fuses.
 - b. Furnishing and installing new surge suppressors within panel to protect the analog signals. It is permissible to re-use existing surge suppressors that are located within the panel.

C. Temperature Control:

1. Freestanding Panels:
 - a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel and on panel.

- b. Ventilated Panels:
 - 1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel and on panel.
 - 2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
 - 3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
 - 4) Louver Construction: Stamped sheet metal.
 - 5) Ventilation Fans:
 - a) Furnish where required to provide adequate cooling.
 - b) Create positive internal pressure within panel.
 - c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
 - 6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
- c. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.
- 2. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel and on panel face.
- 3. Space Heaters:
 - a. Thermostatically controlled to maintain internal panel temperatures above dewpoint.
 - b. Refer to Control Panel Schedule in Article Supplements.

D. Freestanding Panel Construction:

- 1. Materials:
 - a. Sheet steel, unless otherwise shown on Drawings.
 - b. Minimum Thickness: 10-gauge, unless otherwise noted.
- 2. Panel Front:
 - a. Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
 - b. No seams or bolt heads visible when viewed from front.
 - c. Panel Cutouts: Smoothly finished with rounded edges.
 - d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
- 3. Internal Framework:
 - a. Structural steel for instrument support and panel bracing.
 - b. Permit panel lifting without racking or distortion.
- 4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
- 5. Adjacent Panels: Securely bolted together so front faces are parallel.

6. Door:
 - a. Full height, fully gasketed access door where shown on Drawings.
 - b. Latch: Three-point, Southco Type 44.
 - c. Handle: "D" ring, foldable type.
 - d. Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.
 - e. Rear Access: Extend no further than 24 inches beyond panel when opened to 90-degree position.
 - f. Front and Side Access Doors: As shown on Drawings.
- E. Nonfreestanding Panel Construction:
 1. Based on environmental design requirements and referenced in Article Environmental Requirements, provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
 - a. Panels listed as inside, air conditioned:
 - 1) Enclosure Type: NEMA 12.
 - 2) Materials: Steel.
 - b. Other Panels:
 - 1) Enclosure Type: NEMA 4X.
 - 2) Materials: Type 316 stainless steel.
 2. Metal Thickness: 14-gauge, minimum.
 3. Doors:
 - a. Rubber-gasketed with continuous hinge.
 - b. Lockable three-point latch rated to appropriate enclosure rating.
 4. Manufacturers:
 - a. Hoffman Engineering Co.
 - b. H. F. Cox.
- F. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels:
 1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.
- G. Control Panel Electrical:
 1. Power Distribution within Panels:
 - a. Feeder Circuits:
 - 1) One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
 - 2) Make provisions for feeder circuit conduit entry.
 - 3) Furnish terminal block for termination of wires.
 - b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
 - 1) Locate to provide clear view of and access to breakers when door is open.

- 2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
 - a) Branch Circuit Breakers: 15 amps at 250V ac.
- 3) Breaker Manufacturers and Products: Refer to Division 26, Electrical.
- c. Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
 - 1) Devices on Single Circuit: 20, maximum.
 - 2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
 - 3) Branch Circuit Loading: 12 amperes continuous, maximum.
 - 4) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
 - 5) Provide 120V ac plugmold for panel components with line cords.
2. Signal Distribution:
 - a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
 - b. Within Panels: 4 to 20 mA dc signals may be distributed as 1V dc to 5V dc.
 - c. Outside Panels: Isolated 4 to 20 mA dc only.
 - d. Signal Wiring: Twisted shielded pairs.
 - e. RTD and Thermocouple Extension Cable:
 - 1) Continuous field to panel with no intermediate junction boxes or terminations.
 - 2) RTDs in motor windings are considered a 600-volt circuit.
 - 3) Terminate thermocouple extension wire directly to loop instrument.
3. Signal Switching:
 - a. Use dry circuit type relays or switches.
 - b. No interruption of 4 to 20 mA loops during switching.
 - c. Switching Transients in Associated Signal Circuit:
 - 1) 4 to 20 mA dc Signals: 0.2 mA, maximum.
 - 2) 1V dc to 5V dc Signals: 0.05V, maximum.
4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.
5. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
6. Internal Panel Lights for Freestanding Panels:
 - a. Type: Switched 100-watt incandescent back-of-panel lights.
 - b. Quantity: One light for every 4 feet of panel width.
 - c. Mounting: Inside and in the top of back-of-panel area.
 - d. Protective metal shield for lights.

7. Service Outlets for Freestanding Panels:
 - a. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
 - b. Quantity:
 - 1) Panels 4 Feet Wide and Smaller: One.
 - 2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
 - c. Mounting: Evenly spaced along back-of-panel area.
8. Internal Panel Lights and Service Outlets for Smaller Panels:
 - a. Internal Panel Light: Switched fluorescent or LED light.
 - b. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI duplex receptacle:
 - c. Required for panels. Refer to Control Panel Schedule in Article Supplements.
9. Standard Pushbutton Colors and Inscriptions:
 - a. Use following unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

10. Standard Light Colors and Inscriptions:
 - a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber

Tag Function	Inscription(s)	Color
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

H. PIC Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
 - a. Locking-fork-tongue or ring-tongue lugs.
 - b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
 - c. Wires terminated in a crimp lug, maximum of one.
 - d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
 - a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
 - b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
12. Conductors Carrying Foreign Voltages within a Panel:
 - a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
 - b. Use wire with pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.

13. Harness Wiring:
 - a. 120V ac: No. 14 AWG, MTW.
 - b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
 14. Panelwork:
 - a. No exposed connections.
 - b. Allow adjustments to equipment to be made without exposing these terminals.
 - c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
 15. Plastic Wire Ducts Color:
 - a. 120V ac: White.
 - b. 24V dc: Gray.
 - c. Communications Cables and Fiber Optic Jumpers: Orange.
 16. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.
 17. Make plastic wire ducts the same depth.
 18. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.
- I. Control Relay Arrangement: If needed, furnish and install additional control relays with specific loops in same panel section as corresponding terminal blocks or side panels.
- J. Factory Finishing:
1. Furnish materials and equipment with manufacturer's standard finish system in accordance with Section 09 90 00, Painting and Coating.
 2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.
 3. Nonmetallic Panels: Not painted.
 4. Stainless Steel and Aluminum:
 - a. Indoor: Not painted.
 - b. Outdoor: Interior and exterior manufacturer finished white using electrostatically TGIC polyurethane powder coat.
 5. Steel Panels:
 - a. Sand panel and remove mill scale, rust, grease, and oil.
 - b. Fill imperfections and sand smooth.
 - c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.

- d. Sand surfaces lightly between coats.
- e. Dry Film Thickness: 3 mils, minimum.
- f. Color: Manufacturer's standard.

2.12 SOURCE QUALITY CONTROL

A. General:

- 1. Engineer may actively participate in many of the tests.
- 2. Engineer reserves right to test or retest specified functions.
- 3. Engineer's decision will be final regarding acceptability and completeness of testing.
- 4. Procedures, Forms, and Checklists:
 - a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
 - b. Describe each test item to be performed.
 - c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
- 5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
- 6. Conducting Tests:
 - a. Provide special testing materials and equipment.
 - b. Wherever possible, perform tests using actual process variables, equipment, and data.
 - c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
 - d. Define simulation techniques in test procedures.
 - e. Test Format: Cause and effect.
 - 1) Person conducting test initiates an input (cause).
 - 2) Specific test requirement is satisfied if correct result (effect), occurs.

PART 3 EXECUTION

3.01 EXAMINATION

- A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:
 - 1. Proper installation.
 - 2. Calibration and adjustment of positioners and I/P transducers.
 - 3. Correct control action.
 - 4. Switch settings and dead bands.
 - 5. Opening and closing speeds and travel stops.
 - 6. Input and output signals.

3.02 INSTALLATION

- A. Install I&C instruments, panels and components as per Installation Details, which are shown on the P&IDs.
 - 1. Coordinate these installation details with the General Contractor and affected subcontractors such as electrical and mechanical.
- B. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.
- C. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.
- D. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.
- E. Mechanical Systems:
 - 1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
 - 2. Plastic Tubing Support: Except as shown on Drawings, provide continuous support in conduit or by aluminum tubing raceway system.
 - 3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
 - 4. Tubing and Conduit Bends:
 - a. Tool-formed without flattening, and of same radius.
 - b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
 - c. Slope instrument connection tubing in accordance with installation details.
 - d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
 - e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
 - f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
 - g. Blow debris from inside of tubing.
 - h. Makeup and install fittings in accordance with manufacturer's recommendations. Verify makeup of tube fittings with manufacturer's inspection gauge.
 - i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.

- j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
- k. Provide separate support for components in tubing runs.
- l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
- m. Keep tubing and conduit runs at least 12 inches from hot pipes.
- n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
- o. Securely attach tubing raceways to building structural members.
- 5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

F. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

- 1. Coordinate PIC testing with Owner and affected Subcontractors.
- 2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.
- 3. Engineer may actively participate in tests.
- 4. Engineer reserves right to test or retest specified functions.
- 5. Engineer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

- 1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
- 2. Require PIC site representative to supervise and coordinate onsite PIC activities.
- 3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Leak Tests: During preparation for testing, conduct leak tests in accordance with Section 40 80 01, Process Piping Leakage Testing.

D. Testing Sequence:

- 1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.

2. Refer to article Work Sequence under Section 01010, Summary of Work, for a definition of project milestones.
3. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

E. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation.
2. Functional Test: Performed by PIC System Integrator to test and document PIC is ready for operation.
 - a. Loop/Component Inspections and Tests:
 - 1) These inspections and tests will be spot checked by Engineer.
 - 2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
 - 3) Provide space on forms for signoff by PIC System Integrator.
 - 4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
 - a) Project name.
 - b) Loop number.
 - c) Tag number for each component.
 - d) Checkoffs/Signoffs for Each Component:
 - (1) Tag/identification.
 - (2) Installation.
 - (3) Termination wiring.
 - (4) Termination tubing.
 - (5) Calibration/adjustment.
 - e) Checkoffs/Signoffs for the Loop:
 - (1) Panel interface terminations.
 - (2) I/O interface terminations with PLCs and RTUs.
 - f) I/O Signals for PLCs and RTUs are Operational: Received/sent, processed, adjusted.
 - g) Total loop operational.
 - h) Space for comments.
 - 5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLCs and RTUs I/O module and include the following:
 - a) Project name.
 - b) Loop number.

- c) Component tag number or I/O module number.
 - d) Component code number for I&C elements.
 - e) Manufacturer for I&C elements.
 - f) Model number/serial number for I&C elements.
 - g) Summary of Functional Requirements; For Example:
 - (1) Indicators and recorders, scale and chart ranges.
 - (2) Transmitters/converters, input and output ranges.
 - (3) Computing elements' function.
 - (4) Controllers, action (direct/reverse) and control modes (P, I, D).
 - (5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
 - (6) I/O Modules: Input or output.
 - h) Calibrations, for example, but not limited to:
 - (1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
 - (2) Discrete Devices: Actual trip points and reset points.
 - (3) Controllers: Mode settings (P&ID).
 - (4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
 - (5) Space for comments.
 - b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.
 - c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.
 - d. Forms: See Loop Status Report, Instrument Calibration Sheet, and I&C Valve Adjustment Sheet referenced in Article Supplements.
3. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.

F. Performance Acceptance Tests (PAT): These are the activities that Section 01 91 14, Equipment Testing and Facility Startup, refers to as Performance Testing:

- 1. General:
 - a. Test all PIC elements to demonstrate that PIC satisfies all requirements.

- b. Test Format: Cause and effect.
 - 1) Person conducting test initiates an input (cause).
 - 2) Specific test requirement is satisfied if correct result (effect) occurs.
 - c. Procedures, Forms, and Checklists:
 - 1) Conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
 - 2) Describe each test item to be performed.
 - 3) Have space after each test item description for sign off by appropriate party after satisfactory completion.
 - d. Required Test Documentation: Test procedures, forms, and checklists. All signed by Engineer and Contractor.
 - e. Conducting Tests:
 - 1) Provide special testing materials, equipment, and software.
 - 2) Wherever possible, perform tests using actual process variables, equipment, and data.
 - 3) If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.
 - 4) Define simulation techniques in test procedures.
 - f. Coordinate PIC testing with Owner and affected Subcontractors.
2. Test Requirements:
- a. Once facility has been started up and is operating, perform a witnessed PAT on complete PICS to demonstrate that it is operating as required. Demonstrate each required function on a paragraph-by-paragraph and loop-by-loop basis.
 - b. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
 - c. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
 - d. Make updated versions of documentation required for PAT available to Engineer at Site, both before and during tests.
 - e. Make one copy of O&M manuals available to Engineer at the Site both before and during testing.
 - f. Refer to referenced examples of PAT procedures and forms in Article Supplements.

3.04 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: As required by each PIC subsection.
- B. Specialty Equipment: For certain components or systems provided under this section, but not manufactured by PIC System Integrator, provide services of qualified manufacturer's representative during installation, startup, demonstration testing, and training. Provide original equipment manufacturer's services for:
 - 1. A105 ORP Element and Analyzer/Transmitter.
 - 2. A140 Ammonium-Nitrate Analyzer/Transmitter.

3.05 TRAINING

- A. General:
 - 1. Provide an integrated training program for Owner's personnel.
 - 2. Perform training to meet specific needs of Owner's personnel.
 - 3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
 - 4. Provide instruction on one working shift(s) as needed to accommodate the Owner's personnel schedule.
 - 5. Owner reserves the right to reuse videotapes of training sessions.
- B. Operations and Maintenance Training:
 - 1. General:
 - a. Refer to specific requirements specified in PIC Subsections.
 - b. Include review of O&M data and survey of spares, expendables, and test equipment.
 - c. Use equipment similar to that provided.
 - d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.
 - 2. Operations Training: For Owner's operations personnel on operation of I&C components.
 - a. Training Session Duration: 1 instructor day.
 - b. Number of Training Sessions: One.
 - c. Location: Project Site.
 - d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.

- e. Content: Conduct training on loop-by-loop basis.
 - 1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
 - 2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
 - 3) Interfaces with PIC subsystems.
- 3. Maintenance Training:
 - a. Training Session Duration: 1 instructor day.
 - b. Number of Training Sessions: One.
 - c. Location: Project Site.
 - d. Course Objective: Develop skills needed for routine maintenance of PIC.
 - e. Content: Provide training for each type of component and function provided.
 - 1) Loop Functions: Understanding details of each loop and how they function.
 - 2) Component calibration.
 - 3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
 - 4) Troubleshooting and diagnosis for equipment and software.
 - 5) Replacing lamps, chart paper, and fuses.
 - 6) I&C components removal and replacement.
 - 7) Periodic preventive maintenance.

3.06 CLEANING

- A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 SUPPLEMENTS

- A. Supplements listed below, follows “End of Section,” are part of this Specification.
 - 1. Loop Specifications.
 - 2. Instrument List.
 - 3. PLC Input/Output List.
 - 4. Control Panel Schedule.
 - 5. Surge Suppressor Products Table.
 - 6. Compound Loop Trim Control Description.
 - 7. Compound Loop Trim Control Schematic

8. Preparation for Testing and Functional Test Forms:
 - a. Loop Status Report: Each sheet shows status of instruments on a loop. Also, gives functional description for loop.
 - b. Instrument Calibration Sheet: Shows details on each instrument (except simple hand switches, lights, and similar items).
 - c. I&C Valve Adjustment Sheet: Shows details for installation, adjustment, and calibration of a given valve.
9. Performance Test Sheet: Describe Performance Test for a given loop.
 - a. List requirements of the loop.
 - b. Briefly describe test.
 - c. Cite expected results.
 - d. Provide space for checkoff by witness.

END OF SECTION

LOOP SPECIFICATIONS

The Loop Specifications are divided into the following sections:

- **Definitions**

This Section defines basic functions and other terms used in subsequent sections (Global Functions Modular Functions and Unit Processes).

- **Global Functions**

Global functions are required for all applicable variables and are not listed in the Unit Process Loop Specifications.

- **Modular Functions**

Modular functions are included by reference in the subsequent Unit Process Loop Specifications.

- **Unit Process Loop Specification**

Unit Process Loop Specifications are included for each Unit Process and include extensive references to Function Definitions and Modular Functions.

DEFINITIONS

VARIABLE

Any signal (discrete, analog, or pulse frequency), (input, output, or calculated). Pulse frequency signals are a type of analog signal. Provide the same processing and functions for pulse frequency signals as are provided for analog signals.

DISPLAY

- Display all variables on appropriate Human Machine Interface (HMI) graphics. Display status for discrete variables such as ON/OFF/FAIL status for motors and OPEN/CLOSE/FAIL status for valves. Display value for analog variables such as process variables, set points, drive speeds, and valve positions. To prevent clutter and to ease operation, some displayed variables will not normally appear on displays but will be accessible through easily identifiable point-and-click targets. Runtime counters are an example of variables that might not normally appear.

PRESENT

A discrete signal is present when the contact producing the input is closed.

ALARM

Sound the alarm tone, indicate the alarm condition on appropriate HMI displays, and add to the HMI alarm summary display. Upon acknowledgement, silence the alarm tone and indicate the alarm condition on appropriate HMI displays and the alarm summary display. Remove acknowledged alarms from the alarm summary once they are cleared. Log alarm occurrence, acknowledgement, and clearance in the alarm log file. Unless otherwise noted or shown, provide alarm logic that resets automatically when the condition clears. Display alarms as follows:

- Display flashing yellow when Alarm is present and is Unacknowledged.
- Display steady yellow when Alarm is present and is Acknowledged.
- Display ceases when Alarm clears and is or has been Acknowledged.

ON (RUNNING)

A piece of process equipment having an adjustable speed motor is assumed ON when its AFD ON status contact is closed. A piece of process equipment is assumed ON when its normally open auxiliary motor contact (M-Contact) is closed.

TREND

At intervals appropriate for the variable being trended, place the current value of the analog variable, along with a time and date stamp, into a historical trend file for that variable. Display the trend on selectable HMI screens with appropriate scaling and units.

CLOSE FAIL

A valve is commanded-to-close, but is not confirmed closed within a preset time. Unless otherwise noted, a valve is confirmed closed by receiving a closed limit switch contact from the valve.

POSITION FAIL

A modulating valve is commanded to a set point position, but the valve is not confirmed to be within a preset percentage of set point within a preset time.

OPEN FAIL

A valve is commanded-to-open, but is not confirmed open within a preset time. Unless otherwise noted, a valve is confirmed open by receiving an opened limit switch contact from the valve.

RUN FAIL

A motor is commanded-to-run, but is not confirmed running within a preset time. Unless otherwise noted, running is confirmed by receiving an ON status M-contact from either the motor's starter or adjustable speed drive.

START

Issue a maintained Run command.

STOP

Cease the maintained Run command.

TOTALIZE

Integrate flow type variable with respect to time. Unless otherwise noted, include password protected operator reset that sets the totalized value to zero.

ELAPSED RUN TIME

Calculate the total time (in tenths of an hour) that a motor for a piece of process equipment has been in operation. For constant speed motors, use starter M-contacts to detect when the equipment or motor is running. For adjustable speed motors, use ON status contacts from the drive that close when the drive is in operation. For valves, calculate the time that the valve is open. Unless otherwise noted, include password protected operator reset that sets elapsed run time to zero.

CYCLE COUNT

Count the number of cycles a piece of equipment, valve, or motor undergoes. For equipment and motors, one cycle is defined as the transition from OFF to ON. For valves, one cycle is defined as the transition from CLOSED to OPEN.

TWO MODE FEEDBACK CONTROL

Maintain a process variable at a set point value by means of feedback control of a control variable such as pump speed or valve position using both proportional and integral action. During startup, tune the loop by adjusting proportional band and integral time settings. Provide a set point Deviation Alarm that is activated when the process variable deviates by more than x percent from set point for a sustained time. Provide password protected access to tuning parameters such as proportional band and reset rate.

Parameters Defined in the Specific Loops:

Process variable.

Process variable set point.

Controlled DEVICE.

Set point deviation alarm set point.

Controller is reverse acting unless otherwise noted in the specific loop.

FLOW PACING CONTROL

Provide an analog output to adjust the feed rate of the controlled device; e.g., adjustable speed pump, control valve position.

Analog output is the product of Manual Dosage Adjust and Process Flow rate. Units of analog output are in percent. Units of Manual Dosage Adjust are in mg/L. Constants used in calculating the product will be Control Narrative specific. Also include conversion factors to account for a controlled device with non-linear characteristics (such as an equal percentage control valve).

Parameters defined in the specific unit process control narratives include:

- Application point.
- Controlled device.
- Device group.
- Device group assignment.
- Process flow rate.
- Dosage units and substance.

COMPOUND LOOP TRIM CONTROL

Maintain a process variable at a set point value using both flow pacing and two mode feedback trim to control such parameters as pump speed and valve position. Limit the trim by limiting the two mode feedback controller output to a maximum percentage (in absolute value) of the flow pacing controller output. Controller is reverse acting unless otherwise noted in the specific loop.

During startup, tune the loop by adjusting the two mode feedback tuning parameters. Provide a set point Deviation Alarm, which is activated when the process variable deviates by more than x percent from set point for a sustained time. Provide password protected access to tuning parameters such as proportional band and dosage.

Parameters Defined in the Specific Loops:

Application Point.

Controlled Device.

Device Group.

Flow Pacing Parameters

Process variable.

Process Flowrate.

Dosage Units and Substance

Set point deviation alarm set point.

Trim Parameters

Process variable.

Process variable set point.

Step Time Duration

Time Smooth Period of Process Variable.

Attenuation Factor

Trim Controller Output, Range, Min Value

Trim Controller Output, Range, Max Value

Trim Adjustment, Max Absolute Value (Single Step) when PV greater than or equal to setpoint.

Trim Adjustment, Min Absolute Value (Single Step) when PV greater than or equal to setpoint.

Trim Adjustment, Max Absolute Value (Single Step) when PV less than or equal to setpoint.

Trim Adjustment, Min Absolute Value (Single Step) when PV less than or equal to setpoint.

GLOBAL FUNCTIONS

TAGS

Provide unique tags for each variable based on the following specification Format:

Number(s)	Letter(s)	Number(s)	Number(s)	Letter(s)
Unit Process Number	ISA designation of process and function	Loop Number	Parallel Unit Number	Suffix (if used)

Use the clarifying abbreviation to assure that all tags are unique. Use only the underscore character (_) as a separator to improve “human readability.”

Example: The speed feedback tag of Liquid Ammonium Sulfate Feed Pump No. 1 is:

578-P-02-01-SF

AVAILABLE (for AUTOMATIC/PLC Control)

In the PLC, generate an “AVAILABLE for automatic control” status signal when the equipment’s HAND/OFF/AUTO, ON/OFF/AUTO, or OPEN/CLOSE/AUTO selector is in the AUTO position [In PLC (aka In Remote) signal present]; no active alarms affecting the equipment are present; and the equipment is In-Service. Disable FAIL TO START/OPEN/CLOSE alarms when the selector is not in the AUTO position.

IN-SERVICE / OUT-OF-SERVICE

Assigning a piece of process equipment as in-service or out-of-service is done via manual entry on the HMI graphic. If the process equipment has a motor, disable all run commands to the motor.

Implement other in-service/out-of-service logic as described in the individual loop specifications.

Note: Even though a unit is placed out-of-service, it still might be used for secondary service. For example, if a storage tank is taken out-of-service, usually the logic to stop associated feed pump(s) on falling low level is disabled. However, this out-of-service tank may be filled by tanker truck. Thus, the level signal and high level alarms should still remain active.

AUTOMATIC (PLC) Control

Automatically sequence AVAILABLE equipment in accordance with these loop specifications.

BUMPLESS TRANSFER

Configure all “software” Manual/Auto switches to provide “bumpless transfer.”

1. Manual to Auto Transition:
 - a. Once the transition occurs, immediately start the device if the Auto Mode so commands.
 - b. For modulating devices, initially maintain the last manual control variable output value on transition to Auto. After the transition, enable the automatic control algorithm to commence incrementally from the final manual value.
3. Auto to Manual Transition:
 - a. If a device has been running in Auto, configure so it continues to run once placed in Manual.
 - b. If a device has not been running in Auto, configure so it does not run once placed in Manual.
 - c. If an adjustable speed device has been running at a certain speed in Auto, configure so it runs at the same speed once placed in Manual.
 - d. For all modulating devices, maintain the last analog control variable output value on transition to Manual.

RECOVERY AFTER A POWER OUTAGE

In general, provide the following control action when power resumes after an outage:

1. For process equipment with small [less than 2] horsepower motors, resume the previous state, e.g., if the motor is running before a power outage, it resumes running after power recovery.
2. For process equipment with horsepower motors greater than 2 horsepower, time stagger these starts. Provide an individual stagger timer for each piece of equipment started from the PLCs. Set timers so that all equipment has been commanded to start within 120 seconds after power has resumed.
3. Certain major equipment shall require a manual restart after recovery from a power outage. During plant startup, if warranted, provide manual restart for other equipment on an as needed basis.
4. Unless otherwise noted, assign process equipment into groups that are programmed to start in a preassigned sequence. Starting equipment within the next group in the sequence only occurs after all process equipment in the preceding group has been called to run.

Within each group, stagger start each group member.

DISPLAY

Display all discrete and all analog variables that are shown on the P&IDs. The following provides additional guidance:

Process variables, include analytical variables, flowrate, level, pressure, temperature and weight:

Display the process variable.

Unless otherwise noted, create and display High High and Low Low alarms.

ADJUSTABLE PARAMETER ACCESS

Provide password protected display of and entry/modification of all adjustable parameters including, but not limited to, set points, tuning coefficients (for example proportional and integral), timer presets, and alarm trip points.

Present these parameters in an efficient easily navigated format. Provide adequate information to allow the facility maintenance staff to easily identify each variable. The intent is to allow maintenance staff to tune facility performance and operation without having to alter the PLC program.

NUISANCE ALARM SUPPRESSION

Provide nuisance alarm suppression by conditioning alarm signals. For example, disable all but selected alarms when power is off, and include startup delays, momentary excursion delays, and contact bounce delays.

Suppress dysfunctional alarms during and immediately following power outages. For alarms that normally disable equipment, if the alarm becomes dysfunctional during and immediately following the power outage, then do not disable that applicable equipment.

ALARM PRIORITIZATION

Prioritize alarms into two levels: critical and noncritical. Categorize alarms into unit process categories.

RUN FAIL ALARM

Provide a run fail alarm for each motor. Upon motor run fail, remove the run command.

FAIL ALARM

Provide a fail alarm for each fail condition. Upon fail, remove the run command.

FIELD ALARM

Provide an alarm for each field alarm input into a PLC.

OPEN FAIL ALARM

Provide an open fail alarm for each non-modulating valve with opened status feedback; for example, limit switch. Upon open fail, remove the open command.

CLOSE FAIL ALARM

Provide a close fail alarm for each non-modulating valve with closed status feedback; for example, limit switch. Upon close fail, remove the close command.

POSITION FAIL ALARM

Provide a position fail alarm for each modulating valve with position feedback.

PANEL LOSS OF INCOMING POWER ALARM

For those panels that monitor incoming power, alarm loss of power.

Note: If this monitoring signal is not shown as a discrete input on the P&IDs, include it as a PLC discrete input and show it on the submitted panel wiring diagrams.

TOTALIZERS

Provide totalizers for all flow type variables: flow, chemical feed rate, etc.

Totalize within the PLC, and display on the HMI.

Totalizer shall be 6-digit: Select units such that totalizer would reach 999,999 if the input remained as full scale continuously of an interval between 0.5 and 5 years.

Each totalizer shall reset either to 0 at 30,000 counts or by a reset command, supervisor-accessible, from the HMI.

Create a threshold detector to inhibit the totalizer until the process value is greater than a preset percentage of the scale range.

Unless otherwise noted, provide supervisor-accessible reset of totalized value.

Create and display totalization for 5 different time periods as follows:

Today's totalized flowrate.

Yesterday's totalized flowrate.

This month's totalized flowrate.

Last month's totalized flowrate.

"Lifetime" totalized flowrate, until reset as above. Display the starting time and date of the newly reset totalization.

ELAPSED RUN TIME INDICATORS

Provide elapsed run time counters for each process equipment motor, including valves.

Increment counters after each tenth of an hour of operation. Maintain a non-resettable 99,999 hour cumulative counter that rolls over to zero after 99,999 hours. Indicate runtime counters on appropriate HMI displays. Perform all logic in the PLC.

CYCLE COUNTERS

Provide a cycle counter for each motor and electrical equipment including valves.

Maintain a non-resettable 99,999 start cumulative counter that rolls over to zero after 99,999 counts. Indicate counters on appropriate HMI displays. Start counter logic shall be performed in the PLC.

TREND

Trend all analog variables transmitted to the SCADA system.

COMMUNICATIONS WATCHDOG (applies to any PLC or SCADA link).

Create a watchdog alarm at the HMI if any PLC does not communicate within a preset time. To avoid nuisance alarming, make the preset at least three times the nominal update period for the specific device. This nominal update period will be noted during startup. At the HMI, provide a manual means to disable communications alarms during extreme conditions such as storms or network outages. When communications watchdog alarms are disabled, display a message at the HMI indicating such.

For PLC controlled equipment operating under HMI Manual control, maintain equipment in the last state following a loss of communications. For PLC controlled equipment under automatic PLC control, maintain automatic equipment control and sequencing during a loss of communications.

FUTURE EQUIPMENT

If future equipment is shown in the I/O listing for a site, provide all PLC/HMI code and PLC/HMI tags and graphics for the future equipment. Indicate the unavailable status of all future equipment on HMI screens by means of distinctive color and text. Set the HMI tags off scan and disable alarming for all future equipment.

MODULAR FUNCTIONS**MANUAL/OFF/AUTO CONTROL****PMCS Discrete Displays and Controls**

Provide and display Manual/Off/Auto of the controlled device.

Manual Mode:

For a constant-speed pump, provide and display Start/Stop control.

For an adjustable-speed pump, provide and display Start/Stop control and manual speed adjust.

For an Open/Close valve, provide and display Open and Close Commands.

For a modulating valve, provide and display manual position adjust.

Off Mode: No control action.

Auto Mode: As described in the individual loop specification.

Note: Incorporate the “In Remote” status signal into the strategy. Manual/Off/Auto control shall be permitted to operate only if the “In Remote” signal is present.

MANUAL ASSIGNMENT/AUTO ALTERNATION

PMCS Discrete Displays

Change assignments (alternate) a group of controlled equipment in a predetermined automatic sequence.

Provide alternation that is either manually assigned or triggered automatically. Configure a software switch of the form:

X / X+1 / X+2 / etc./ ALT where

X+N... series represents each piece of equipment in the controlled equipment group.

In Manual, one piece of equipment is manually assigned as the Lead device, and other pieces of controlled equipment are accordingly assigned. Unless otherwise noted, the following example illustrates the convention:

For pumps 1, 2, 3 in a three-pump group, permissible manual assignments are:

1, 2, 3

2, 3, 1

3, 2, 1

ALT represents the mode where alternation is triggered automatically. For example, suppose there are three pumps in a group. Configure a 1/2/3/ALT selector switch to provide the following assignments.

Selector Position	Lead	Lag	Lag 2
1	1	2	3
2	2	3	2
3	3	1	2
ALT	Automatically alternate as per trigger		

See specific unit process requirements for:

Sequence.

Controlled equipment group.

Alternation Trigger. See Specific Unit Process Requirements for:

Sequence.

Controlled equipment group.

Alternation trigger.

MODULAR FUNCTION: Flow Pacing

PMCS Discrete Displays

PMCS Value Displays

Active substance.

Active substance required (dosage set point by process flow).

Active feed pump rate, in bulk units (gph).

Active feed pump rate, in units of active substance (gph).

Process flow.

Dosage set point.

Pump capacity.

Also, display the following values necessary to calculate active solution strength in the storage tank:

Solution density (bulk pounds per gallon).

Solution Concentration (% active substance).

PMCS Display and Control Functions

Provide flow pacing of the controlled equipment, including manual dosage adjustment.

Calculate in real time the pump speed required for flow pacing. Required variables in the calculation include:

Solution density (bulk pounds per gallon).

Solution Concentration (% active substance).

Pump Capacity (gph).

Process Flowrate (gpm).

Dosage set point (mg/l).

Review calculation equation with Engineer and Owner during the submittal process.

Basic Flow Pacing Equation in Common Units.

(When Process Flow is in MGD).

Accept operator Inputs:

Dosage [mg/l]

Volumetric Pump Capacity [gal/hr.]

Bulk Density [lbs/gal]

Percent Bulk Strength (=Percent Active Chemical) [%]

Calculate the active chemical demand flow as follows:

[Demand, Active Chemical] = $0.3477 * [\text{Dosage}] * [\text{Process Flow}]$, units as follows:

[Demand, Active Chemical] = [lbs/hr.]

[Dosage] = [mg/l]

[Process Flow] = [MGD]

Calculate the active chemical pump capacity at 100 percent as follows:

[Pump Capacity, Active Chemical] = [Volumetric Pump Capacity] * [Bulk Density] * [Percent Bulk Strength/100], units as follows:

[Pump Capacity, Active Chemical] = [lbs/hr.]

[Volumetric Pump Capacity] = [gal/hr.]

[Bulk Density] = [lbs/gal]

Calculate the pump speed as follows:

[Pump Speed] = $100 * [\text{Demand Flow, Active Chemical}] / [\text{Pump Capacity, Active Chemical}]$
 $= 10,000 * (0.3477 * [\text{Dosage}] * [\text{Process Flow}] / ([\text{Volumetric Pump Capacity}] * [\text{Bulk Density}] * [\text{Percent Bulk Strength}])$

[Pump Speed] = [%]

Example:

Ferric Chloride dosing with the following operator inputs/given values:

Dosage	[2 mg/l]
Volumetric Pump Capacity	[20 gal/hr.]
Bulk Density	[11.93 lbs/gal]
Percent Bulk Strength	[40 %]
Process Flow	[3 MGD]

[Pump Speed] = $100 * [\text{Demand Flow, Active Chemical}] / [\text{Pump Capacity, Active Chemical}]$
 $= 10,000 * (0.3477 * [2 \text{ mg/l}] * [3 \text{ MGD}]) / ([20 \text{ gal/hr.}] * [11.93 \text{ lbs/gal}] * [40])$

[Pump Speed] = 2.19 %

(When Process Flow is in gpm)

Accept operator Inputs:

Dosage	[mg/l]
Volumetric Pump Capacity	[gal/hr.]
Bulk Density	[lbs/gal]
Percent Bulk Strength (=Percent Active Chemical)	[%]

Calculate the active chemical demand flow as follows:

[Demand Flow, Active Chemical] = $5.007 \times 10^{-4} * [\text{Dosage}] * [\text{Process Flow}]$, units as follows:

[Demand Flow, Active Chemical] = [lbs/hr.]

[Dosage] = [mg/l]

[Process Flow] = [gpm]

Calculate the active chemical pump capacity at 100% as follows:

[Pump Capacity, Active Chemical] = $[\text{Volumetric Pump Capacity}] * [\text{Bulk Density}] * [\text{Percent Bulk Strength}/100]$

[Pump Capacity, Active Chemical] = [lbs/hr.]

[Volumetric Pump Capacity] = [gal/hr.]

[Bulk Density] = [lbs/gal]

Calculate the pump speed as follows:

$$[\text{Pump Speed}] = 100 * [\text{Demand Flow, Active Chemical}] / [\text{Pump Capacity, Active Chemical}] = 10,000 * (5.007 \times 10^{-4} * [\text{Dosage}] * [\text{Process Flow}] / ([\text{Volumetric Pump Capacity}] * [\text{Bulk Density}] * [\text{Percent Bulk Strength}]))$$

$$[\text{Pump Speed}] = [\%]$$

Example:

Ferric Chloride dosing with the following operator inputs/given values:

Dosage	[2 mg/l]
Volumetric Pump Capacity	[20 gal/hr.]
Bulk Density	[11.93 lbs/gal]
Percent Bulk Strength	[40 %]
Process Flow	[3,000 gpm]

$$[\text{Pump Speed}] = 100 * [\text{Demand Flow, Active Chemical}] / [\text{Pump Capacity, Active Chemical}] = 10,000 * (5.007 \times 10^{-4} * [2 \text{ mg/l}] * [3,000 \text{ gpm}] / ([20 \text{ gal/hr.}] * [11.93 \text{ lbs/gal}] * [40]))$$

$$[\text{Pump Speed}] = 3.15\%$$

MODULAR FUNCTION: Compound Loop Trim Control & Flow Pacing

PMCS Discrete Displays

PMCS Value and Control Displays

Enable/Disable Trim Function

Flow Pacing Parameters:

Active substance.

Active substance required (dosage set point by process flow).

Active feed pump rate, in bulk units (gph).

Active feed pump rate, in units of active substance (gph).

Process flow

Dosage set point.

Pump capacity.

Trim Parameters

Process variable.

Process variable set point.

Step Time Duration

Time Smooth Period of Process Variable.

Attenuation Factor

Trim Controller Output, Range, Min Value

Trim Controller Output, Range, Max Value

Trim Adjustment, Max Absolute Value (Single Step) when PV greater than or equal to setpoint.

Trim Adjustment, Min Absolute Value (Single Step) when PV greater than or equal to setpoint.

Trim Adjustment, Max Absolute Value (Single Step) when PV less than or equal to setpoint.

Trim Adjustment, Min Absolute Value (Single Step) when PV less than or equal to setpoint.

Also, display the following values necessary to calculate active solution strength in the storage tank:

Solution density (bulk pounds per gallon).

Solution Concentration (% active substance).

PMCS Control Functions

Provide compound loop trim control of the controlled equipment.

Flow pacing control output is multiplied by trim controller output. Limit the trim controller output so it does not dominate flow pacing control.

The basic control strategy for trim control is:

Based on ongoing timed steps. While in a current step,

Trim controller output is constant.

Several error functions are calculated based on how far way the process variable is from setpoint. This results in calculating a trim adjustment that is used in the next step.

During the next step, the trim controller output is the sum of the trim controller output of the previous step and the trim adjustment calculated in the previous step.

Provide Enable/Disable selection of the trim control function. When in Disable, control reverts to Flow Pacing.

See the supplemental figure and spreadsheet titled “Trim Control Action” for further description of trim control.

Calculations

Calculate in real time the pump speed required for compound loop trim control. Required variables in the calculation include:

Trim Term

See the supplemental spreadsheet titled “Trim Control Action”.

Flow Pacing Term:

Solution density (bulk pounds per gallon).

Solution Concentration (% active substance).

Pump Capacity (gph).

Process Flowrate (gpm).

Dosage set point (mg/l).

Review calculation equation with Engineer and Owner during the submittal process.

Basic Flow Pacing Equation in Common Units.

(When Process Flow is in MGD).

Accept operator Inputs:

Dosage	[mg/l]
Volumetric Pump Capacity	[gal/hr.]
Bulk Density	[lbs/gal]
Percent Bulk Strength (=Percent Active Chemical)	[%]

Calculate the active chemical demand flow as follows:

[Demand, Active Chemical] = $0.3477 * [\text{Dosage}] * [\text{Process Flow}]$, units as follows:

[Demand, Active Chemical] = [lbs/hr.]

[Dosage] = [mg/l]

[Process Flow] = [MGD]

Calculate the active chemical pump capacity at 100 percent as follows:

[Pump Capacity, Active Chemical] = [Volumetric Pump Capacity] * [Bulk Density] * [Percent Bulk Strength/100], units as follows:

[Pump Capacity, Active Chemical] = [lbs/hr.]

[Volumetric Pump Capacity] = [gal/hr.]

[Bulk Density] = [lbs/gal]

Calculate the pump speed as follows:

[Pump Speed] = $100 * [\text{Demand Flow, Active Chemical}] / [\text{Pump Capacity, Active Chemical}]$
 $= 10,000 * (0.3477 * [\text{Dosage}] * [\text{Process Flow}] / ([\text{Volumetric Pump Capacity}] * [\text{Bulk Density}] * [\text{Percent Bulk Strength}]))$

[Pump Speed] = [%]

Example:

Ferric Chloride dosing with the following operator inputs/given values:

Dosage	[2 mg/l]
Volumetric Pump Capacity	[20 gal/hr.]
Bulk Density	[11.93 lbs/gal]
Percent Bulk Strength	[40 %]
Process Flow	[3 MGD]

$[\text{Pump Speed}] = 100 * [\text{Demand Flow, Active Chemical}] / [\text{Pump Capacity, Active Chemical}] = 10,000 * (0.3477 * [2 \text{ mg/l}] * [3 \text{ MGD}]) / ([20 \text{ gal/hr.}] * [11.93 \text{ lbs/gal}] * [40])$

$[\text{Pump Speed}] = 2.19 \%$

(When Process Flow is in gpm)

Accept operator Inputs:

Dosage	[mg/l]
Volumetric Pump Capacity	[gal/hr.]
Bulk Density	[lbs/gal]
Percent Bulk Strength (=Percent Active Chemical)	[%]

Calculate the active chemical demand flow as follows:

$[\text{Demand Flow, Active Chemical}] = 5.007 \times 10^{-4} * [\text{Dosage}] * [\text{Process Flow}]$, units as follows:

$[\text{Demand Flow, Active Chemical}] = [\text{lbs/hr.}]$

$[\text{Dosage}] = [\text{mg/l}]$

$[\text{Process Flow}] = [\text{gpm}]$

Calculate the active chemical pump capacity at 100% as follows:

$[\text{Pump Capacity, Active Chemical}] = [\text{Volumetric Pump Capacity}] * [\text{Bulk Density}] * [\text{Percent Bulk Strength}/100]$

$[\text{Pump Capacity, Active Chemical}] = [\text{lbs/hr.}]$

$[\text{Volumetric Pump Capacity}] = [\text{gal/hr.}]$

$[\text{Bulk Density}] = [\text{lbs/gal}]$

Calculate the pump speed as follows:

$$[\text{Pump Speed}] = 100 * [\text{Demand Flow, Active Chemical}] / [\text{Pump Capacity, Active Chemical}] = 10,000 * (5.007 \times 10^{-4} * [\text{Dosage}] * [\text{Process Flow}] / ([\text{Volumetric Pump Capacity}] * [\text{Bulk Density}] * [\text{Percent Bulk Strength}])$$

$$[\text{Pump Speed}] = [\%]$$

Example:

Ferric Chloride dosing with the following operator inputs/given values:

Dosage	[2 mg/l]
Volumetric Pump Capacity	[20 gal/hr.]
Bulk Density	[11.93 lbs/gal]
Percent Bulk Strength	[40 %]
Process Flow	[3,000 gpm]

$$[\text{Pump Speed}] = 100 * [\text{Demand Flow, Active Chemical}] / [\text{Pump Capacity, Active Chemical}] = 10,000 * (5.007 \times 10^{-4} * [2 \text{ mg/l}] * [3,000 \text{ gpm}] / ([20 \text{ gal/hr.}] * [11.93 \text{ lbs/gal}] * [40])$$

$$[\text{Pump Speed}] = 3.15\%$$

MODULAR FUNCTION: Tank Level Drop Rate Indication and Alarm

Purpose of this function is to alarm a potential leak in the tank/piping delivery system.

Create a tank level drop rate variable. Units are in inches of tank level / hour. Calculate this variable continuously, even though time units are in hours.

Time smooth this variable.

Display the time-smoothed tank level drop rate on the HMI.

Create an alarm setpoint as follows:

- With no feed pumps running: Alarm setpoint is a constant value, with initial setpoint of 3 inches/hour.

For the case of multiple tanks, base the initial setpoint assuming all tanks in service. But adjust the setpoint based on number of tanks in service. For example, suppose there are three tanks total. With all tanks in-service, enter the initial setpoint as 3-inches per hour, falling. With only two tanks-in-service, increase alarm setpoint to 4.5 inches, falling.

- With any feed pump running, alarm setpoint is a variable, and is a multiple of the instantaneous summed flowrate command to all pumps. Initial setpoint of the multiple is 3.0.
- Example: Suppose the summed flowrate command to all pump is 150 gph, which say is equivalent to a drop rate of 2 inches / hour. If the drop rate exceeds 6 inches an hour, then issue an alarm (but do not stop the feed pumps).

For the case of multiple tanks, adjust the setpoint to account for number of in-service tanks with logic similar to above.

Display the following setpoints, and make each adjustable from the HMI.

Alarm setpoint with no pumps running: Tank drop rate in units of inches/hr.

Alarm setpoint with pumps running: Tank drop rate in units of inches/hr.

- Also display the multiple value used in this calculation.

If the time-smoothed tank level drop rate exceeds the alarm setpoint, display an alarm on the HMI.

Trend the time-smoothed tank level drop rate.

UNIT PROCESS LOOP SPECIFICATIONS

Note: These unit process loop specifications specify certain displays and functions. Also provide displays as per global functions, modular functions, and as shown on the P&IDs.

Prior to configuring and programming, participate in a coordination meeting with the Owner to discuss their preferences. Modify accordingly. In many cases, it is anticipated that existing displays and functions shall be matched as closely as possible.

Drawing 008-N-601, Unit Process 580, Corrosion Inhibitor, Storage Tank and Feed System

Overview: Discharge from the existing transfer pumps is sent to the recharge well at a controlled rate by means of a modulating valve. Well inlet pressure is measured, as is recharge well level. On occasion, the recharge well is under artesian pressure when well is at maximum level.

Loop 01, Well Inlet Flow Control

PMCS Display and Control Functions

Display flowrate 580FE-01-01.

Totalize and display above flowrate.

Provide Manual/Off/Auto control of modulating valve 580FCV-01-01.

Auto Mode:

- Provide two mode feedback control of the modulating valve, with parameters of:
 - Process Variable: Flowrate, 580FE-01-01.
 - Controlled Device: 580FCV-01-01.
 - Setpoint Units, MGD.
- Maximum allowable setpoint is 14.9 MGD. Issue alert on screen if there is attempt to change the setpoint to 15 MGD and above.
- Alarm if flowrate is a sustained rising High flowrate. Initial settings are 60 seconds, sustained and High flowrate = 16 MGD, rising. Display both sustained time and High flowrate settings.

Loop 02, Well Inlet Pressure

Display pressure.

Alarm rising high pressure with an initial setting of 95 psig, rising.

Loop 03, Well Level

Display level.

When level exceeds max level, well is at artesian pressure. Issue alert, “Well under Artesian Pressure”.

Calculate and display well artesian pressure, as follows:

Artesian pressure (psig) = $[(\text{Level (in ft.)} - \text{Max level (in ft.)}) / 2.31]$

Drawing 08-N-602, Unit Process 005, Monitoring Wells

Overview: Each of the two monitoring wells includes a submersible sampling pump. Each well level is measured. Each discharge flowrate is measured, but only displayed locally.

Loop 01, Well Level and Discharge Flowrate

Measure each discharge flowrate, but display only locally.

Display each monitoring well level.

When level exceeds max level, well is at artesian pressure. Issue alert, “Well under Artesian Pressure”.

Calculate and display well artesian pressure, as follows:

Artesian pressure (psig) = $[(\text{Level (in ft.)} - \text{Max level (in ft.)}) / 2.31]$

Drawing 008-N-603, Unit Process 578, Liquid Ammonium Sulfate Storage Tank and Feed System

Overview: There are four feed pumps. Pumps 1 and 2 are dedicated to feeding liquid ammonium sulfate to the AB Filter influent pipe. Pumps 3 and 4 are dedicated to feeding liquid ammonium sulfate to the disc filter effluent pipe. One storage tank supplies all four pumps. For pumps 1 and 2, there are two auto mode control strategies; namely, flow pacing and compound loop trim control. For pumps 3 and 4, flow pacing is the auto mode control strategy.

Loop 01, Storage Tank and Safety Shower

PMCS Display and Control Functions

Display level.

Create and display an alarm on rising high level. Retransmit the alarm signal to activate light and horn on local panel 578-FP-01.

Display the safety shower alarm.

Implement the **Tank Level Drop Rate Indication and Alarm Modular Function** for:

Liquid Ammonium Sulfate Storage Tank

Loop 02, Feed Pumps

PMCS Display and Control Functions

For each pump, display status, alarms, and values as shown on the P&IDs; namely,

Fail Alarm

On Status.

Under Remote Control Status.

Speed Adjust Command.

Speed Feedback.

Feed Pumps 1 and 2, ABW Filter Influent Pipe Application Point

Provide Active / Standby Selection of Pumps 1 and 2.

Provide Manual/Off/Auto control of each pump.

In Auto,

- Provide compound loop trim control. When trim control is disabled, control reverts to flow pacing control. Select and display each active control mode.
- Provide compound loop trim control of the active pump, with parameters as follows:
 - Application: ABW Filter Influent Pipe.
 - Process Flowrate Variable: The sum of the existing three effluent flowmeters in the chlorine contact basins.

- Process variable: Ammonium Ion.
 - Process variable setpoint, initial value: 1.5 mg/l ammonium.
 - Dosage: Manual setpoint, in units of mg/l ammonium.
 - Controlled Device: Active Feed Pump
 - Equipment Group: Feed Pumps 1 and 2.
 - Other parameters as per Supplement Trim Control Action Setpoint.
-
- Enable the Active pump to run when process flowrate is sustained above rising low for a present time, initial setting = 30 seconds. Field determine suitable rising low flowrate setpoint.
 - Create and display a fail alarm signal if the pump has been called to run, but has not been confirmed running as determined by its On status contact within a preset time, within an initial setting of 10 seconds.
 - If the active pump fails, then “fail-over” and replaced with the standby pump.
 - Provide Enable/Disable selection of pump “fail-over”.

Feed Pumps 3 and 4, Disc Filter Effluent Pipe Application Point

Provide Active / Standby Selection of Pumps 3 and 4.

Provide Manual/Off/Auto control of each pump.

In Auto,

- Provide flow pacing of the active pump, with parameters as follows:
 - Application: Disc Filter Effluent Pipe.
 - Process Flowrate Variable: Existing flowmeter that measures storage pond return flowrate.
 - Dosage: Manual setpoint, in units of mg/l ammonium.
 - Controlled Device: Active Feed Pump
 - Equipment Group: Feed Pumps 3 & 4.

- Enable the Active pump to run when process flowrate is sustained above rising low for a present time, initial setting = 30 seconds. Field determine suitable rising low flowrate setpoint.

- Create and display a fail alarm signal if the pump has been called to run, but has not been confirmed running as determined by its On status contact within a preset time, within an initial setting of 10 seconds.
 - If the active pump fails, then “fail-over” and replaced with the standby pump.
 - Provide Enable/Disable selection of pump “fail-over”.

Drawing 08-N-604, Liquid Ammonium Sulfate Injection and Monitoring

Overview:

The ammonium ion is measured by two sensors in the channel upstream the chlorine channel basins. Due to existing conduit/conductor limitations, only one analog signal is transmitted to existing plant PLC. This signal will be used in the control strategy of Liquid Ammonium Sulfate Feed Pumps 1 and 2.

Probes in four locations associated with the existing chlorine contact basins measure ORP, Display each ORP value. Note that ORP will not be used in real time control of the feed pumps.

PMCS Displays

Ammonium Concentration, Upstream Chlorine Contact Basin

ORP Value, Chlorine Contact Basin 1.

ORP Value, Chlorine Contact Basin 2.

ORP Value, Chlorine Contact Basin 3.

ORP Value, Disc Filter Effluent.

END OF LOOP SPECIFICATIONS

INSTRUMENT LIST						
DWG	TAG	QTY	CODE	Code and Description	Options (See P&IDs for Options, unless otherwise noted.)	Standard Details
008-N-601	580FE-01-01 / 580FIT-01-01	1	F04A	Flow Element and Transmitter,	Line Size: 24-inches; Process Range = 5 - 15-MGD; Scale Range = 0 - 16-MGD.	See P&IDs
008-N-601	580PIT-02-01	1	P9	Pressure Transmitter	Process Range: 30 - 100 psig; Scale Range: 0-120 psig.	See P&IDs
008-N-601	580LE-03-01 / 580LIT-03-01	1	L143	Level Transmitter, Pressure, Submersible, Wells, Type D	Zero Reference: 20 ft. below wellhead; Range: 0 - 20 ft plus an artesian pressure of 10 ft. Thus the adjusted required range is 0 - 30 ft.	See P&IDs
008-N-601	580FI-03-01	1	F16B	Flow Element, Rotameter	Flowrate Range: 0 - 0.38 gpm ; Connection Size: 1/2-inch NPTF	See P&IDs
008-N-601	580FI-03-02	1	F16B	Flow Element, Rotameter	Flowrate Range: 0 - 2.0 gpm ; Connection Size: 1/2-inch NPTF	See P&IDs
008-N-602	005LE-01-X / 005LIT-01-X, where X=01,02.	2	L143	Level Transmitter, Pressure, Submersible, Wells, Type D	Zero Reference: 30 ft. below grade; Range: 0 - 30 ft plus artesian pressure of 10 ft. Thus, adjusted range is 0 - 40 ft.	See P&IDs
008-N-602	005FI-01-X/ 005FQ-01-X, where X=1,2	2	F319	Turbine Meter, Corrosive Service	Flow Range: 40-60 gpm; Size: 2-inches	See P&IDs
008-N-603	578LT-01-01	1	L05E	Level Element and Transmitter, Ultrasonic	Zero Reference: Tank Bottom; Range: 0 - 12 ft.	See P&IDs
008-N-603	578LI-01-01	1	S724	Indicator, NEMA 4X, Sunlight, Readable		
008-N-603	578LLH-01-01	1	M26	Handswitch, Light, or Pushbutton, NEMA 4X	Device: Light, Amber Lens	
008-N-603	578HS-01-01 [SILENCE]	1	M26	Handswitch, Light, or Pushbutton, NEMA 4X	Device: Pushbutton	
008-N-603	578YA-01-01	1	M30	Horn, Indoor/Outdoor		
008-N-604	570HS-01-01[A/B]	1	M26	Handswitch, Light, or Pushbutton, NEMA 4X	Device: Handswitch	
008-N-604	570AE-01-01A/ 570AE-01B / 570AIT- 01-01[NH4]	1	A140	Ammonium-Nitrate Analyzer	Process Range: 0 - 5 mg/l ammonium; Furnish pole mount kit assembly.	See P&IDs
008-N-604	570AE-01-02/ 570AE- 01-03 / 570AIT-01- 23[ORP]	1	A105	ORP Element and Analyzer/Transmitter	Process Range: 200 - 800 mv; Wall and pipe mounting kit not required.	See P&IDs
008-N-604	570AE-01-04/ 570AE- 01-05 / 570AIT-01- 45[ORP]	1	A105	ORP Element and Analyzer/Transmitter	Process Range: 200-800 mv; Wall and pipe mounting kit not required.	See P&IDs
008-N-604	570AY-01-X[I/I] X=02,03,04,05	4	S600	Analog Signal Isolator, 4-Wire		

PLC I/O LIST								
DWG	PLC	Tag	IO Function	Description	DI	DO	AI	AO
008-N-601	SP-08-PLC-1	580FCV-01-01	Remote	Recharge Flow Control Valve	1			
008-N-601	SP-08-PLC-1	580FCV-01-01	Position Command	Recharge Flow Control Valve				1
008-N-601	SP-08-PLC-1	580FCV-01-01	Position Feedback	Recharge Flow Control Valve			1	
008-N-601	SP-08-PLC-1	580FIT-01-01	Flow	Recharge Flow Mag Meter			1	
008-N-601	SP-08-PLC-1	580PIT-02-01	Pressure	Recharge Pressure			1	
008-N-601	SP-08-PLC-1	580LIT-03-01	Level	Recharge Well			1	
008-N-602	SP-08-PLC-1	005LIT-01-01	Level	Monitor Well No.1			1	
008-N-603	SP-02-PLC-1	578FSH-01-01	Flow	Eyewash Station Flow Detected	1			
008-N-603	SP-02-PLC-1	578LT-01-01	Level	Ammonia Sulfate Storage Tank No.1			1	
008-N-603	SP-02-PLC-1	578-P-02-0Y, Y=1..4	Fault	Ammonia Sulfate Pump (1-4)	4			
008-N-603	SP-02-PLC-1	578-P-02-0Y, Y=1..4	Run Indication	Ammonia Sulfate Pump (1-4)	4			
008-N-603	SP-02-PLC-1	578-P-02-0Y, Y=1..4	In Remote	Ammonia Sulfate Pump (1-4)	4			
008-N-603	SP-02-PLC-1	578-P-02-0Y, Y=1..4	Run Command	Ammonia Sulfate Pump (1-4)		4		
008-N-603	SP-02-PLC-1	578-P-02-0Y, Y=1..4	Speed Feedback	Ammonia Sulfate Pump (1-4)			4	
008-N-603	SP-02-PLC-1	578-P-02-0Y, Y=1..4	Speed Command	Ammonia Sulfate Pump (1-4)				4
008-N-604	SP-02-PLC-1	570AIT-01-0Y, Y=2..5	ORP Value	Chlorine Contact Basin ORP			4	
008-N-604	SP-01-PLC-1	570AIT-01-01	NH4 Value	Chlorine Contact Effluent Chamber NH4			1	
				SP-08-PLC-1	1	0	5	1
				SP-02-PLC-1	13	4	9	4
				SP-01-PLC-1	0	0	1	0
				I/O Total	14	4	15	5

Control Panel Schedule

DWG	TAG	NAMEPLATE	Panel Description	SIZE (H x W x D)	NEMA Rating	Options (See P&IDs for Options, unless otherwise noted.)	Standard Details
008-N-602	005-RTU-02	005-RTU-02	Monitoring Well No.2 RTU Panel	(By Radio Vendor)	4X	(By Radio Vendor)	4091-440
008-N-603	578-FP-01	578-FP-01	Liquid Ammonia Sulfate Storage Tank No.1 Fill Panel	24"x24"x8"	4X	Hoffman Type 4X Wall Mount 304 SST factory painted white. 3pt padlocking handle. Cat. No. A24H2408SSLP3PTW	4091-402BG 4091-384 4091-422G
008-N-603	578-FP-02-01	578-FP-02-01	Liquid Ammonia Sulfate Feed Pump Control Panel No.1	(By Pump Package Vendor)	4X	(By Pump Package Vendor)	
008-N-603	578-FP-02-02	578-FP-02-02	Liquid Ammonia Sulfate Feed Pump Control Panel No.2	(By Pump Package Vendor)	4X	(By Pump Package Vendor)	
008-N-604	570-FP-01-01	570-FP-01-01	Chlorine Contact Basin NH4 Analyzer Panel	24"x24"x8"	4X	Hoffman Type 4X Wall Mount 304 SST factory painted white. 3pt padlocking handle. Cat. No. A24H2408SSLP3PTW	4091-402BG 4091-384 4091-435GD
008-N-604	570-FP-01-02	570-FP-01-02	Chlorine Contact Basin ORP Analyzer Panel	30"x24"x8"	4X	Hoffman Type 4X Wall Mount 304 SST factory painted white. 3pt padlocking handle. Cat. No. A30H2408SSLP3PTW	4091-388G

Surge Suppressor Products Table

SS Type	Application	Enclosure/ Mounting	Manufacturer/ Model	Principle of Operation/ Performance Criteria	Comments/ Performance Criteria
1	Protect 120V ac, single-phase power in control panels	NEMA Rating: None Locate inside panel	Emerson EDCO, HSP-121; or approved equal	Principle of Operation: Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device Performance Criteria: 1) ARC: Handles 60 kA on 10 by 350 waveform 2) MOV: Handles 40 kA on 8 by 20	Nominal Amp Capacity: 15A Provide parallel units if needed
1	Protect 120V ac, single-phase power in control panels	NEMA Rating: None Locate inside panel	Mains-Plugtrab; Phoenix Contact, PT 2-PE/S	Principle of Operation: Gas tube and varistors. Nominal discharge surge current when subject to 8/20 waveform testing: 10 kA	Nominal Amp Capacity: 20A; provide parallel units if needed
2	Protect analog signals within control panels	NEMA Rating: None Locate inside panel	Emerson EDCO, PC-642 or SRA-64; or approved equal	Principle of Operation: Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device	Tested and rated for 50 occurrences of 2,000-amp peak test waveform. Provide as needed
2	Protect analog signals within control panels	NEMA Rating: None Locate inside panel	Phoenix Contact; TT-2-PE-24DC	Principle of Operation: Three Stage 1) Gas-filled arrestors for coarse protection 2) Medium protection varistors 3) Final stage suppressor diodes	Nominal discharge surge current when subject to 8/20 wave form testing: 5kA per path
3	Analog signal of 2-wire transmitters	Field installed in stainless steel pipe nipple adjacent to 2-wire transmitter	Emerson EDCO, SS64 Series; or approved equal	Principle of Operation: Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device	

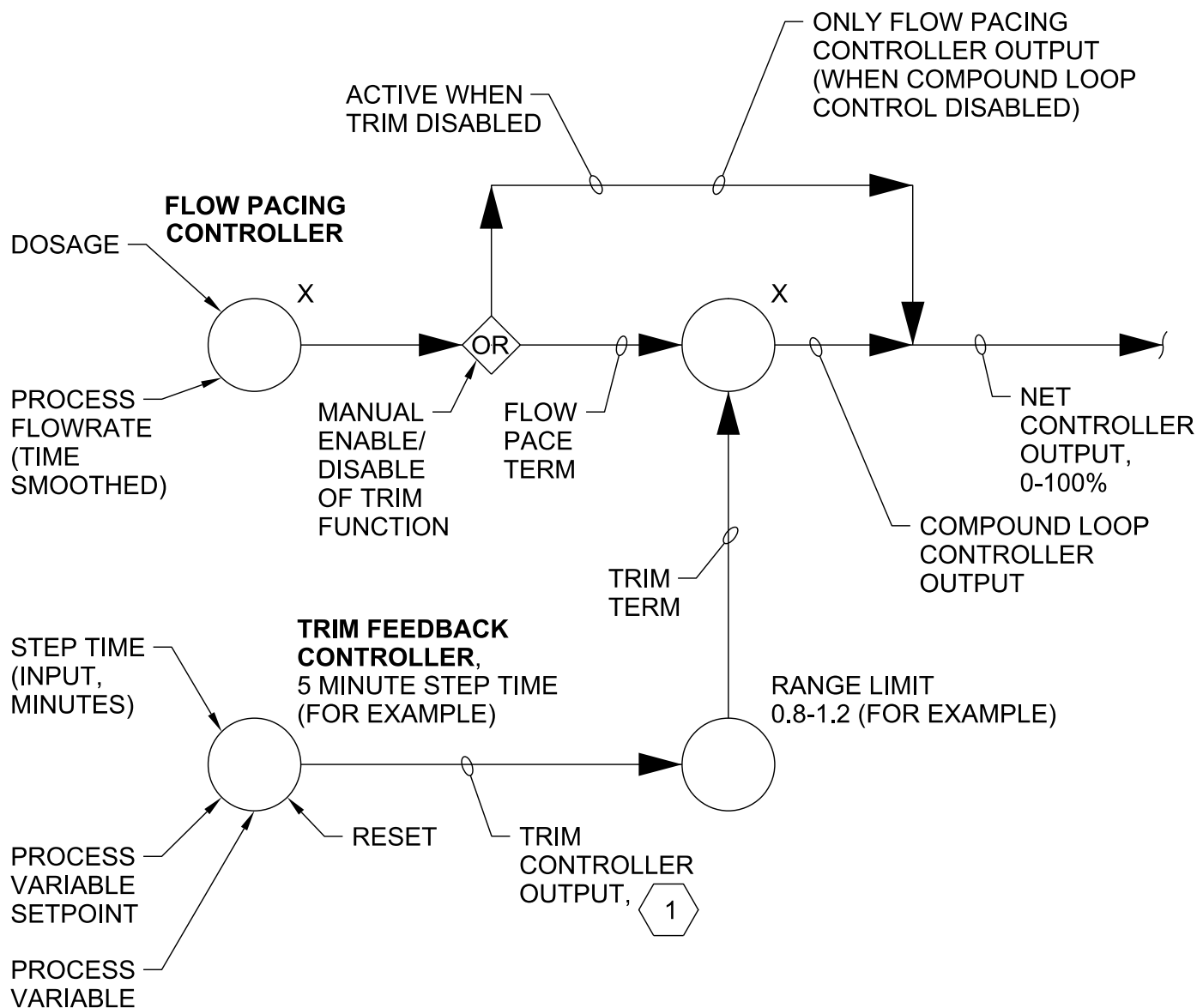
Surge Suppressor Products Table

SS Type	Application	Enclosure/ Mounting	Manufacturer/ Model	Principle of Operation/ Performance Criteria	Comments/ Performance Criteria
3	Analog signal of 2-wire transmitters	Field installed in stainless steel pipe nipple adjacent to 2-wire transmitter	Phoenix Contact, S-PT1-2PE-24DC	Principle of Operation: Two-Stage 1) Gas-filled electrode 2) Suppressor Diode	Nominal discharge current when subject to 8/20 waveform: 10kA
4	Both analog signal and 120V ac power of 4-wire transmitter	NEMA Rating: NEMA 4X Field installed; adjacent to 4-wire transmitter	Emerson EDCO, SLAC-12036; or approved equal	Principle of Operation: Two-Stage 1) High energy metal oxide varistor 2) Bipolar silicon avalanche device Performance Criteria: 1) With 120V AC outlet and AC circuit breaker in a weatherproof enclosure	Tested and rated for 50 occurrences of 2,000-amp peak test waveform. Provide as needed
4	Both analog signal and 120V ac power of 4-wire transmitter	NEMA Rating: NEMA 4X Field installed; adjacent to 4-wire transmitter	Phoenix Contact, Type 1 plus PT 1X2-24VDC-ST	Nominal discharge current of PT unit when subject to 8/20 wave form: 10kA testing	

SUPPLEMENT 6: Compound Loop Trim Control Description			
NOTE: The trim term as described below is multiplied by the flow pacing term to calculate the compound loop controller output.			
Abbreviations, Assumptions and Equations			
Reverse acting controller (Decrease pump speed if process variable higher than setpoint)			
Assume Attenuation Factor = AF =10			
Abbreviations:			
AF = Attenuation Factor			
CO = Controller Output			
HMI = Human Machine Interface			
NE = Normalized Error			
PV = Process Variable			
TCO = Trim Controller Output			
Cells in Gray are input manually on HMI Graphic			
Equations			
Error = (Time Smoothed PV) - PV Setpoint			
Normalized Error = Error / PV Setpoint			
Incremental Trim Adjustment = Normalized Error / AF			
Limits of calculated variables			
Check each calculation to ensure that calculated variables are within permissible ranges and values.			
Trim Controller Output, Range Min Value, Typical Value = 0.8			
Trim Controller Output, Range Max Value, Typical Value = 1.2			
Trim Adjustment, Max Absolute Value (Single Step) when PV greater than or equal to setpoint = 0.05 for this example			
Trim Adjustment, Min Absolute Value (Single Step) when PV greater than or equal to setpoint = 0.005 for this example			
Trim Adjustment, Max Absolute Value (Single Step) when PV less than setpoint = 0.05 for this example			
Trim Adjustment, Min Absolute Value (Single Step) when PV less than or equal to setpoint = 0.005 for this example			
Descriptor	Action	Trim Controller Output in Current Step	Trim Adjustment Calculated in Current Step & Used in Next Step
1	Input Step Time Duration	NA	NA
2	Input process variable setpoint	NA	NA
3	Input time smooth period of process variable	NA	NA
4	Input Attenuation Factor	NA	NA
5	Input TCO Range Min Value	NA	NA
6	Input TCO Range Max Value	NA	NA
7	Input Trim Adjustment, Max Absolute Value (Single Step) when PV greater than or equal to setpoint	NA	NA
8	Input Trim Adjustment, Min Absolute Value (Single Step) when PV greater than or equal to setpoint	NA	NA
9	Input Trim Adjustment, Max Absolute Value (Single Step) when PV less than setpoint	NA	NA
10	Input Trim Adjustment, Min Absolute Value (Single Step) when PV less than setpoint	NA	NA

11	Descriptors 12-15 show control action when PV is above setpoint.	NA	NA
12	Initialize and Start Step 0 by Invoking Reset, which resets trim controller output to 1.0	1	NA
12A	At end of Step 0, calculate error, normalized error, incremental trim adjustment (for next step).	1	NA
12B	Example: Time smoothed PV= 2.0; PV setpoint = 1.5, AF =10; Calculated Variables: Error = 0.5; Normalized Error: 0.333; Next step incremental trim adjustment = (NE/AF) = 0.0333	1	0.0333
13	After Step 0 time elapses, start Step I	NA	NA
13A	Calculate trim controller output for Step I. $CO(I) = CO(0) - \text{Trim Adjustment} = 1.0 - 0.0333 = 0.967$. Note CO(0) is the previous step controller output	0.967	NA
13B	At end of Step I, calculate error, normalized error, (next step) incremental trim adjustment.	0.967	NA
13C	Example: Time smoothed PV= 1.8; PV setpoint = 1.5, AF =10; Calculated Variables: Error = 0.3; Normalized Error: 0.2; Next step trim adjustment = (NE/AF) = 0.02	0.967	0.02
14	After Step I time elapses, start Step I+1	NA	NA
14A	Calculate trim controller output for Step I+1. $CO(I+1) = CO(I) - \text{Trim Adjustment} = 0.967 - 0.02 = 0.947$. Note CO(I) is the previous step controller output	0.947	NA
14B	At end of Step I+1, calculate error, normalized error, (next step) incremental trim adjustment.	0.947	NA
14C	Example: Time smoothed PV= 1.6; PV setpoint = 1.5, AF =10; Calculated Variables: Error = 0.1; Normalized Error: 0.066; Next step trim adjustment = (NE/AF) = 0.0066	0.947	0.0066
15	And so forth	NA	NA
16	Descriptors 17-20 show control action when PV is below setpoint.		
17	Initialize and Start Step 0 by Invoking Reset, which resets trim controller output to 1.0	1	0
17A	During Step 0, calculate error, normalized error, incremental trim adjustment (for next step).	1	0

17B	Example: Time smoothed PV= 1.0; PV setpoint = 1.5, AF =10; Calculated Variables: Error = -0.5; Normalized Error: -0.333; Next step trim adjustment = $(NE/AF) = -0.0333$	1	-0.0333
18	After Step 0 time elapses, start Step I	NA	NA
18A	Calculate trim controller output for Step I. $CO(I) = CO(0) - \text{Trim Adjustment} = 1.0 - (-0.0333) = 1.0333$. Note CO(0) is the previous step controller output	1.033	NA
18B	At end of Step I, calculate error, normalized error, incremental trim adjustment (for next step).	1.033	NA
18C	Example: Time smoothed PV= 1.2; PV setpoint = 1.5, AF =10; Calculated Variables: Error = - 0.3; Normalized Error: -0.2; Next step trim adjustment = $(NE/AF) = -0.02$	1.033	-0.02
19	After Step I time elapses, start Step I+1	NA	NA
19A	Calculate trim controller output for Step I+1. $CO(I+1) = CO(I) - \text{Trim Adjustment} = 1.033 - (-0.02) = 1.0533$. Note CO(I) is the previous step controller output	1.0533	NA
19B	At end of Step I+1, calculate error, normalized error, incremental trim adjustment (for next step).	1.0533	NA
19C	Example: Time smoothed PV= 1.4; PV setpoint = 1.5, AF =10; Calculated Variables: Error = -0.1; Normalized Error: -0.066; Next step trim adjustment = $(NE/AF) = -0.0066$	1.0533	-0.00666
20	And so forth		

**KEYED NOTES:**

1

TRIM CONTROLLER OUTPUT CHANGES AFTER STEP TIME HAS ELAPSED, SEE SUPPLEMENT TRIM CONTROL ACTION FOR ADJUSTMENT LIMITS.

SUPPLEMENT 7

COMPOUND LOOP TRIM CONTROL
SCHEMATIC

CH2M HILL

LOOP STATUS REPORT—EXAMPLE FORMAT Rev.06.05.92

Project Name: <i>Newport News WTP</i>						Project No. <i>WDC23456.C1</i>	
FUNCTIONAL REQUIREMENTS:							
<i>1. Measure, locally indicate, and transmit RAS flow to LP-10.</i>							
<i>2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.</i>							
<i>3. Provide high RAS flow alarm on LP-10.</i>							
COMPONENT STATUS (Check and initial each item when complete)							
Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	
<i>FE/FIT-10-2</i>	<i>Jan-12-90 DWM</i>	<i>Jan-12-90 DWM</i>	<i>Feb-7-90 DWM</i>	<i>Mar-5-90 DWM</i>	<i>N.A.</i>	<i>May-6-90 VDA</i>	
<i>FIC-10-2</i>	<i>Jan-12-90 DWM</i>	<i>Jan-12-90 DWM</i>	<i>Mar-5-90 DWM</i>	<i>Apr-4-90 DWM</i>		<i>May-4-90 VDA</i>	
<i>FSH-10-2</i>	<i>Jan-12-90 DWM</i>	<i>Jan-12-90 DWM</i>	<i>Mar-5-90 DWM</i>	<i>Apr-4-90 DWM</i>		<i>May-7-90 VDA</i>	
<i>FAH-10-2</i>	<i>Jan-12-90 DWM</i>	<i>Jan-12-90 DWM</i>	<i>Mar-5-90 DWM</i>	<i>Apr-4-90 DWM</i>		<i>May-7-90 VDA</i>	
<i>FCV-10-2</i>	<i>Mar-2-90 DWM</i>	<i>Mar-2-90 DWM</i>	<i>Apr-20-90 DWM</i>	<i>Apr-30-90 DWM</i>		<i>May-16-90 VDA</i>	
REMARKS: <i>None.</i>							
Loop Ready for Operation		By: <i>D.W. Munzer</i>		Date: <i>May-18-90</i>		Loop No.: <i>10-2</i>	

CH2M HILL

INSTRUMENT CALIBRATION SHEET—EXAMPLE—ANALYZER/TRANSMITTER

Rev.06.05.92

COMPONENT			MANUFACTURER			PROJECT						
Code: A7			Name: Leeds & Northrup			Number: WDC30715.B2						
Name: pH Element & Analyzer/Transmitter			Model: 12429-3-2-1-7		Serial #: 11553322		Name: UOSA AWT PHASE 3					
FUNCTIONS												
Indicate? Y Record? N	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N			CONTROL? N					
	Chart:			Describe:			Action? direct / reverse Modes? P / I / D					
Transmit/ Convert? Y	Scale:	1-14	pH units				SWITCH? N					
	Input:	1-14	pH units				Unit Range:					
	Output:	4-20	mA dc				Differential: fixed/adjustable Reset? automatic / manual					
ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS				Note No.	
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point		Reset Pt.
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
1.0	1.0	4.0	1.0	4.0	1.0	3.9	1.	N.A.		N.A.		
2.3	2.3	5.6	2.2	5.5	2.3	5.6	2.					
7.5	7.5	12.0	7.5	11.9	7.5	12.0	3.					
12.7	12.7	18.4	12.7	18.3	12.6	18.3	4.					
14.0	14.0	20.0	14.0	20.0	14.0	20.0	5.					
CONTROL MODE SETTINGS:			P: N.A.	I:	D:		6.					
#	NOTES:								Component Calibrated and Ready for Start-up			
	1. Need to recheck low pH calibration solutions.								By: J.D. Sewell			
									Date: Jun-6-92			
									Tag No.: AIT-12-6[pH]			

CH2M HILL

I&C VALVE ADJUSTMENT SHEET—EXAMPLE Rev.06.05.92

PARTS	Project Name: <i>SFO SEWPCP</i>	Project Number: <i>SFO10145.G2</i>			
Body	Type: <i>Vee-Ball</i>	Mfr: <i>Fisher Controls</i>			
	Size: <i>4-inch</i>	Model: <i>1049763-2</i>			
	Line Connection: <i>159 # ANSI Flanges</i>	Serial #: <i>1003220</i>			
Operator	Type: <i>Pneumatic Diaphragm</i>	Mfr: <i>Fisher Controls</i>			
	Action: <i>Linear – Modulated</i>	Model: <i>4060D</i>			
	Travel: <i>3-inch</i>	Serial #: <i>2007330</i>			
Positioner	Input Signal: <i>3-15 psi</i>	Mfr: <i>Fisher Controls</i>			
	Action: <i>Direct - air to open</i>	Model: <i>20472T</i>			
	Cam: <i>Equal percentage</i>	Serial #: <i>102010</i>			
Pilot	Action:	Mfr:			
Solenoid	Rating: <i>None</i>	Model: Serial #:			
I/P Converter	Input: <i>4-20 mA dc</i>	Mfr: <i>Taylor</i>			
	Output: <i>3-15 psi</i>	Model: <i>10-T-576-3</i>			
	Action: <i>Direct</i>	Serial #: <i>1057-330</i>			
Position Switch	Settings: <i>Closed / Open 5 deg. rising</i>	Mfr: <i>National Switch</i>			
	Contacts: <i>Close / Close</i>	Model: <i>1049-67-3</i>			
		Serial #: <i>156 & 157</i>			
Power Supply	Type: <i>Pneumatic</i>	Air Set Mfr: <i>Air Products</i>			
	Potential: <i>40 psi</i>	Model: <i>3210D</i>			
		Serial #: <i>1107063</i>			
ADJUSTMENTS	Initial	Date	VERIFICATION	Initial	Date
Air Set	<i>JDS</i>	<i>Jun-06-92</i>	Valve Action	<i>JDS</i>	<i>Jun-03-92</i>
Positioner	<i>JDS</i>	<i>Jun-06-92</i>	Installation	<i>JDS</i>	<i>Jun-03-92</i>
Position Switches	<i>JDS</i>	<i>Jun-06-92</i>	Wire Connection	<i>JDS</i>	<i>Jun-04-92</i>
I/P Converter	<i>JDS</i>	<i>Jun-07-92</i>	Tube Connection	<i>JDS</i>	<i>Jun-04-92</i>
Actual Speed	<i>JDS</i>	<i>Jun-07-92</i>			
REMARKS: <i>Valve was initially installed backwards.</i>				Valve Ready for Start-up	
<i>Observed to be correctly installed May-25-92</i>				By: <i>J.D. Sewell</i>	
				Date: <i>Jun-07-92</i>	
				Tag No.: <i>FCV-10-2-1</i>	

CH2M HILL PERFORMANCE TEST SHEET - EXAMPLERev.06.05.92

Project Name: <i>SFO SEWPCP Plant Expansion</i>			Project No.: <i>SFO12345.C1</i>
Demonstration test(s): For each functional Requirement of the loop: (a) List and number the requirement. (b) Briefly describe the demonstration test. (c) Cite the results that will verify the required performance. (d) Provide space for signoff.			
<i>1. MEASURE EFFLUENT FLOW</i>			
<i>1.a With no flow, water level over weir should be zero and</i>			
<i>FIT indicator should read zero.</i>			<i>Jun-20-92 BDG</i>
<i>2. FLOW INDICATION AND TRANSMISSION TO LP & CCS</i>			
<i>With flow, water level and FIT indicator should be related by expression</i>			
<i>$Q(\text{MGD}) = 429 \cdot H^{2/3}$ (H = height in inches of water over weir).</i>			
<i>Vary H and observe that following.</i>			
<i>2.a Reading of FIT indicator.</i>			<i>Jun-6-92 BDG</i>
<i>2.b Reading is transmitted to FI on LP-521-1</i>			<i>Jun-6-92 BDG</i>
<i>2.c Reading is transmitted and displayed to CCS.</i>			<i>Jun-6-92 BDG</i>
<i>H(measured) 0 5 10 15</i>			
<i>Q(computed) 0 47.96 135.7 251.7</i>			
<i>Q(FIT indicator) 0 48.1 137 253</i>			
<i>Q(LI on LP-521-1) 0 48.2 138 254</i>			
<i>Q(display by CCS) 0 48.1 136.2 252.4</i>			
Forms/Sheets Verified	By	Date	Loop Accepted By Owner
Loop Status Report	<i>J.D. Sewell</i>	<i>May-18-92</i>	By: <i>J.D. Smith</i>
Instrument Calibration Sheet	<i>J.D. Sewell</i>	<i>May-18-92</i>	Date: <i>Jun-6-92</i>
I&C Valve Calibration Sheet	<i>N.A.</i>		
Performance Test	By	Date	
Performed	<i>J. Blow MPSDC Co.</i>	<i>Jun-6-92</i>	
Witnessed	<i>B. DeGlanville</i>	<i>Jun-6-92</i>	Loop No.: <i>30-12</i>

SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This section gives general requirements for instrumentation and control components.

PART 2 PRODUCTS

2.01 GENERAL

- A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.
- B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.
- C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.

2.02 MECHANICAL SYSTEMS COMPONENTS

- A. Flow Element, Rotameter, Purge:
 - 1. For air or water service, unless otherwise noted.
 - 2. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.
 - 3. Direct-Reading Scale Length: 2-1/2 inches, minimum.
 - 4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
 - 5. Integral inlet needle valves.
 - 6. Integral differential pressure regulators:
 - a. For water service.
 - b. For air service for level ranges greater than 10 feet of water.
 - 7. Rotameters for water service.
 - 8. Manufacturers and Products:
 - a. Fischer & Porter; Series 10A3130.
 - b. Brooks; Series DS-1350.

B. Manifold, Three-Valve Equalizing:

1. Type: For isolation and equalization of differential pressure transducers.
2. Materials: Stainless steel.
3. Manufacturers and Products:
 - a. Anderson, Greenwood and Co.; Type M1.
 - b. Evans.

C. Pressure Gauge: For other than process variable measurement.

1. Dial Size: Nominal 2-inch dial size.
2. Accuracy: 2 percent of span.
3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.
4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
5. Manufacturers and Products:
 - a. Ashcroft Utility; Gauge Series 1000.
 - b. Marsh; Standard Gauge Series.
 - c. Ametek U.S.; Gauge Series P500.
 - d. Acculite; Series 2000.

D. Valve, Needle:

1. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
2. Size: 0.020-inch orifice.
3. Manufacturers and Products:
 - a. Whitey; Model 21RF2.
 - b. Hoke; 3700 Series.

E. ON/OFF Valves:

1. Type: Ball valve.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
 - a. Whitey; Series 41 through Series 43.
 - b. Hoke; Flomite 7100 Series.

F. Regulating Valves:

1. Type: Needle valves, with regulating stems and screwed bonnets.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
 - a. Whitey; Catalog No. RF or No. RS.
 - b. Hoke; 3100 through 3300 Series.

G. Valve, Three-Way:

1. Type: Ball valve.
2. Materials: Brass or stainless steel with nylon handle as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
 - a. Whitey; Series 41 through Series 43.
 - b. Hoke; Selecto-Mite Series.

H. Valve, Four-Way:

1. Type: Four-way, two-position ball valve.
2. Materials:
 - a. Body and Stem: Type 316 stainless steel.
 - b. Handle: Black nylon.
 - c. Packing Gland: Teflon.
3. Ball and stem bed, one-piece assembly.
4. Machined handle stops and directional nameplates.
5. Manufacturers and Products:
 - a. Whitey; Series 457.
 - b. Hoke; Multi-Mite Series.

I. Spool Valve:

1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
2. Materials: Aluminum construction with Teflon impregnated aluminum spool, stainless steel spring, and Buna-N O-rings.
3. Port Connection: 1/4-inch outside diameter tube fittings.
4. Manufacturer and Product: Norgren; T71DAOO-TSO-TKO.

J. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
2. Materials:
 - a. Body: Brass or stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
 - b. Valve Seat: Buna-N.
3. Size: Normally closed or opened, as noted.
4. Coil: 115V ac, unless noted otherwise.
5. Solenoid Enclosure: NEMA 4.
6. Manufacturer and Product: ASCO; Red Hat Series 8260.

K. Pressure Regulator, Air:

1. Provide air at reduced pressures, as shown, constant to within plus or minus 10 percent for flows from 0 scfh to 300 scfh with 100 psi supply pressure.
2. Setscrew for outlet pressure adjustment.
3. Integral filter and relief valve.
4. Manufacturers and Products:
 - a. Masoneilan; Series 77-4.
 - b. Fisher; Series 67FR.

L. Pressure Regulator, Water:

1. Materials:
 - a. Body: Bronze.
 - b. Spring Case: Cast iron.
 - c. Seat Rings: Brass.
 - d. Valve Disk and Holder: Buna-N and bronze.
 - e. Diaphragm: Buna-N diaphragm.
2. Sizing: For maximum of 7 psi offset pressure.
3. Manufacturers and Products:
 - a. Fisher; Controls Type 95H or 95L.
 - b. Masoneilan; Series 17.

M. Test Tap:

1. Manufacturers and Products:
 - a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
 - b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
 - c. Parker; CPI Series precision quick couplings.

N. Copper Tubing and Fittings:

1. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
2. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on Drawings.
3. Manufacturers:
 - a. Parker-Hannifin.
 - b. Swagelok tube fittings.

O. Plastic Tubing and Fittings:

1. Tubing:
 - a. Polyethylene capable of withstanding 190 psig at 175 degrees F.
 - b. Manufacturers and Products:
 - 1) Dekoron; Type P.
 - 2) Imperial Eastman; Poly-Flo black instrument tubing.
2. Fittings:
 - a. Type: Brass compression.
 - b. Manufacturers and Products:
 - 1) Imperial Eastman; Poly-Flo tube fittings.
 - 2) Dekoron; E-Z fittings.

P. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on Drawings.

Q. Stainless Steel Fittings:

1. Compression Type:
 - a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
 - b. Manufacturers and Products:
 - 1) Parker Flodar; BA Series.
 - 2) Swagelok tube fittings.
 - 3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.
2. Socket Weld Type:
 - a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
 - b. Manufacturers:
 - 1) Cajon.
 - 2) Swagelok.
 - 3) Parker WELDLOK.

- R. Air Set: Consists of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.
- S. Purge Set:
 - 1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on Drawings and as required in this section.
 - 2. Pressure Gauge Scale Range: 150 percent of the process variable.
 - 3. Mounting:
 - a. Within consoles, panels, or a separate enclosure as shown.
 - b. For separate enclosure mounted purge sets, refer to paragraphs Nonfreestanding Panel Construction and Factory Finishing for enclosure requirements.
- T. Tubing Raceways:
 - 1. Cable tray systems complete with tees, elbows, reducers, and covers.
 - 2. Size in accordance with manufacturer's recommendations for intended service.
 - 3. Materials: Galvanized steel or aluminum brass as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
 - 4. Manufacturers:
 - a. Globetray.
 - b. Cope.
- U. Air Supply Sets:
 - 1. Parts: Integrally Mounted:
 - a. Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
 - b. Valves: Manual drain, manual shutoff, pressure relief, and check valve.
 - c. Pressure gauge.
 - d. Inlet filter muffler.
 - e. Power: 120V ac.
 - f. Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
 - g. Manufacturers and Products:
 - 1) ITT Pneumotive; GH Series.
 - 2) Gast.
 - 2. Simplex Air Supply Sets:
 - a. Air Receiver: 2 gallons.
 - b. Compressors: One.

3. Duplex Air Supply Sets:
 - a. Air Receiver: 20 gallons.
 - b. Compressors: Two.
 - c. Automatic Failover Control: Factory set at 20 psig.

2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
 - a. Connection Type: Screw compression clamp.
 - b. Compression Clamp:
 - 1) Complies with DIN-VDE 0611.
 - 2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
 - 3) Guides strands of wire into terminal.
 - c. Screws: Hardened steel, captive, and self-locking.
 - d. Current Bar: Copper or treated brass.
 - e. Insulation:
 - 1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
 - 2) Two funneled shaped inputs to facilitate wire entry.
 - f. Mounting:
 - 1) Standard DIN rail.
 - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - 3) End Stops: Minimum of one at each end of rail.
 - g. Wire Preparation: Stripping only permitted.
 - h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
 - i. Marking System:
 - 1) Terminal number shown on both sides of terminal block.
 - 2) Allow use of preprinted and field marked tags.
 - 3) Terminal strip numbers shown on end stops.
 - 4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
 - 5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
2. Terminal Block, General Purpose:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 30 amp.
 - c. Wire Size: 24 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Gray body.

- f. Spacing: 0.25 inch, maximum.
 - g. Test Sockets: One screw test socket 0.079-inch diameter.
 - h. Manufacturer and Product: Entrelec; Type M4/6.T.
- 3. Terminal Block, Ground:
 - a. Wire Size: 24 AWG to 10 AWG.
 - b. Rated Wire Size: 10 AWG.
 - c. Color: Green and yellow body.
 - d. Spacing: 0.25 inch, maximum.
 - e. Grounding: Electrically grounded to mounting rail.
 - f. Manufacturer and Product: Entrelec; Type M4/6.P.
- 4. Terminal Block, Blade Disconnect Switch:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 10 amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Gray body, orange switch.
 - f. Spacing: 0.25 inch, maximum.
 - g. Manufacturer and Product: Entrelec; Type M4/6.SNT.
- 5. Terminal Block Diode:
 - a. Rated Voltage: 24V dc.
 - b. Rated Current: 30 ma.
 - c. Wire Size: 16 AWG.
 - d. Manufacturer and Product: Phoenix Contact ST-IN.
- 6. Terminal Block, Fused, 24V dc:
 - a. Rated Voltage: 600V dc.
 - b. Rated Current: 25 amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Gray body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: LED diode 24V dc.
 - h. Spacing: 0.512 inch, maximum.
 - i. Manufacturer and Product: Entrelec; Type ML10/13.SFD.
- 7. Terminal Block, Fused, 120V ac:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 25 amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Gray body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: Neon lamp, 110V ac.
 - h. Leakage Current: 1.8 mA, maximum.
 - i. Spacing: 0.512 inch, maximum.
 - j. Manufacturer and Product: Entrelec; Type ML10/13.SFL.

8. Terminal Block, Fused, 120V ac, High Current:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 35 amps.
 - c. Wire Size: 18 AWG to 8 AWG.
 - d. Rated Wire Size: 8 AWG.
 - e. Color: Gray.
 - f. Fuse: 13/32 inch by 1.5 inches.
 - g. Spacing: 0.95 inch, maximum.
9. Manufacturer and Product: Entrelec; Type MB10/24.SF.

B. Relays:

1. General:
 - a. Relay Mounting: Plug-in type socket.
 - b. Relay Enclosure: Furnish dust cover.
 - c. Socket Type: Screw terminal interface with wiring.
 - d. Socket Mounting: Rail.
 - e. Provide holddown clips.
2. Signal Switching Relay:
 - a. Type: Dry circuit.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 5 amps at 28V dc or 120V ac.
 - d. Contact Material: Gold or silver.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Seal Type: Hermetically sealed case.
 - k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.
3. Control Circuit Switching Relay, Nonlatching:
 - a. Type: Compact general purpose plug-in.
 - b. Contact Arrangement: 3 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Push-to-test button.
 - k. Manufacturer and Product: Potter and Brumfield; Series KUP.

4. Control Circuit Switching Relay, Latching:
 - a. Type: Dual coil mechanical latching relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 120V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
 - g. Expected Mechanical Life: 500,000 operations.
 - h. Expected Electrical Life at Rated Load: 50,000 operations.
 - i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
5. Control Circuit Switching Relay, Time Delay:
 - a. Type: Adjustable time delay relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 30V dc or 277V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
 - g. Repeatability: Plus or minus 2 percent.
 - h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
 - i. Time Delay Setpoint: As noted or shown.
 - j. Mode of Operation: As noted or shown.
 - k. Adjustment Type: Integral potentiometer with knob external to dust cover.
 - l. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.

C. Power Supplies:

1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays. Provide dual power supplies with diode auctioneered outputs.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
 - a. Protect instruments from damage due to power supply failure.
 - b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1.
5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
 - a. Type: Indicating.
 - b. Mount so fuses can be easily seen and replaced.

D. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
 - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
 - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.

E. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

2.04 I&C COMPONENTS

A. A105 ORP Element and Analyzer/Transmitter:

1. General:
 - a. Function: Measure, indicate, and transmit ORP of process liquid.
 - b. Parts: Electrode, electrode mounting, mounting kit, pre-amp module, analyzer/transmitter, interconnecting cable, and noted accessories.
 - c. Up to two electrodes per analyzer/transmitter.
2. Performance:
 - a. Electrode:
 - 1) Process Range: If and as noted.
 - 2) Range: Minus 1500 to plus 1500 mV.
 - 3) Operating Temperature: 40 degrees C to 110 degrees C.
 - 4) Operating Pressure: 50 psig maximum at 176 degrees F.
 - b. Analyzer/Transmitter:
 - 1) Range: Minus 1600 mV to plus 1600 mV.
 - 2) Accuracy: 0.5 percent of reading.
 - 3) Repeatability: 0.05 percent.
 - 4) Operating Temperature: 32 degrees F to plus 140 degrees F.
 - 5) Operating Humidity: 5 - 90 percent maximum, relative humidity, noncondensing, up to 104 degrees F.
3. Electrode:
 - a. Quantity: Two, unless otherwise noted.
 - b. Process Connection: 3/4-inch FNPT, both ends.
 - c. Process Liquid: As noted.
 - d. Wetted Materials: Compatible with process liquid.
 - e. Electrode Type: Platinum ORP; inline.
 - f. Direct connection to analyzer/transmitter.

- g. Mounting/Process Connections:
 - 1) In-Line.
 - 2) As shown on Drawings.
- h. Suitable for installation in Class I Div 2 hazardous locations: If noted or shown.
 - 1) Install in accordance with manufacturer's instructions and applicable codes.
- 4. Analyzer/Transmitter:
 - a. Display: Graphical LED, with backlighting.
 - b. Signal Interface:
 - 1) Analog Outputs:
 - a) Two isolated 4 mA to 20 mA dc outputs (ORP).
 - b) Process Variable: Two ORP, unless otherwise noted.
 - 2) Discrete Outputs:
 - a) Process Alarms: Two SPDT.
 - b) Contact Rating: 120 volts, 4 amps, resistive.
 - c. Enclosure.
 - 1) Type: NEMA 4X.
 - 2) Suitable for panel, 2-inch pipe, or wall mounting.
 - a) Wall and 2-inch pipe mounting kit, unless otherwise noted.
 - d. Power: 115V ac, 50/60-Hz, unless otherwise noted.
 - e. Interconnecting Cable:
 - 1) Length as required.
 - 2) Sampling piping will be installed as part of a separate project. Once installed, field evaluate and then furnish required length, either 20 or 50 feet.
 - f. Suitable for installation in Class I Div 2 hazardous locations: If noted or shown.
- 5. Expendables (for each unit provided):
 - a. Chemicals:
 - 1) ORP reference solution.
 - 2) 32 ounces, minimum.
- 6. Accessories:
 - a. Special CPVC pipe tee for 3/4-inch in-line mounting: Required.
 - b. Junction Box: If noted.
 - 1) NEMA 4X box for cable extension.
- 7. Manufacturers and Products:
 - a. Honeywell Series 7777 ORP Meridian II Electrode and UDA2182 Universal Dual Analyzer.

B. A140 Ammonium-Nitrate Analyzer/Transmitter:

1. General:
 - a. Function: Measure, indicate, and transmit either ammonium or nitrate concentration in aqueous stream.
 - b. Type: Ion-selective electrode (ISE); immersion.
 - c. Parts: Probe, controller/transmitter, interconnecting cable, mounting hardware and accessories.
2. Performance:
 - a. Range:
 - 1) Process Range: As noted.
 - 2) Maximum Measuring Ranges:
 - a) 0 – 1000 mg/l ammonium.
 - b) 0 - 1000 mg/l nitrate.
 - b. pH Range: 5 – 9.
 - c. Response Time: less than 3 minutes to 90 percent of actual value.
 - d. Calibration Method: Factory Calibrated.
 - e. Precision: 5 percent of the measured value plus 0.2 mg/l.
 - f. Reproducibility: 5 percent of the measured value plus 0.2 mg/l.
 - g. Temperature Range, Operating Ambient: Minus 4 to 113 degrees F.
3. Probe:
 - a. Probes per analyzer: Two, unless otherwise noted.
 - b. Type: ISE.
 - c. Removable cartridge that contains four electrodes.
 - d. Sample Temperature Range: 35 degrees F to 104 degrees F.
 - e. Channel cross-sectional flowrate: less than 4 meters/sec.
 - f. Materials:
 - 1) Cartridge: Stainless steel, PVC, others.
 - 2) Sensor: Stainless steel, PVC, others.
 - g. Process Connections: 1-inch thread.
 - h. Enclosure: IP 68.
 - i. Radio Frequency Identification (RFID) technology: Required, unless otherwise noted.
 - 1) RFID allows identifying the factory calibration.
4. Transmitter:
 - a. Features:
 - 1) Nonvolatile memory.
 - 2) Graphic LCD display with LED backlighting.
 - 3) Data logging at 15-minute intervals for up to 6 months.
 - b. Enclosure:
 - 1) NEMA 4X metallic.
 - 2) Dimensions, Nominal: 6 inches by 6 inches by 6 inches.
 - 3) Mounting: Wall, panel, or pipe (horizontal and vertical).

- c. Signal Interface:
 - 1) Analog Output:
 - a) Two 4 mA to 20 mA dc signals for load impedance 0 ohm to 500 ohms minimum for 24V dc supply without load adjustments.
 - b) Span configurable over any portion of the 0 to 1000 mg/l Ammonium or Nitrate range.
 - c) Field configurable to select either ammonium or nitrate to be measured.
 - 2) Alarm Contacts: Three independent alarm setpoints; each SPDT and rated at 5 amps continuous between 100V ac and 230V ac, minimum. Each setpoint adjustable over the full range.
 - 3) Digital Communications:
 - a) MODBUS/RS485: If noted.
 - b) MODBUS/RS32: If noted.
- d. Power: 100V ac to 230V ac, 50-Hz to 60-Hz, auto-selecting.
- 5. Cable Length: 33 feet.
- 6. Accessories (for each unit furnished):
 - a. Mounting and installation hardware.
 - 1) Handrail mounting kit: Required, unless otherwise noted.
 - a) Chain mounting and wall mounting kits also available.
 - b) Pole mount kit also available.
 - b. Power cord.
 - c. High Output Air Blast Cleaning Compressor, 115V ac: If noted.
 - d. High Output Air Blast Cleaning Compressor, 230V ac: If noted.
- 7. Accessories (per lot of analyzers furnished):
 - a. One Spare Cartrical Cartridge: Required.
 - b. Cleaning Unit for AN-ISE sensor: If noted.
- 8. Manufacturer and Product: Hach AN-ISE sc: Combination Sensor for Ammonium and Nitrate with Hach sc200 Controller.

C. F04A Flow Element and Transmitter, Electromagnetic:

- 1. General:
 - a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
 - b. Type:
 - 1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.

- 2) Full bore meter with magnetic field traversing entire flow-tube cross section.
 - 3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
- c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
- 2. Service:
 - a. Stream Fluid:
 - 1) Reclaimed Water.
 - 2) Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.
 - b. Flow Stream Descriptions: If and as described below.
- 3. Operating Temperature:
 - a. Element:
 - 1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
 - 2) Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.
 - b. Transmitter:
 - 1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
 - 2) Storage: 15 to 120 degrees F, typical, unless otherwise noted.
- 4. Performance:
 - a. Flow Range: As noted.
 - b. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.
 - c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
- 5. Features:
 - a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
 - b. No obstructions to flow.
 - c. Very low pressure loss.
 - d. Measures bi-directional flow.
- 6. Process Connection:
 - a. Meter Size (diameter inches): As noted.
 - b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
 - c. Flange Material: Carbon steel, unless otherwise noted.
- 7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.

8. Element:
 - a. Meter Tube Material: Type 304 or 316 stainless steel, unless otherwise noted.
 - b. Liner Material:
 - 1) Elastomer.
 - 2) For potable water service, must have appropriate approvals.
 - c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
 - d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
 - e. Electrode Material: Hastelloy C, unless otherwise noted.
 - f. Grounding Ring:
 - 1) Required, unless otherwise noted.
 - 2) Quantity: Two, unless otherwise noted.
 - 3) Material: Stainless steel, unless otherwise noted.
 - g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
 - h. Submergence:
 - 1) Continuous (up to 10 feet depth), NEMA 6P/IP68: Required.
 - i. Direct Buried (3 to 10 feet): If noted.
 - j. Hazardous Area Certification:
 - 1) Class 1, Division 2, Groups A, B, C, D: If noted.
 - 2) Class 1, Division 1, Groups A, B, C, D, and FM approved: If noted.
 - 3) Class 1, Division 1, Groups C, D, and FM approved: If noted.
9. Transmitter:
 - a. Mounting: Surface (wall), unless otherwise noted.
 - b. Display: Required, unless otherwise noted.
 - 1) Digital LCD display, indicating flow rate and total.
 - 2) Bi-directional Flow Display: Required, unless otherwise noted.
 - a) Forward and reverse flow rate.
 - b) Forward, reverse and net totalization.
 - c. Parameter Adjustments: By keypad or non-intrusive means.
 - d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
 - e. Empty Pipe Detection:
 - 1) If noted.
 - 2) Drives display and outputs to zero when empty pipe detected.
10. Signal Interface (at Transmitter):
 - a. Analog Output:
 - 1) Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
 - 2) Supports Superimposed Digital HART protocol: If noted.

- b. Discrete Outputs: If noted.
 - 1) Two discrete outputs, typical, rated for up to 30 volts, typical.
 - 2) Programmable as noted for the following typical parameters:
 - a) Totalizer pulse, high/low flow rates, percent of range, empty pipe zero, fault conditions, forward/reverse, etc.
 - c. Discrete Input: If noted.
 - 1) Contact closure, configured as noted for the following typical parameters: reset totalizer, change range, hold output constant, drive output to zero, and low flow cutoff, etc.
 - d. Other: As noted.
- 11. Cables:
 - a. Types: As recommended by manufacturer.
 - b. Lengths: As required to accommodate device locations.
- 12. Built-in Diagnostic System:
 - a. Features:
 - 1) Field programmable electronics.
 - 2) Self-diagnostics with troubleshooting codes.
 - 3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
 - 4) Initial flow tube calibration and subsequent calibration checks.
 - b. Verimaster: Required.
- 13. Factory Calibration:
 - a. Calibrated in an ISO 9001 and NIST certified factory.
 - b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
 - c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
- 14. Factory Ready for Future In situ Verifications: If noted.
 - a. Original meter parameter values available from vendor by request.
- 15. Accessories:
 - a. In situ Verification System: If noted.
 - 1) Quantity: One complete system provided for the project.
 - 2) Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
 - 3) Physical access to the flow-tube not required.
 - 4) Meet standards established by the National Testing Laboratory.

- 5) Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.
- 6) Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.
- 7) Windows-based software
- b. Primary Simulation System: If noted.
 - 1) Quantity: One complete system provided for the project.
 - 2) Verifies proper operation of the signal converter by simulating the flow meter's output signal.
 - a) Generates pulsed dc excitation signal with a reference voltage of 70 mV.
 - b) Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.
 - c) Switch selectable for forward, reverse and zero flow rate.
 - 3) Verifies various input and output signals.
- 16. Manufacturers: ABB Automation Watermaster (includes Remote Transmitter).

D. F16B Flow Element, Rotameter:

- 1. General:
 - a. Function: Indicate flow rate.
 - b. Type: Variable area; float and tapered tube.
- 2. Service Conditions:
 - a. Process Fluid: Water, unless otherwise noted.
 - b. Temperature Range:
 - 1) Process Fluid: 33 degrees F to 250 degrees F.
 - 2) Ambient: 32 degrees F to 125 degrees F.
 - c. Maximum Operating Pressure:
 - 1) As noted.
 - 2) Size dependent.
- 3. Performance:
 - a. Flowrate Range: As noted.
 - b. Accuracy: Plus or minus 2 percent of maximum flow.
 - c. Repeatability: 0.5 percent of full scale.
- 4. Features:
 - a. Float Material and Type: As required to meet flow range, or as noted.
 - b. Tube: Borosilicate glass.

- c. Seal:
 - 1) Type: O-ring, unless otherwise noted.
 - 2) Material: Buna-N, unless otherwise noted.
 - d. Direct-reading external metal scale.
 - 5. Size and Process Connections:
 - a. Connection Size: As noted.
 - b. Tube Length:
 - 1) Flow range dependent.
 - 2) Ranges from 8 inches – 21 inches, nominal.
 - c. Connection Material: Type 316 stainless steel, unless otherwise noted.
 - d. Connection Type: Threaded NPT, unless otherwise noted.
 - e. Connection Orientation: Vertical, unless otherwise noted.
 - 6. Signal Interface: None, unless otherwise noted.
 - 7. Manufacturers and Products:
 - a. Emerson Process Management Brooks; Series GT1000.
- E. F319 Turbine Meter, Corrosive Service:
 - 1. General:
 - a. Function: Continuous flow measurement of liquids.
 - b. Type: Turbine, suitable for corrosive service.
 - c. Parts: Element, indicator and transmitter.
 - 2. Service:
 - a. Application: If and as noted.
 - b. Operating Range: Ambient Temperature: Plus 35 to plus 125 degrees F.
 - 3. Performance:
 - a. Linearity: Plus or minus 1.0 percent over turndown range.
 - b. Repeatability: Plus or minus 0.1 percent over turndown range.
 - c. Turndown: At least 10:1.
 - d. Head Loss: Less than 4 psid at maximum flow in clean water.
 - e. Flow Range: As noted.
 - 4. Features:
 - a. Materials:
 - 1) Metal body.
 - 2) Wetted parts: PTFE and poly-ether-ether-ketone (PEEK).
 - 3) Housing: PTFE.
 - b. Bearings: PEEK/PTFE.
 - c. Pick-up Coil: One magnetic, unless otherwise noted.
 - d. Coil Enclosure: 1-inch MNPT riser, welded to body, unless otherwise noted.

5. Connections:
 - a. Raised face 150-lb. ANSI stainless steel flange, unless otherwise noted.
 - b. Size: As noted.
6. Transmitter:
 - a. Enclosure: NEMA 4X.
 - b. Mount integral to meter.
 - c. Power Supply: Battery; 1 C-sized lithium.
 - d. Display:
 - 1) 5-digit flowrate.
 - 2) 8-digit totalizer, configured in gallons.
 - 3) Low battery warning.
7. Other Requirements:
 - a. NIST certified calibration.
8. Manufacturer and Product:
 - a. Hoffer TEFLON Series Turbine Flowmeter for Corrosive Service with HIT-2A Rate Indicator and Totalizer.

F. L05E Level Element and Transmitter, Ultrasonic:

1. General:
 - a. Function: Continuous, non-contacting level measurement.
 - b. Type: Ultrasonic.
 - c. Parts: Element, transmitter, interconnecting cable, and accessories as noted.
2. Service:
 - a. Application: If and as noted.
 - b. Vapor Space Pressure: Atmospheric, unless otherwise noted.
 - c. Operating Temperature Range: Element:
 - 1) Ambient: Minus 40 degrees F to plus 176 degrees F.
 - 2) Ambient: Minus 40 degrees F to plus 176 degrees F.
3. Performance:
 - a. Range: As noted.
 - b. Zero Reference: As noted.
 - c. Accuracy: Plus or minus 0.2 percent of maximum range or 6 mm, whichever is greater.
 - d. Blanking Distance: Approximately 1.4 foot.
4. Element:
 - a. NEMA 6P waterproof.
 - b. Housing: PVDF, unless otherwise noted.
 - 1) Other materials subject to Engineer approval.
 - c. Facing: None, unless otherwise noted.
 - d. Integral Flange: Required.
 - 1) Face: PPVDF, unless otherwise noted.
 - 2) Size: 6 inches.

- e. Process Connection:
 - 1) 2-inch NPT, unless otherwise noted.
 - 2) Mount to flange.
- f. Electrically Hazardous Rating:
 - 1) Class I, Div 1, Groups A, B, C, and D: If noted.
 - 2) Class II, Div 1, Groups E, F, and G: If noted.
 - 3) Other Ratings: As noted.
- g. Beam Angle: 12 degrees or less.
- h. Integral temperature compensation.
- 5. Transmitter:
 - a. Integral to element
 - b. Display: Not required.
 - c. Power Supply: Loop Powered.
 - d. Isolated Analog Output:
 - 1) One Minimum: 4 mA to 20 mA dc for load impedance of 0 to 750 ohms.
 - e. Digital Communication: As noted.
 - f. Discrete Outputs:
 - 1) Minimum, two relay (SPDT) rated for 2 amps continuous at 230V ac.
 - 2) Assignable and as noted.
- 6. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.
- 7. Accessories:
 - a. Submergence Shield: If noted.
 - b. Remote Programming Software: If noted.
 - 1) Allows remote programming via computer and echo traces for troubleshooting.
 - 2) One per lot of units furnished.
 - c. Furnish one handheld programmer (Field Xpert).
 - d. Weather Protection Cover: Required.
- 8. Manufacturers and Products:
 - a. Endress & Hauser; Model Prosonic M FMU42.

G. L143 Level Transmitter, Pressure, Submersible, Wells, Type D:

- 1. Use this spec when the designer wants to specify only an Echo Oyster Model 701 General Purpose or Model 711 Intrinsically Safe. This spec was written for the GRU Dewatering Project.
- 2. Note that Echo offers other similar probes; namely,
 - a. Most Accurate: Model 703 General Purpose & Model 713 Intrinsically Safe.
 - b. Extra slim body Model 705.
 - c. Corrosive Resistant, Model 706 Non-Submersible.

3. General:
 - a. Function: Measure and transmit signal proportional to level.
 - b. Type:
 - 1) Totally submersible pressure sensor (loop powered).
 - 2) Silicon strain gauge.
 - c. Parts: Sensor, interconnecting cable, other parts as noted.
4. Service:
 - a. Fluid: Wellwater, unless otherwise noted.
5. Performance:
 - a. Zero Reference: As noted.
 - b. Process Range:
 - 1) As noted.
 - 2) Process Range adjustable from 30 – 100 percent of full scale range.
 - 3) Available full scale ranges: 3.5 to 500 foot water column.
 - c. Accuracy: 0.25 percent of full scale or better.
 - d. Temperature:
 - 1) Operating: Minus 20 to plus 220 degrees F.
 - 2) Compensation: 30 to 130 degrees F.
 - e. Overpressure: Twice full scale range (35 psig min) without damage.
6. Features:
 - a. Sensor:
 - 1) Conical, unless otherwise noted.
 - a) If noted: Perforated, for sludge.
 - 2) Housing: 316 Stainless steel, unless otherwise noted.
 - a) Hastelloy C: If noted.
 - 3) Thermal Error: Plus or minus 0.02 percent full scale / degree F. or better.
 - 4) Dimensions, Nominal:
 - a) Diameter: 0.85-inch.
 - b) Length: 4.5-inch max.
 - 5) Loop powered, 10-35V dc.
 - b. Interconnecting Cable:
 - 1) Length:
 - a) As required – sum of lengths (1) between strain relief assembly and sensor AND (2) strain relief assembly and transmitter.
 - 2) Integral vent tube.
 - 3) PVC Outer Jacket, unless otherwise noted.
 - a) TEF Outer Jacket: If noted.

- c. Transmitter:
 - 1) PVC, NEMA 4X, intrinsically safe, unless otherwise noted.
 - a) Aluminum, explosion proof: If noted.
 - 2) LCD Display: Required, unless otherwise noted.
 - 3) Bracket to mount housing on 2-inch pipe stand or surface: Required, unless otherwise noted.
- d. Accessories:
 - 1) Vent Tube Isolation Bladder (installed in transmitter): Required, unless otherwise noted.
 - 2) Tank Pressure Corrector: If noted.
 - 3) Steel Cable Clamp Support for Vertical Wall: If noted.
 - 4) 20-4 mA dc Reverse Calibration: If noted.
- 7. Signal Interface: 4 to 20 mA dc output, for load impedance of 0 to 550 ohms, minimum for 24V dc supply without load adjustment.
- 8. Process Pipe Connection:
 - a. 3/4-inch MPT fitting with strain relief for interconnecting cable.
 - b. Maximum process pressure: 50 psig.
- 9. Manufacturer(s): Delta Controls Corporation, Model 592.

H. M26 Hand Switch and Light, Corrosion, Round:

- 1. General:
 - a. Function: Select, initiate, and display discrete control functions.
 - b. Type: Heavy-duty, corrosion-resistant, industrial.
- 2. General Features:
 - a. Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to 1/4 inch.
 - b. Legend Plate: Standard size, square style laminate with white field and black markings, unless otherwise noted. Markings as shown, or as implied by P&IDs.
 - c. Configuration: Light, pushbutton, or switch as noted or shown.
- 3. Light Features:
 - a. Lights: 6V ac lamps and integral transformer for operation for operation from 120V ac, unless otherwise noted.
 - b. Lens Color: Color as specified, noted, or shown.
 - c. Push-to-test, unless otherwise noted.
 - d. Additional: As noted.
- 4. Pushbutton Features:
 - a. Operator: Single pushbutton, flush, unless otherwise noted.
 - b. Color: Black, unless otherwise noted.
 - c. Boot: None, unless otherwise noted.
 - d. Contact Arrangement: As required or shown.
 - e. Additional: As noted.

5. Selector Switch Features:
 - a. Operator: Knob, unless otherwise noted.
 - b. Color: Black, unless otherwise noted.
 - c. Boot: None, unless otherwise noted.
 - d. Positions: As required or shown.
 - e. Return: Manual, unless otherwise noted.
 - f. Contact Arrangement: As required or shown.
 - g. Additional: As noted.
 6. Signal Interface:
 - a. Contact Block:
 - 1) Type: Standard, unless otherwise noted.
 - 2) Materials: Silver amalgam, unless otherwise noted.
 - 3) Rating: 10 amps continuous at 120V ac, unless otherwise noted.
 - 4) Sequence: Break-before-make, unless otherwise noted or shown.
 - 5) Arrangement: Normally open or normally closed as shown, or to perform the functions noted.
 - 6) Finger safe.
 7. NEMA Rating: NEMA 4, watertight, dust-tight, and NEMA 4X, corrosion-resistant.
 8. Manufacturers and Products:
 - a. Allen-Bradley; Bulletin 800HC.
 - b. Schneider Electric, Harmony; Class 9001, Type SK.
- I. M30 Horn, Indoor/Outdoor:
1. General:
 - a. Function: Audible alarm. Produces sound by electro-mechanical vibration of a diaphragm.
 2. Performance:
 - a. Temperature, Operating: Minus 65 degrees F to 150 degrees F.
 - b. Sound Output Level: 100 dB nominal at 10 feet (110 dB at 1 meter).
 3. Features:
 - a. Dimensions: 4-3/8 inches in height and width, and 2.5 inches in depth, for horn and enclosure.
 - b. Body: Die-cast zinc.
 - c. Diaphragm: Stainless steel.
 - d. Projector: None, unless otherwise noted.
 - e. Listings: UL, cUL listed, FM, CSA approved.
 4. Enclosure:
 - a. Type: Cast aluminum with neoprene-gasketed NEMA 4X housing.
 - b. Mounting: Surface mount.

5. Power: 120V ac, 50/60-Hz, unless otherwise noted.
6. Manufacturer: Federal Signal Corp.; Model 350WB.

J. P9 Pressure Transmitter:

1. General:
 - a. Function: Measure pressure and transmit signal proportional to pressure.
 - b. Type:
 - 1) Electronic variable capacitance or silicon strain gauge.
 - 2) Two-wire transmitter; "smart electronics".
 - c. Parts: Transmitter and accessories.
2. Performance:
 - a. Range: As noted.
 - 1) Select transmitter's factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
 - b. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
 - c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
 - d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
 - e. Humidity: 0 to 100 percent relative humidity.
 - f. Hazardous Location Certifications: If and as noted.
3. Features:
 - a. Type: Gauge pressure, unless otherwise noted.
 - b. Adjustable damping.
 - c. LCD indicator, unless otherwise noted.
 - 1) Display in either percent or engineering units, field configurable.
 - d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
 - 1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
 - e. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
 - f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
 - g. Fill Fluid: Silicone, unless otherwise noted.
4. Process Connections:
 - a. Line Size: 1/2 inch.
 - b. Connection Type: FNPT.
 - c. Direct/remote Diaphragm Seal: If and as noted.

5. Signal Interface:
 - a. 4mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
 - 1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
 - b. FOUNDATION fieldbus protocol: If noted.
 - c. Profibus: If noted.
6. Enclosure:
 - a. Type: NEMA 4X.
 - b. Materials: Coated aluminum, unless otherwise noted.
 - c. Mounting bracket, unless otherwise noted.
 - 1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
7. Accessories:
 - a. Two-valve (isolate and vent) Stainless Steel Manifold: If noted.
8. Manufacturers and Products:
 - a. Gauge Pressure Units:
 - 1) Endress and Hauser; Model PMP-71.

K. S600 Analog Signal Isolator, 4-wire:

1. General:
 - a. Function:
 - 1) Provide electric isolation of an analog signal.
 - 2) 4-wire isolation.
 - 3) One-channel, two-channel, or splitter as noted.
 - b. Type: DIN rail compatible.
 - c. Parts: Isolator.
2. Environmental:
 - a. Operating Temperature: Minus 25 to 75 degrees C.
 - b. Relative Humidity: 5 to 95 percent.
3. Performance:
 - a. Accuracy: plus or minus 0.05 percent of output span.
 - b. Thermal Drift: less than 0.005 percent / degree C.
 - c. Electrical Isolation: Inputs, outputs, individual channels, power, and excitation supplies are isolated from each other by common-mode voltages up to 250V ac.
 - d. Response Time: For a step input, output goes to 98 percent of output span in 25 mS, typical.
4. Features:
 - a. LED indicator(s): Green: One per channel, meaning power applied.
 - b. Calibration: Two 15-turn potentiometers.

5. Signal Interface:
 - a. Number of Channels: One, unless otherwise noted.
 - 1) Two channels also available.
 - 2) Signal splitter also available.
 - b. Input: 4 to 20 mA dc.
 - c. Output: 4 to 20 mA dc.
 - d. Output Load: At least 900 ohms at 20 mA.
 6. Enclosure:
 - a. Dimensions: 4.7H X 1.1W X 4.4, inches, nominal.
 - b. Mounting: DIN Rail.
 7. Power:
 - a. 120V ac, unless otherwise noted.
 - b. 24V dc also available.
 8. Approvals:
 - a. CE marked, UL listed.
 - b. Class I, Div 2, Groups A,B,C,D.
 9. Accessories: If and as noted.
 10. Manufacturer and Product: Acromag Isolated Transmitters, Multi-Channel 4-Wire Isolators, 631T, 632T, 633T.
- L. S724 Indicator, NEMA 4X, Sunlight Readable, Panel Mount.
1. General:
 - a. Function: Display the value of an analog signal.
 - b. Type: Digital, panel mount, dual line, sunlight readable.
 - c. Parts: Transmitter and accessories.
 2. Environmental:
 - a. Operating Temperature: Minus 40 to 65 degrees C.
 - b. Humidity: 0 to 90 percent non-condensing.
 3. Performance:
 - a. Input Range: 4-20 mA dc.
 - b. Accuracy: Plus or minus 0.03 percent of span; plus or minus 1 count.
 4. Features:
 - a. Display:
 - 1) 6 digits, 0.60 inches high, dual line.
 - 2) LED, Sunbright.
 - b. Custom engineering units on display.
 - 1) Units match scale range of associated transmitter.
 - c. Non-Volatile Memory – no battery needed.
 - d. Password protected.
 - e. Programmable via four front panel buttons.
 - f. Integral 24 dc power supply.
 5. Power: Universal 85-265V ac or 12/24V dc input power.

6. Signal Interface:
 - a. Isolated analog retransmission output.
 - b. Relays:
 - 1) Two Form C (SPDT).
 - 2) 3 amps at 30V dc and 125/250V ac resistive load.
 - c. Digital Communications: Modbus RTU.
7. Enclosure:
 - a. Type: NEMA 4X.
 - b. Panel Mount.
 - c. Dimensions: 4.5W X 2.5H X 5.5 D inches, nominal.
8. Accessories: Mounting brackets.
9. Manufacturer and Product: Precision Digital ProVu PD6000-7H2.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 40 95 60 TELEMETRY SUBSYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Telemetry Subsystem (TS) is part of the overall PICS. This section specifies TS products, functional requirements and interface with the existing telemetry system.
- B. Work consists of the following:
 - 1. Provide one complete RTU/tower assembly, whose major components consist of an RTU, tower, antenna and interconnecting cable.
 - 2. Establish communications with the existing master RTU of the existing system-wide telemetry system.
 - a. Existing communication link is licensed radio with a frequency in the 200 MHz band.
 - b. Design the concrete base for the RTU/tower assembly.
 - 3. As shown on the Drawings.

1.02 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. Federal Aviation Administration (FAA).
 - 2. Federal Communications Commission (FCC).
 - 3. International Society of Automation (ISA): 50-00.01, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
 - 4. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

1.03 DEFINITIONS

- A. Abbreviations:
 - 1. AI: Analog inputs.
 - 2. AO: Analog outputs.
 - 3. DI: Discrete inputs.
 - 4. DO: Discrete outputs.
 - 5. FAA: Federal Aviation Administration.
 - 6. FCC: Federal Communication Commission.
 - 7. I/O: Input/output.
 - 8. LED: Light emitting diode.
 - 9. N.C.: Normally open.

10. N.O.: Normally closed.
11. PIC: Process Instrumentation and Control.
12. PICS: PIC System.
13. RTU: Remote Telemetry Unit.
14. SCADA: Supervisory control and data acquisition.
15. SPDT: Single-pole double-throw.
16. TS: Telemetry Subsystem.

- B. Article Definitions in Section 40 90 00, Instrumentation and Control for Process Systems, apply to this section.

1.04 SUBMITTALS

A. Action Submittals:

1. Radio Communication Link Design: Submit information and/or calculations that show the estimated fade margin of the new RTU at an assumed height above grade, as it communicates with the existing master RTU.
2. Overview Equipment List: List all major components of the RTU/tower assembly, including, as a minimum:
 - a. Reference or tag number.
 - b. Name.
 - c. Description.
 - d. Actual equipment manufacturer and model number.
 - e. Quantity.
3. Descriptive Information: Provide for each component of the RTU/tower assembly:
 - a. Manufacturer's part and model number with all options clearly defined.
 - b. Catalog information.
 - c. Installation dimensions and requirements.
4. Interconnecting Wiring Diagrams: Show interconnecting cable and wiring terminations.
5. Installation Details: All modifications and details adequately showing the installation of the RTU/tower assembly components.
6. Input/Output List: For each I/O point, list the type of I/O point, point ID number, tag number of source or final control equipment, and equipment description.
 - a. Point type, point ID number.
7. Estimated time of one complete poll of the existing telemetry subsystem.
8. Once RTU is installed, determine the actual fade margin. Submit results.
9. Concrete Base Design:
 - a. Design shall be in conformance with parameters noted on General Structural Notes as shown on Drawing 001-G-104, but modified as follows:
 - 1) Net Allowable Soil Bearing Pressure: 2,000 psf.

- b. Submit calculations that include such parameters as wind load, below grade depth of support, effective area of antenna, soil strength, concrete strength, and size of concrete base.
- c. Concrete base design package shall be signed and sealed by a Professional Engineer registered in the State of Florida.

B. Informational Submittals:

- 1. Owner training plan.
- 2. Operation and Maintenance Data: As specified in Section 01730, Operation and Maintenance Data, and the following:
 - a. Updated version of the Action Submittals.
 - b. O&M Manuals of each major component.
 - c. List of required and recommended spares, expendables, and test equipment.

1.05 QUALITY ASSURANCE

- A. Maintenance Technician Qualifications: Factory training and a minimum of 2 years of experience in the installation and maintenance of RTUs of the type required for this Project.

1.06 SEQUENCING AND SCHEDULING

- A. Coordinate the external circuit portion of the Interconnecting Wiring Diagrams required in paragraph Shop Drawings with the electrical requirements of Division 26, Electrical.

PART 2 PRODUCTS

2.01 REMOTE TELEMETRY UNIT

- A. General: The new RTU provides the interface between field signal(s) and the existing SCADA System. Receive and transmit digital messages over communication circuits to SCADA System in accordance with the protocol.
- B. Performance: Incorporate new RTU as a node on the existing telemetry subsystem. RTU uses real-time, multitasking firmware to implement system communication protocol and local data acquisition and control functions. Shutdown due to loss of power shall not result in loss of programs. Startup after restoration of power shall not require manual intervention.
 - 1. Interface:
 - a. With communication circuits to existing SCADA System.
 - b. With facility input and output signals.
 - c. With power source.

2. Communication: Provide an appropriate communication interface for the new RTU with the existing master RTU.
3. Input/Output: Receive one 4-20 mA dc analog input into the new RTU as shown on the Drawings.
4. Power: Operate RTU on 117V rms plus or minus 10 percent at 60 plus or minus 0.5-Hz.

2.02 EQUIPMENT

A. Remote Telemetry Unit/Tower Assembly:

1. Enclosure: 304 stainless steel rated NEMA 4X.
2. Within panel, provide 20-amp circuit breaker on incoming power.
3. Modular Backplane.
4. RF Pigtail.
5. Telemetry Interface Module/radio.
6. Power Supply Module.
7. Spare Module Positions.
8. RTU Surge Protection Kit.
9. Polyphaser Coaxial Surge Protector.
10. 2.6 Ah Backup Battery.
11. EDCO DRS-036 Analog Surge Protector.
12. Antenna Subsystem.
 - a. 21-foot tower assembly.
 - b. LAA217 Antenna and Coaxial Cable Assembly.
13. Manufacturer: Data Flow Systems, Melbourne, Florida.

2.03 SOURCE QUALITY CONTROL

- ### A. Factory test the entire assembly.

2.04 FCC LICENSING SERVICES.

- ### A. Perform all required licensing to incorporate the new RTU as a node on the existing telemetry system.

PART 3 EXECUTION

3.01 INSTALLATION

- ### A. Mount the RTU on the tower.
- ### B. Touchup RTU enclosures after installation with two-component epoxy enamel.

3.02 RTU CONFIGURATIONS

- A. Complete all RTU configurations at the central site.
- B. Assist in transferring the digital version of the analog input signal to the plant SCADA System.

3.03 STARTUP SERVICES

- A. Establish radio communications between the new RTU and the existing master RTU. Calculate the fade margin and verify that it is adequate.
- B. Demonstrate that the analog input signal is displayed on a central site graphical computer screen.

3.04 FIELD QUALITY CONTROL

- A. Operational Readiness Test (ORT): Prior to Performance Test.
 - 1. Confirm that RTU is properly wired.
 - 2. Confirm that radio communications with the Master RTU have been established with adequate fade margin.

3.05 TRAINING

- A. Provide a minimum of 4 hours of maintenance training specific to the Telemetry Subsystem hardware. Provide training at the Site of Work after RTU installation.

END OF SECTION

SECTION 40 99 90
PACKAGE CONTROL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
C62.41, IEEE Recommended Practice on Surge Voltages in
Low-Voltage AC Power Circuits.
2. International Society of Automation (ISA): S50.1, Compatibility of
Analog Signals for Electronic Process Instruments.
3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts
Maximum).
 - b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
 - c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
4. National Fire Protection Association (NFPA): 70, National Electrical
Code (NEC).
5. Underwriters Laboratories Inc. (UL): 508A, Standards for Safety,
Industrial Control Panels.

1.02 SYSTEM DESCRIPTION

- A. Assemble panels and install instruments, plumbing, and wiring in equipment
manufacturer's factories.
- B. Test panels and panel assemblies for proper operation prior to shipment from
equipment manufacturer's factory.

1.03 SUBMITTALS

A. Action Submittals:

1. Bill of material, catalog information, descriptive literature, wiring
diagrams, and Shop Drawings for components of control system.
2. Catalog information on electrical devices furnished with system.
3. Shop Drawings, catalog material, and dimensional layout drawings for
control panels and enclosures.
4. Panel elementary diagrams of prewired panels. Include in diagrams
control devices and auxiliary devices, for example, relays, alarms, fuses,
lights, fans, and heaters.

5. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.
6. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.
7. Calculations for heat dissipation and power requirements.

B. Informational Submittals:

1. Programmable Controller Submittals:
 - a. Complete set of user manuals.
 - b. Fully documented ladder logic listings.
 - c. Function listing for function blocks not fully documented by ladder logic listings.
 - d. Cross-reference listing.
2. Manufacturer's list of proposed spares, expendables, and test equipment.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.05 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:

1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
2. Light Bulb: 100 percent, 2 minimum, of each type used.
3. Fuse: 100 percent, 5 minimum, of each type used.
4. Surge Suppressors: 20 percent, one minimum, of each type used.

PART 2 PRODUCTS

2.01 SIGNAL CHARACTERISTICS

A. Analog Signals:

1. 4 to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.
2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
3. Transmitters: Load resistance capability conforming to Class L.
4. Fully isolate input and output signals of transmitters and receivers.

- B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.

- 1. Power source: Less than 30V dc.

- C. Discrete Signals:

- 1. Two-state logic signals.
 - 2. Utilize 120V ac sources for control and alarm signals.
 - 3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.

2.02 CONTROL PANEL

- A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.

- B. Conform to NEMA ratings as specified in individual equipment sections.

- C. Minimum Metal Thickness: 14-gauge.

- D. NEMA 250, Type 4X Panels:

- 1. Type 304 stainless steel construction unless otherwise specified.
 - 2. For outdoor applications, paint exterior of panel white to reduce solar effects.

- E. Doors:

- 1. Rubber-gasketed with continuous hinge.
 - 2. Lockable three-point rate to appropriate enclosure rating.

- F. Cutouts: punched, or drilled and finished smoothly with rounded edges.

- G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

- H. Temperature Control:

- 1. Design panels to adequately dissipate heat generated by equipment mounted on or in the panel.
 - 2. Furnish cooling fans with air filters or A/C if required to dissipate heat.
 - 3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.

- I. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
- J. Lighting: Minimum of one hand switch controlled internal 100-watt light for panels 12 cubic feet and larger.
- K. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.
- L. Finish:
 - 1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer's standard gray unless otherwise specified.
 - 2. Internal Surfaces: White enamel.
- M. Panel Manufacturers:
 - 1. Hoffman.
 - 2. H.F. Cox.
- N. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.
 - 1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

2.03 CONTROL PANEL ELECTRICAL

- A. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.
- B. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.
- C. Control Panels without Motor Starters:
 - 1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
 - 2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
 - 3. Circuit Breakers:
 - a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
 - b. Branch Circuit Breakers: 15 amps at 250V ac.
 - c. Breaker Manufacturers and Products:
 - 1) Heineman Electric Co.; Series AM.
 - 2) Airpax/North American Philips Controls Corp.; Series 205.

D. Control Panels with Three-Phase Power Supplies and Motor Starters:

1. Interlock main circuit breaker with panel door.
 - a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
 - b. Mount operator controls and indications on front access door.
2. Circuit Breakers:
 - a. In accordance with NEMA AB 1.
 - b. 18,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified.
 - c. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
 - d. 65,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment Specification sections.
 - e. Tripping: Indicate with operator handle position.
3. Magnetic Motor Starters:
 - a. Full voltage, NEMA ICS 2, Class A, Size O minimum.
 - b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
 - c. Manual reset type with reset button mounted on panel door.
4. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
 - a. Power Control Transformer:
 - 1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
 - 2) Limit voltage variation to 15 percent during contact pickup.
 - 3) Fuse one side of secondary winding and ground the other.
 - 4) Furnish primary winding fuses in ungrounded conductors.
5. Power Monitoring Relay:
 - a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
 - b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
 - c. Transient Voltage Protection: 10,000 volts.
 - d. Manufacturer and Product: Furnas; Class 47.
6. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not "leap frog" power conductors.
7. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Wiring:

1. ac Circuits:
 - a. Type: 600-volt, Type MTW stranded copper.
 - b. Size: For current to be carried, but not less than 14 AWG.

2. Analog Signal Circuits:
 - a. Type: 600-volt, Type 2 stranded copper, twisted shielded pairs.
 - b. Size: 18 AWG, minimum.
3. Other dc Circuits.
 - a. Type: 600-volt, Type MTW stranded copper.
 - b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.
6. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Machine printed, heat shrink.
 - b. Manufacturers:
 - 1) Brady PermaSleeve.
 - 2) Tyco Electronics.

F. Wiring Interface:

1. For analog and discrete signal, terminate at numbered terminal blocks.
2. For special signals, terminate power (240 volts or greater) at manufacturer's standard connectors.
3. For panel, terminate at equipment on/with which it is mounted.

G. Terminal Blocks:

1. Quantity:
 - a. For external connections.
 - b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
 - c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
 - a. Connection Type: Screw connection clamp.
 - b. Compression Clamp:
 - 1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
 - 2) Guides strands of wire into terminal.
 - c. Screws: Hardened steel, captive, and self-locking.
 - d. Current Bar: Copper or treated brass.
 - e. Insulation:
 - 1) Thermoplastic rated for minus 55 to plus 110 degrees C.
 - 2) Two funnel shaped inputs to facilitate wire entry.

- f. Mounting:
 - 1) Rail.
 - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - 3) End Stops: One at each end of rail, minimum.
- g. Wire Preparation: Stripping only.
- h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
- i. Marking System:
 - 1) Terminal number shown on both sides of terminal block.
 - 2) Allow use of preprinted and field marked tags.
 - 3) Terminal strip numbers shown on end stops.
 - 4) Mark terminal block and terminal strip numbers as shown.
- 3. Terminal Block, 120-Volt Power:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 30 amp.
 - c. Wire Size: 22 through 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Gray body.
 - f. Spacing: 0.25 inch, maximum.
 - g. Manufacturer and Product: Entrelec; Type M4/6.
- 4. Terminal Block, Ground:
 - a. Wire Size: 22 through 12 AWG.
 - b. Rated Wire Size: 12 AWG.
 - c. Color: Green and yellow body.
 - d. Spacing: 0.25 inch, maximum.
 - e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
 - f. Manufacturer and Product: Entrelec; Type M4/6.P.
- 5. Terminal Block, Blade Disconnect Switch:
 - a. Use: Provide one for each discrete input and output field interface wire.
 - b. Rated Voltage: 600V ac.
 - c. Rated Current: 10 amp.
 - d. Wire Size: 22 through 12 AWG.
 - e. Rated Wire Size: 12 AWG.
 - f. Color: Gray body, orange switch.
 - g. Spacing: 0.25 inch, maximum.
 - h. Manufacturer and Product: Entrelec; Type M4/6.SN.
- 6. Terminal Block, Fused, 24V dc:
 - a. Rated Voltage: 600V dc.
 - b. Rated Current: 6.3 amp.
 - c. Wire Size: 22 through 12 AWG.
 - d. Rated Wire Size: 12 AWG.
 - e. Color: Gray body.
 - f. Fuse: 5 by 20 GMA fuses.

- g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
 - h. Indication: LED diode 24V dc.
 - i. Leakage Current: 5.2 mA, maximum.
 - j. Spacing: 0.32 inch, maximum.
 - k. Manufacturer and Product: Entrelec; Type M4/6.SFD.
7. Terminal Block, Fused, 120V ac:
- a. Rated Voltage: 600V ac.
 - b. Rated Current: 6.3 amp.
 - c. Wire Size: 22 through 12 AWG
 - d. Rated Wire Size: 12 AWG.
 - e. Color: Gray body.
 - f. Fuse: 5 by 20 GMA fuses.
 - g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
 - h. Indication: Neon lamp 110V ac.
 - i. Leakage Current: 1.8 mA, maximum.
 - j. Spacing: 0.32 inch, maximum
 - k. Manufacturer and Product: Entrelec; Type M4/6.SFL.
- H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.
- I. Relays:
- 1. General:
 - a. Relay Mounting: Plug-in type socket.
 - b. Relay Enclosure: Provide dust cover.
 - c. Socket Type: Screw terminal interface with wiring.
 - d. Socket Mounting: Rail.
 - e. Furnish holddown clips.
 - 2. Control Circuit Switching Relay, Nonlatching:
 - a. Type: Compact general purpose plug-in.
 - b. Contact Arrangement: 3 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Push-to-test button.
 - k. Manufacturer and Product: Potter and Brumfield; Series KUP.

3. Control Circuit Switching Relay, Latching:
 - a. Type: Dual coil mechanical latching relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 120V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
 - g. Expected Mechanical Life: 500,000 operations.
 - h. Expected Electrical Life at Rated Load: 50,000 operations.
 - i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
4. Control Circuit Switching Relay, Time Delay:
 - a. Type: Adjustable time delay relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As specified or shown.
 - f. Operating Temperature: Minus 10 to 55 degrees C.
 - g. Repeatability: Plus or minus 2 percent.
 - h. Delay Time Range: Select range such that time delay setpoint fall between 20 to 80 percent or range.
 - i. Time Delay Setpoint: As specified or shown.
 - j. Mode of Operation: As specified or shown.
 - k. Adjustment Type: Integral potentiometer with knob external to dust cover.
 - l. Manufacturer and Products: Potter and Brumfield.
 - 1) Series CB for 0.1-second to 100-minute delay time ranges.
 - 2) Series CK for 0.1- to 120-second delay time ranges.

J. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
 - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
 - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.

K. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

L. Power Supplies:

1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays. Provide dual power supplies with diode auctioneered outputs.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
 - a. Protect instruments from damage due to power supply failure.
 - b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1.
5. Mount such that dissipated heat does not adversely affect other components.

M. Programmable Controllers:

1. Solid state units capable of performing same function as conventional relays, timers, counters, drum sequencers, arithmetic, and other special functions necessary to perform required control functions.
2. Minimum of 64 internal control relays, 16 timer/counters, and four, 16 stop drum sequencers. Furnish minimum of 256 words of nonvolatile memory.
3. Minimum of 12 discrete inputs and 8 discrete outputs, optical isolations rated at 2,500-volt rms. Discrete inputs shall be 120V ac. Discrete outputs shall be rated for 2 amps at 120V ac. Each input and output shall have an LED ON/OFF status indicator.
4. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions.
5. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 to 60 degrees C and up to 95 percent humidity, noncondensing.
6. Furnish with a handheld, CRT, or personal computer programmer that plugs into controller. Program using conventional relay ladder diagram notation and drum sequencer chart notation. Programmer shall provide a force function to set inputs or outputs to a given state regardless of program or input conditions. Programmer shall indicate power flow through internal elements.
7. Manufacturer: Allen-Bradley, CompactLogix.

N. Front-of-Panel Devices in Conjunction with NEMA 250,
Type 1 and 12 Panels:

1. Potentiometer Units:
 - a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
 - b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
 - c. Include legend plates with service markings.
 - d. Manufacturers and Products:
 - 1) Allen-Bradley; Model 800T.
 - 2) Eaton/Cutler-Hammer; Model 10250T.
2. Indicating Lights:
 - a. Heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V ac applications.
 - b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
 - c. Manufacturers and Products:
 - 1) Eaton/Cutler-Hammer; Type 10250T.
 - 2) General Electric; CR2940U.
3. Pushbutton, Momentary:
 - a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
 - b. Standard size legend plates with black field and white markings for service legend.
 - c. Manufacturers and Products:
 - 1) Square D; Class 9001, Type K.
 - 2) Eaton/Cutler-Hammer; Type T.
 - 3) General Electric; Type CR-2940.
4. Selector Switch:
 - a. Heavy-duty, oiltight, industrial type with contacts rated for 120V ac service at 10 amperes continuous.
 - b. Standard size, black field, legend plates with white markings, for service legend.
 - c. Operators: Black knob type.
 - d. Single-hole mounting, accommodating panel thicknesses from 1/16 inch to 1/4 inch.
 - e. Manufacturers and Products for Units with up to Four Selection Positions:
 - 1) Eaton/Cutler-Hammer; Type T.
 - 2) Square D; Type K.
 - f. Manufacturers and Products for Units with up to 12 Selection Positions:
 - 1) Rundel-Idec; Standard Cam Switch.
 - 2) Electroswitch; 31.

O. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

1. Potentiometer, Watertight:
 - a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
 - b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
 - c. Include engraved legend plates with service markings.
 - d. Finger-safe.
 - e. Manufacturer and Product: Allen-Bradley; Bulletin 800HC.
2. Indicating Lights, Watertight:
 - a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
 - b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
 - c. Finger-safe.
 - d. Manufacturers and Products:
 - 1) Square D; Type SK, finger-safe style.
 - 2) Allen-Bradley; Type 800HC.
3. Pushbutton, Momentary, Watertight:
 - a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
 - b. Standard size, black field, legend plates with white markings for service legend.
 - c. Finger safe.
 - d. Manufacturers and Products:
 - 1) Square D; Type SK, finger-safe style.
 - 2) Allen-Bradley; Type 800HC.
4. Selector Switch, Watertight:
 - a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
 - b. Standard size, black field, legend plates with white markings, for service legend.
 - c. Operators: Black knob type.
 - d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.
 - e. Finger safe.
 - f. Manufacturer and Products:
 - 1) Square D; Class 9001, Type SK, finger safe style.
 - 2) Allen-Bradley; Type 800HC.

2.04 INSTRUMENT TAG NUMBERS

- A. A shorthand tag notation is used. For example:

XXX-AI-YYY-ZZ [BB]

Notation **Explanation**

XXX Unit process number

AI ISA designator for Analysis Indicator

YYY Loop number

ZZ Unit Number

[BB] Same notation shown at 2 o'clock position on ISA circle symbol on Process and Instrument Diagram

2.05 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

- A. Nametags: Permanently mounted bearing entire ISA tag number.
1. Panel Mounted: Plastic, mounted to instrument behind panel face.
 2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.
- B. Service Legends (Integrally Mounted with Instrument) and Nameplates:
1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
 2. Color: Black with white letters.
 3. Letter Height: 3/16 inch.
 4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be black with white letters 1/2-inch high.
- C. Standard Light Colors and Inscriptions: Unless otherwise specified in individual equipment specifications, use the following color code and inscriptions:

Tag	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red

Tag	Inscription(s)	Color
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow
FORWARD	FORWARD	Red
REVERSE	REVERSE	Blue

1. Lettering: Black on white and amber lenses; white on red and green lenses.
2. Standard Pushbutton Colors and Inscriptions:
 - a. Use following unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

- b. Lettering Color:
 - 1) Black on white and yellow buttons.
 - 2) White on black, red, and green buttons.

2.06 ELECTRICAL SURGE AND TRANSIENT PROTECTION

- A. Equip control panels with surge-arresting devices to protect equipment from damage as a result of electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices.
- B. Suppressor Locations:
 - 1. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
 - 2. On analog pairs at each end when the pair travels outside of building.
 - 3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.
- C. Suppressor Design:
 - 1. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
 - 2. Response: 5 nanoseconds maximum.
 - 3. Recovery: Automatic.
 - 4. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
 - 5. Enclosure Mounted: Encapsulated inflame retardant epoxy.
- D. Suppressors on 120V ac Power Supply Connections:
 - 1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
 - 2. First-Stage Clamping Voltage: 350 volts or less.
 - 3. Second-Stage Clamping Voltage: 210 volts or less.
 - 4. Power Supplies for Continuous Operation:
 - a. Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
 - b. All Other Applications: Minimum 30 amps at 130V ac.
- E. Suppressors on Analog Signal Lines:
 - 1. Test Waveform: Linear 8-microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
 - 2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
 - a. dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
 - b. dc Clamping Voltage Tolerance: Plus or minus 10 percent.
 - c. Maximum Loop Resistance: 18 ohms per conductor.

F. Manufacturers and Products:

1. Panel Mounted Analog Signals Lines (SS2): Emerson Edco PC-642 or SRA-64 series.
2. 120V ac Lines (SS1): Emerson Edco HSP-121.
3. 480-Volt, Three-Phase Power Supplies: Square D Model SDSA3650.
4. Field Mounted at Two-Wire Instruments (SS3):
 - a. Encapsulated in stainless steel pipe nipples.
 - b. Emerson Edco SS64 series.
5. Field Mounted at Four-Wire Instruments (SS4): With 120V ac outlet, ac circuit breaker, and 10-ohm resistor on signal line, all in enclosure.
 - a. Enclosure:
 - 1) NEMA 4X Type 316 stainless steel with door.
 - 2) Maximum Size: 12 inches by 12 inches by 8 inches deep.
 - b. Emerson Edco; SLAC series.
6. Equivalent Phoenix Contact products are permissible.

G. Grounding:

1. Coordinate surge suppressor grounding in field panels and field instrumentation with suppressor manufacturer's requirements.
2. Provide control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.

PART 3 EXECUTION

3.01 ELECTRICAL POWER AND SIGNAL WIRING

- A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.
- B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.
- C. Use manufacturer's recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.
- D. Do not splice or tap wiring except at device terminals or terminal blocks.

END OF SECTION

SECTION 43 40 01
POLYETHYLENE STORAGE TANK

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the work necessary to furnish and install a bulk chemical storage tank for 38 percent liquid ammonium sulfate.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Society of Mechanical Engineers (ASME): B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
 2. ASTM International (ASTM):
 - a. C177, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - b. D638, Test Method for Tensile Properties of Plastics.
 - c. D648, Test Method for Deflection Temperature of Plastics Under Flexural Load.
 - d. D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - e. D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - f. D833, Standard Definitions of Terms Relating to Plastics.
 - g. D1505, Test Method for Density of Plastics by the Density-Gradient Technique.
 - h. D1525, Test Method for Vicat Softening Temperature of Plastics.
 - i. D1621, Test Method for Compressive Properties of Rigid Cellular Plastics.
 - j. D1622, Test Method for Apparent Density of Rigid Cellular Plastics.
 - k. D1623, Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
 - l. D1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
 - m. D1940, Method of Test for Porosity of Rigid Cellular Plastics.
 - n. D1998, Specification for Polyethylene Upright Storage Tanks.
 - o. E84, Test Method for Surface Burning Characteristics of Building Materials.

1.03 DEFINITIONS

- A. XLHDPE: Cross-linked high-density polyethylene.

1.04 DESIGN REQUIREMENTS

- A. Manufacturer shall design a bulk chemical storage tank, including wall thickness and methods and locations of support and anchorage. Design shall be prepared and sealed by designer meeting requirements of Article Quality Assurance.
- B. Tank manufacturer must be capable of providing Underwriters Laboratories Listing for Nonmetallic Aboveground Tanks for Chemicals.

1.05 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Fabricator's catalog information, descriptive literature, specifications, and identification of materials of construction. Provide catalog cuts for all off-the-shelf items.
 - b. Detailed fabrication drawings shall be scale drawings showing the relative size, configuration, location, materials of construction, and details of all equipment and materials to be furnished including the tanks, fittings, access ladders, supports, and tank holddown and support systems. Both plan and elevation views shall be provided. All piping terminal points shall be clearly shown and fully dimensioned.
 - c. Resin used for each tank and all supporting specifications for resins.
 - d. Foundation and Anchor Bolt Drawings: Drawings shall be provided that show all data and details required for design of the tank foundations including locations and dimensions for knockouts and embedded items, and the size, type, location, embedment and projection of anchor bolts.
 - e. Complete design calculations for tanks, supports and appropriate accessories, signed and sealed by a Professional Engineer registered in the State of Florida. Diagrams and calculations shall be provided that indicate all static and dynamic loads. Reactions (uplift, shear, gravity loads, etc.) shall be indicated for each of the applicable loading combinations required for loading identified on 001-G-104 General Structural Notes. Calculations for anchor bolt type, size, and location shall be indicated for the controlling load condition.

- f. Tank data indicating pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, and details of nozzle designs.
 - g. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
 - h. Certified test data on representative samples of standard materials which demonstrate compliance with the physical properties specified herein.
 - i. Certified copy of all factory test results including gel tests, impact tests, and hydrostatic tests. Provide a listing of procedures used in testing.
 - j. Installation instructions shall be completed, detailed, and sequenced instructions for original installation. Recommended methods for assembly and adjustment including all bolt torques shall be provided along with special precautions and the sequence of work. Rigging and lifting details shall also be included for all factory-fabricated assemblies and individual components weighing over 100 pounds.
 - k. All exceptions and any proposed revisions to the requirements of the Specifications shall be included with the Submittals.
2. Samples: Representative Samples of the high density cross-linked polyethylene with anti-oxidant resistant linear low density polyethylene liner tank shall be provided.

B. Informational Submittals:

- 1. Fabricator's Certificate of Compliance with fabrication requirements.
- 2. Quality Assurance Inspection:
 - a. Initial QA Inspection Report.
 - b. Certification of Factory Testing.
- 3. Special shipping, storage and protection, and handling instructions.
- 4. Fabricator's written/printed installation and tank support instructions.
- 5. Manufacturer's Certificate of Proper Installation.
- 6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.06 QUALITY ASSURANCE

- A. Fabricator's Quality Assurance Supervisor: Minimum of 5 years' experience in the fabrication of polyethylene storage tanks of similar size and usage.
- B. Tanks shall be manufactured by a firm with a nationally accepted quality standard (i.e., ISO9001).

1.07 DELIVERY, STORAGE, AND HANDLING

- A. All materials fabricated to this Specification must be packaged, crated, or protected in such manner so as to prevent damage in handling and while in transit. Details of these procedures shall be the responsibility of manufacturer.
- B. In addition, prepare and protect the tanks for shipment as follows:
 - 1. Mount tanks on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
 - 2. Protect all flanged nozzles with wooden blinds bolted to the flange and having a diameter of 2 inches greater than the outside diameter of the flange.
 - 3. Provide either rigid plugs inside the ends to prevent deflection or wooden boxes for all unflanged components. Brace the open ends of tanks with a suitable stiffening member to prevent deflection.
 - 4. Do not ship components or other pieces loose inside the tanks.
 - 5. Load tanks with at least 2 inches clearance between the tank (including fittings) and the bulkheads or bed of the vehicle.
 - 6. Regardless of the mode of transportation, firmly fasten and pad all components to prevent shifting of the load or flexing of components while in transit.
 - 7. Nozzles or other fittings shall not be used for lifting.

1.08 SPECIAL GUARANTEE

- A. Tanks shall have a minimum 2-year guarantee from the tank manufacturer, covering the complete cost of repair and replacement of the tanks (not including any costs associated with altering, removing, or demolishing the existing facility structure for such removal which shall be borne by Contractor) during the first 2 years of service, should leakage occur through the tank or the tank fittings, or should the tank or tank fittings show signs of fatigue or failure as determined by Engineer.

PART 2 PRODUCTS

2.01 GENERAL

- A. All equipment specified herein shall be factory fabricated and assembled to the maximum extent possible requiring a minimum of field assembly. Field installation shall be limited to anchoring the tanks and making external piping connections.
- B. All equipment specified herein shall be suitable for contact with the stored chemicals.

- C. Like items of materials and equipment shall be the end products of one manufacturer in order to provide standardization for appearance operation, maintenance spare parts, and manufacturer's service.

2.02 MANUFACTURERS

- A. Poly Processing Company.
- B. Or equal.

2.03 SERVICE CONDITIONS

- A. Location: Outdoors.
- B. Ambient Air Temperature Range: 50 to 100 degrees F.
- C. Relative Humidity: Up to 100 percent.
- D. Operating Pressure: Atmospheric.
- E. Stored Materials:

Stored Materials		
Equipment	Chemical	Specific Gravity
Liquid Ammonium Sulfate Tank	38% (NH ₄) ₂ SO ₄	1.77

2.04 TANK DESIGN CRITERIA

- A. Load: See General Structural Notes Drawings.
- B. Special Loads: Design tanks for dead loads from all attached piping.
- C. Hydrostatic Load: For specific gravities of stored materials specified herein. Tanks shall be designed to withstand the hydrostatic pressure resulting from a full tank.

2.05 TANK CONSTRUCTION

- A. Tanks specified herein shall be cross linked high-density polyethylene construction with interior anti-oxidant resistant linear HDPE liner and integrally mounted flanged outlet (IMFO) and shall meet or exceed all requirements of ASTM D1998.
- B. Tanks shall be vertical, flat bottom, dome top construction with translucent materials to allow observation of liquid level.

- C. Tank manufacturer must be capable of issuing gel test results with 1/8-inch inner wall reading no less than 65 percent and outer wall no less than 90 percent gel. Entire thickness must be at least 80 percent gelled.
- D. The XLHDPE tanks shall be constructed using the rotational molding process.
- E. Tanks shall be fabricated to the dimensions shown on the Tank Datasheet:

Tank Schedule			
Equipment No.	Capacity	Maximum Diameter*	Sidewall Height*
Liquid Ammonium Sulfate Tank (578-T-01)	8,100 gal	12 ft	12 ft
*Tank sizes are nominal sizes.			

- F. Materials shall meet or exceed the following properties:

Parameter	ASTM Test	Requirement
Density	D1505	0.944-0.946 gm/cc
Environmental Stress, Cracking Resistance (F50)	D1693	1,000 hrs
Tensile Strength, Ultimate (2" min.)	D638	2,600-3,000 psi
Elongation at Break (2" min.)	D638	400%
Vicat Softening Point	D1525	240 degrees F
Flexural Modulus	D790	100,000 psi
Brittleness Temperature	D746	-130 degrees F
Heat Distortion Temp	D648	67 degrees C
Polyethylnene Notch Test (PENT)	F1473	>1,000 hours

2.06 TANK SUPPORT AND RESTRAINT SYSTEM

- A. Each tank and its associated attachments shall be structurally adequate for all tank design criteria specified herein.
- B. Provide a minimum of four Type 316 stainless steel holddown lugs, complete with plate, anchor bolts, nuts, and washers for proper anchoring of the tank. Actual number of holddown lugs shall be calculated with the tank empty.
- C. All exposed metal surfaces not constructed of stainless steel shall be painted in accordance with and as specified in Section 09 90 00, Painting and Coating.

2.07 FITTINGS

- A. Tank fittings and openings shall be provided as listed in the Fitting/Opening Schedule and located as shown on the Drawings.

Fitting/Opening Schedule		
Service	Type/Location	Diameter
Fill	Flanged/Top	2-inch
Vent	Flanged/Top	6-inch
Overflow	Flanged/6" below tank top	3-inch
Discharge	Flanged at tank bottom	4-inch
Level sensor	Flanged/Top	6-inch
Manway	Flanged/Top	24-inch

- B. PVDF flexible bellow shall be provided with the discharge fitting. The bellow shall be designed to provide sufficient flexibility that additional flexible connections will not be needed.
- C. Provide fill pipe drop leg inside tank connecting to fill connection. Pipe drop leg shall extend down into tank interior and shall have a 45 degree elbow installed on its end to discharge to interior sidewall of tank. Drop leg shall be supported internally by a pipe support. Pipe support shall be a bolted fitting at tank sidewall.
- D. Fittings shall be PVC compressive type, with long shank, deep cut threaded with dual wide nut assembly. End type of fittings for connection to facility piping shall be as shown in the Fitting/Opening Schedule.
- E. All flanged fittings shall be gasketed with materials compatible with the chemical service.
- F. Bolted fittings shall use Type 316 stainless steel bolts with polyethylene-encapsulated heads and PVC external flanges.
- G. All materials used in tank fitting assemblies shall be resistant to the stored chemicals. No wetted fittings or appurtenances shall be of metallic construction.

2.08 ACCESSORIES AND APPURTENANCES

- A. Ladder and safety cage:
1. Material: FRP.
 2. Fasteners: Type 316 stainless steel.

3. Supports, FRP: Locate as required for field installation of ladder and cage.
 4. Ladder and handrails shall comply with all OSHA requirements.
- B. All tank accessories and appurtenances shall be chemically compatible with the stored materials and shall be designed to withstand the hydrostatic pressure resulting from a full tank.
- C. Calibration Tape: Calibration tape shall be self-adhesive, translucent tape calibrated in multiples of 50 gallons or less. Strips shall use black numerals and tick marks to denote gallonage.
- D. Gaskets:
1. Material compatible with chemical service, low torque, full face, ASME B16.1 dimensions, two concentric, convex, molded rings between center hole and bolt hole circle.
 2. Type: 1/4-inch thick, low torque, full face, ASME B16.1 dimensions.
- E. Pipe Supports:
1. Provide pipe supports for the fill pipe, overflow pipe, and discharge pipe attached to the tank.
 2. Spacing of pipe supports shall be as recommended by the fabricator, but shall not be greater than 5 feet on center.
 3. Pipe supports shall allow removal of supported pipes.
 4. Complete with Type 316 stainless steel bolts, nuts, washers, and other necessary hardware for easy field assembly.
- F. Lifting Lugs: Provide suitably attached for all tanks weighing over 100 pounds. Lifting lugs shall be bolted fittings in sidewall of tank. Bolted fittings shall be as specified herein.
- G. Anchor Bolts: Type 316, stainless steel bolts, sized by fabricator and at least 3/4-inch diameter, or as shown and as specified in Section 05 50 00, Metal Fabrications.

2.09 SOURCE QUALITY CONTROL

- A. General: The tank fabricators shall have a quality control procedure adequate to ensure that all fabrication complies with these Specifications.
- B. Factory Tests:
1. Impact Tests: A representative sample from each tank shall undergo a factory impact test. Impact test must meet the requirements of ASTM D1998.

2. Gel Tests: A representative sample from each tank provided shall undergo a factory gel test, as prescribed by ASTM D1998.
3. Hydrostatic Leak Tests:
 - a. Perform on each tank.
 - b. Fill to overflow nozzle; allow to stand for 24 hours with no visible leakage.
4. Wall Thickness: Each tank shall have an actual wall thickness measurement taken at every 90 degrees, at each one foot elevation, up to three feet from the bottom of the tank.
5. Reports: Certify, by signature, the results of the factory testing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with the manufacturer's written instructions.
- B. Contractor shall provide all supervision, labor, tools, construction equipment, incidental materials, and the necessary services required to complete the installation and testing of the equipment.
- C. Accurately place anchor bolts using templates furnished by the manufacturer or as otherwise recommended by manufacturer and as specified in Section 05 50 00, Metal Fabrications.
- D. Tanks shall be installed in such a manner that no stresses shall be applied to flanged outlet as per manufacturer's installation instructions.
- E. Uniform and level surface contact shall be made between all tank bottoms and the support foundations by means of grouting. Tanks shall be set in wet grout tapered from a point 1 inch higher at tank center to the foundation edges. Initially, grouting shall be finished to leave no voids. Tanks shall be settled down squeezing out excess grout in such a manner as to leave no voids in the tank bottom/foundation interface. The grout shall not be used to support any load, only to fill irregularities in the tank bottoms and foundations. The in-place tanks shall not be exposed to any loads until the grout has hardened.
- F. Bolt torques on gaskets shall be as recommended by the equipment manufacturer.

3.02 FIELD QUALITY CONTROL

A. Field Tests:

1. Hydrostatic Test: Storage tanks shall be filled with clean water to the overflow level after all connections have been made. There shall be no leakage, no signs of weeping, and no signs of capillary action over a period of 48 hours.
2. Quality control shall include a final inspection by Contractor and a written record of this final inspection.
3. After testing, the tanks shall be thoroughly cleaned and dried.

3.03 MANUFACTURER'S SERVICES

A. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by Owner for the minimum person-days listed for the services hereunder, travel time excluded:

1. 1 person-day for inspection and certification of the installation.

B. Manufacturer shall Certify in Writing:

1. Equipment has been provided in accordance with this Specification.
2. Equipment has been installed in accordance with the manufacturer's recommendations and inspected by a manufacturer's authorized representative.
3. Proper mechanical connections have been made.
4. Equipment is ready for startup and operation.

3.04 CHEMICALS SUPPLIED BY CONTRACTOR

- A. Fill the storage tank with 38 percent ammonium sulfate prior to functional and performance testing. Replace chemicals used during testing and provide Owner with full tanks of chemical prior to Contract Closeout.
- B. Coordinate with Owner to ensure delivered sodium hydroxide and sodium hypochlorite solution adheres to Owner's specifications for the chemicals.

3.05 SUPPLEMENT

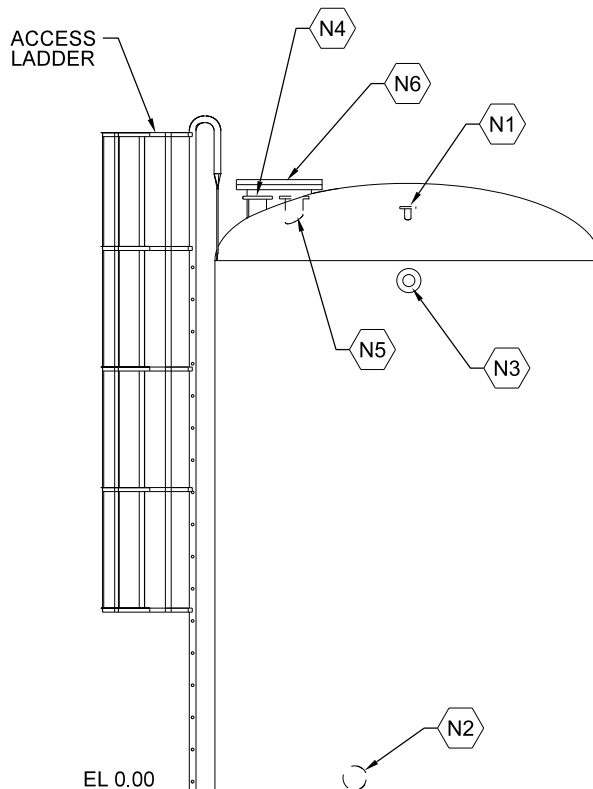
- A. The supplement listed below, following "End of Section," is a part of this Specification.
 1. Supplement 1, Tank Datasheet.

END OF SECTION

TANK NAME:	LIQUID AMMONIUM SULFATE STORAGE TANK		
TAG NUMBER(S):	578-T-01		
QUANTITY:	1		
SERVICE:	38% AMMONIUM SULFATE	SPECIFIC GRAVITY:	1.77 @ 68°F
pH RANGE:	5.5	TEMP. RANGE (°F):	MIN 30°F MAX 100°F
DIAMETER:	11'-11"	STRAIGHT SHELL HEIGHT:	11'-10"
CAPACITY:	8,100 GALLONS NOMINAL	STRAIGHT SKIRT HEIGHT:	NA

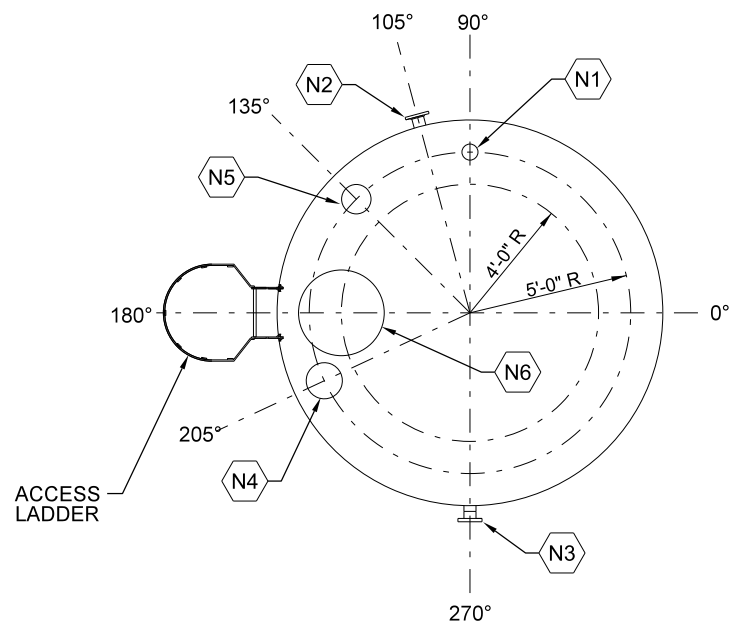
NOTES:

- HORIZONTAL NOZZLE ELEVATIONS TO CENTERLINE OF FITTING.
- PROVIDE SCH 80 CPVC FILL AND OVERFLOW PIPE AND SUPPORTS.



COMPOSITE SECTION

NTS



PLAN

NTS

NOZZLES	MARK	QTY	SIZE	ELEV	CL RADIUS	NOTES	DESIGN DATA
FILL	N1	1	2"	TOP	2'-0"		TANK LOCATION: OUTDOORS
OUTLET	N2	1	4"	6"			TYPE OF TOP HEAD: DISH (STAND FINISH)
OVERFLOW	N3	1	3"	11'-0"			TYPE OF BOTTOM HEAD: FLAT
LEVEL INSTRUMENT	N4	1	6"	TOP	5'-0"		LADDER REQUIRED: YES
VENT	N5	1	6"	TOP	5'-0"		PIPE SUPPORTS FOR INTERIOR PIPING: YES
ACCESSWAY	N6	1	24"	TOP	4'-0"		PIPE SUPPORTS FOR EXTERIOR PIPING: YES
NA							GRADUATED STANDPIPE: NO
NA							HEAT TRACING AND INSULATION: NO
NA							HANDRAILS: NO
NA							TIE DOWN SYSTEM: YES
NA							
NA							
NA							
NA							N/A = NOT APPLICABLE

SECTION 44 44 13.01 CHEMICAL METERING PUMPS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the work necessary to furnish and install complete, two prefabricated skid-mounted chemical metering systems and appurtenances specified herein.
- B. All equipment provided under this section shall be obtained from a single supplier or manufacturer who shall assume full responsibility for the completeness and proper operation of the chemical feed system, specified herein. The skid systems shall be assembled, tested and certified at the manufacturer's facility.
- C. All control system components shall be supplied in accordance with Section 40 99 90, Package Control Systems.

1.02 DEFINITIONS

- A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 EQUIPMENT NUMBERS

- A. Identification numbers assigned to equipment and accessories on Process and Instrumentation Drawings (P&ID) as follows:

Metering Pump Number	Name
578-P-02-01	Liquid Ammonium Sulfate Feed Pump 1
578-P-02-02	Liquid Ammonium Sulfate Feed Pump 2
578-P-02-03	Liquid Ammonium Sulfate Feed Pump 3
578-P-02-04	Liquid Ammonium Sulfate Feed Pump 4

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Make, model, weight, and horsepower of each equipment assembly.
 - 2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

3. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity.
4. Detailed Drawings showing the equipment dimensions, size, locations of connections, and weights of associated equipment.
5. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
6. Power and control wiring diagrams, including terminals and numbers.
7. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
8. Shop and Field Painting Systems Proposed: Include manufacturer's descriptive technical catalog literature and specifications, hazardous communication data sheets, and written certification that the factory-applied coating system(s) is identical to the requirements specified.
 - a. Where system proposed is different from that specified or where, in the manufacturer's opinion, the coating system(s) exceed(s) the requirements specified, submit complete technical literature of the proposed system(s) to the Engineer for review.
9. Refer to Section 40 99 90, Package Control Systems for additional submittal requirements.

B. Quality Control Submittals:

1. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's printed installation instructions.
4. Manufacturer's Certificate of Proper Installation.
5. Suggested spare parts list to maintain the equipment in service for a period of 2 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Manuals: As specified in Section 01730, Operation and Maintenance Data.
8. Field Performance Test Certificate.

1.05 EXTRA MATERIALS

A. Furnish:

1. Four pump diaphragms.
2. Four suction valves, complete.

3. Four discharge valves, complete.
4. Four ball check valves.
5. Four complete sets of o-rings and seals.
6. One complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

- A. Manufacturers: ProMinent.
- B. The chemical pump manufacturer/supplier shall furnish diaphragm chemical metering pump skids, with all accessories, fittings, appurtenances, specialty items and all supports and anchors required for complete and operating pumping systems.
- C. All parts and mechanisms shall be designed for all stresses that may occur during fabrication, shipping, erection, and intermittent or continuous operation. All units shall be constructed such that dismantling and repairing can be accomplished without difficulty.
- D. The pumping units shall operate without vibration or excessive noise over the operating speed range.
- E. Pumping system vibration shall not exceed the acceptable field vibration limits given in the standards of the Hydraulic Institute.
- F. All wetted surfaces of the diaphragm chemical metering pumps and appurtenances shall be suitable for continuous exposure to the chemical being pumped as outlined in the Pump Data Sheets.

2.02 MOTOR DRIVEN DIAPHRAGM TYPE POSITIVE DISPLACEMENT PUMP

- A. The pump shall be of the motor driven diaphragm positive displacement type. The pump shall be able to withstand closed suction or discharge valves without damage to the internals of the pump. Peristaltic tube, peristaltic hose, and progressing cavity pumps shall not be accepted.
- B. Pumps shall use a cam driven by the worm gear to actuate a reciprocating piston to drive the hydraulically actuated diaphragm. The pump shall have an integrated hydraulic relief valve to protect the pump from overloading. The diaphragms shall be PTFE coated.

- C. The pump shall be capable of pumping with a net positive suction head available as low as 3 psia.
- D. The pump shall have the ability to be hydrostatically tested in the actual installation at 1.5 times the rated pressure of the pump to ensure a safe environment.

2.03 SKID MOUNTED SYSTEM

- A. The pumps shall be mounted on skids in one duty/one standby arrangement. Two skids shall be provided for the four pumps. The standby pump shall be automatically turned on if the duty pump loses flow. Skid mounted chemical metering pump systems shall be complete with the skid assembly containing chemical metering pumps, all necessary piping, valves, fittings, supports, electrical controls, and accessories as specified herein. The metering pump skid shall contain the following items:
 - 1. Skid shall be mounted within a UV protected enclosure with access door and fan ventilation.
 - 2. The skid base and enclosure shall be made from 1/2 inch thick white PVC or HDPE. The skid shall have a drip lip. Doors shall be tinted Lexan sliding doors or HDPE roll up doors.
 - 3. Metering pumps with manual stroke length adjustment.
 - 4. Pump motors.
 - 5. Calibration columns.
 - 6. Pulsation dampeners.
 - 7. Pressure gauges with diaphragm seals.
 - 8. Ball valves.
 - 9. Pressure relief valves.
 - 10. Backpressure/antisiphon valve.
 - 11. Y-strainer: Each pump suction shall be supplied with a 40-60 mesh "Y" strainer to prevent foreign material from getting into the ball checks of the metering pump. The strainer shall be constructed of material suitable for the chemical service. Alloy 20 strainer shall be used for sulfuric acid service.
 - 12. All piping, valves, gaskets, supports, hardware, wiring, junction boxes, and accessories necessary for a fully functioning skid. Piping shall be terminated within 2 inches from the edge of skid. Electrical cables shall terminate in the control panel.
- B. Contractor to coordinate size of skid with pump manufacturer to ensure that the skid size is consistent with the concrete pads shown on Drawings.

- C. They shall be specially designed, constructed, and installed for the service intended and shall comply with the conditions listed in the schedule at the end of this section. The chemical pump manufacturer/supplier shall submit compatibility data from the manufacturer being supplied to confirm the materials of construction.
- D. The skid mounting of the metering pumps shall conform to the following requirements:
 - 1. Each chemical feed system shall be completely assembled, mounted, calibrated, tested, and delivered to the site on a single skid. Components to be mounted on the skid are as indicated on the Drawings and shall include the metering pumps, calibration column, piping valves, piping accessories (pulsation dampeners, strainers, etc.), and wiring integral to the skid. The chemical feed system supplier shall be responsible for providing all equipment, valves, and piping within the skid boundary as shown on Drawings.
 - 2. The skids shall be constructed of fusion welded polypropylene with adequate supports for all equipment and piping. Fork lift truck cut outs and anchor bolt holes shall also be provided.
 - 3. The skid shall be provided with venting and valves to allow venting of offgas.
 - 4. All components of the skid mounted system (pumps, piping, and controls) shall be tested at the pump manufacturer's facility prior to shipment as described below.
 - 5. All supports and standoffs contained within the skid boundary shall be of welded construction – bolted stand offs or the use of strapping shall not be acceptable.
 - 6. All pulsation dampeners and pressure gauges with diaphragm seals shall be provided with isolation ball valves such that the item can be removed from the feed system while the system is operational.
 - 7. All control panels shall be factory skid mounted within the skid boundary and wired complete prior to shipment.
- E. Pulsation Dampeners:
 - 1. Pulsation dampeners shall be of the single diaphragm design, capable of arresting water hammer in the pump discharge lines created by the metering pumps. Pulsation dampener shall dampen flow a minimum of 95 percent.
 - 2. Pulsation dampeners shall be provided with valves, gauges, and fittings necessary for maintaining required air pressure in the air chamber.
 - 3. Materials of construction of diaphragm and body shall be corrosion-resistant to the chemical fluid pumped.
 - 4. Provide one dampener on the discharge side of each metering pump.

5. Each pulsation dampener shall include an integral pressure gauge.
6. Size: Pulsation dampeners shall be sized appropriately for each pump stroke volume to remove a minimum of 95 percent of the pulsations. The manufacturer shall provide calculations to verify sizing if requested by the Engineer.

F. Piping, Valves, and Appurtenances:

1. Skid pipe shall be schedule 80 PVC with socket or flanged ends. Cement shall be as recommended by the pipe manufacturer for the service outlined in this section. Piping shall be in accordance with Section 40 27 00, Process Piping – General.
2. Seals shall be compatible with the chemical being pumped. Shutoff valves shall be Type V330, drilled with vent hole, in accordance with Section 40 27 02, Valves and Operators.
3. Adjustable diaphragm back pressure sustaining type installed on pump discharge header. Materials to be suitable for respective chemical service and shall provide minimum backpressure for pumps to work properly. Furnish quantity and install in locations as indicated on the Drawings.
4. Adjustable external pressure relief type installed on pump discharge header set as recommended by pump manufacturer. Relief shall be to the suction side of the pump.
5. Backpressure/antisiphon valve shall be made of PVC.

G. Accessories:

1. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
2. Lifting Lugs: Equipment weighing over 100 pounds.
3. Anchor Bolts/Clips: Type 316 stainless steel, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Design of anchor clips shall be coordinated with the FRP grating manufacturer.
4. Screens or Guards: Where applicable, provide mesh, size of less than 0.5 inch, exposed rotating shafts, rotors, couplings, pulley, wheel, bolts, chains, or similar components. Where guards/screens are over grease fittings, couplings, or other items requiring maintenance, provide a means for ready access with the screens/guards.

H. Calibration Columns:

1. Calibration columns shall be 1,000 ml, clear PVC.
2. The top of the chamber shall have a threaded fitting to allow for piping to a common vent.
3. Calibration columns shall be made of clear material described above. Cylinder material shall have fully circumscribed markings with black numerals of at least 1/4-inch height, PVC with 1-inch NPT threaded ports both top and bottom. Graduation markings shall be in fractions of gallons in proportion to size of column.

2.04 INSTRUMENTATION AND CONTROLS

- A. General: Provide all instrumentation and controls in accordance with this section, Section 40 99 90, Package Control Systems and related P&ID Contract Drawing(s).
- B. Provide control system and panel for chemical feed systems meeting the following minimum requirements:
 1. Provide 316 stainless steel control panel enclosure that is rated NEMA 4X.
 - a. Factory paint panel exterior white to reduce solar effects.
 2. Control panel shall be UL508A listed.
 3. System shall operate on one single-phase 120V ac circuit with 20 amp molded case circuit breaker. Provide disconnect switch on metering pump skid external to control enclosure or interlocked with control panel door handle.
 4. Within each panel provide a surge suppressor on the incoming 120V ac power, as specified in Section 40 99 90, Package Control Systems.
 5. For each pump: Operator Controls and Indicators, except for stroke length, are made through the 6-button touch pad on Pump:
 - a. Stroking rate push button, one per pump.
 - b. Yes/ Accept push button, one per pump.
 - c. No/Reject push button, one per pump.
 - d. Up/Increment push button, one per pump.
 - e. Down/Decrement push button, one per pump.
 - f. Stop Function Red indicator light, one per pump.
 - g. Stroke indicator flashing green light, one per pump.
 - h. LCD Display, displays Circuit Failure, Signal Loss, Full count, Pulse Overflow, or Pulse Rate High.

6. Provide the following Operator Controls and Indicators on the pump control panel at a minimum:
 - a. LOCAL/OFF/AUTO hand switch, one per pump.
 - b. Digital Speed indicator, one per pump.
 - c. Digital Speed controller, one per pump.
 - d. Fail Alarm light, one per pump.
 - e. ON/OFF indicating light, one per pump.
7. Each panel is to be fabricated by the chemical skid manufacturer and tested with the chemical feed skid prior to shipment to the Site.

C. Functional Requirements:

1. As shown on the P&IDs.
2. The stroke length shall be manually adjustable with a stroke adjustment knob on the pump face. The knob shall be adjustable between 0 percent and 100 percent.
3. Local/Off/Auto:
 - a. Local: The pump shall activate via a start/stop switch on the pump. The speed shall be adjustable by the speed controller on the local pump panel (one speed adjust per pump).
 - b. Auto: The pump shall respond to a remote run command. The speed shall be controlled by a remote analog speed command signal.
4. Fault Relay Output: The metering pump shall have an integral relay to allow remote annunciation of a fault condition (i.e. low supply solution early warning/lack of supply solution shut down, flow monitor, system faults, and fuse/power supply failure).
5. Analog 4-20mA Output: The pump shall have an analog output corresponding to the flow output of the metering pump. This output shall represent pumped flowrate, which combines both stroke length and stroke frequency.

D. External Inputs and Outputs:

1. Provide the following discrete outputs:
 - a. ON Status.
 - b. REMOTE Status.
 - c. FAIL Status.
2. Accept the following discrete input: RUN Command.
3. Provide the following analog feedback signal: Combined stroke and speed signal to indicate pumped flowrate, 4-20mA.
4. Accept the following analog signal: Speed adjust, 4-20mA.

E. Special Requirements for Panels:

1. Within each panel, provide a 20A, minimum, main circuit breaker (20A, 120 volts, ac, 1 phase, 60-Hz).
2. Within each panel, provide for each pump a 15A circuit breaker.
3. All discrete signals shall be dry contacts suitable for 5A at 120V ac.
4. Provide surge suppressors on all analog signals at the control panel. Surge suppressors shall be as specified in Section 40 99 90, Package Control Systems.
5. Within panel, provide a surge suppressor on the incoming 120V ac power supply. Surge suppressor shall be as specified in Section 40 99 90, Package Control Systems.

F. Instrumentation:

1. Provide all instrumentation as shown on the P&IDs.
2. Pressure Gauges:
 - a. Provide pressure gauge for each pump discharge.
 - 1) Liquid fill front of gauge.
 - b. Provide diaphragm seal for each pressure gauge of suitable material and fill liquid compatible with chemical.
 - c. Provide pressure gauge with range suitable to cover the pump operating range.

2.05 FACTORY TESTING

- A. Perform manufacturer's standard factory testing of assembled pumping skids.
- B. Tests shall be conducted on the actual pumps, and skids being provided for the Project.
- C. Each skid system must be tested prior to shipment. The system shall be operated throughout the entire operating range of the pumps, in all automatic and manual modes.
- D. Manufacturer shall make temporary electrical connections between the control panel and the pump skid to perform the tests.
- E. All piping shall be hydrostatically tested to a pressure of 100 psi without leakage.

2.06 SOURCE QUALITY CONTROL

- A. Functional Test: Perform manufacturer's standard test on equipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD QUALITY CONTROL

- A. Conduct tests on each pump.
- B. Functional Test:
 - 1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
- C. Performance Test:
 - 1. The Contractor shall perform field tests on all completed pump assemblies to demonstrate their conformance to the Specifications to the satisfaction of the Engineer. A test log shall be presented to the Engineer upon completion of each test that records flow, as measured by graduated containers or storage volumes.
 - 2. Flow measurements shall be made at the following conditions:
 - a. 100 Percent Stroke Length: 50 and 100 percent speed.
 - b. 50 Percent Stroke Length: 50 and 100 percent speed.
 - 3. Units apparently failing to meet the Specifications to the satisfaction of the Engineer shall be more accurately tested in accordance with Hydraulic Institute Standards. If the pump fails the second test, the unit will be rejected, and the Contractor shall furnish a unit that will perform as specified. In addition, if the specified pump fails the second test, all identical pumps covered by the Detail Specification for the pump under test shall be tested under the same proviso, whether specified or not, at the Contractor's sole expense.
 - 4. Test the control system, including interface with the plant control system.

3.03 MANUFACTURERS' SERVICES

- A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
 - 1. 1 person-day for installation assistance and inspection.
 - 2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
 - 3. 1/2 person-day for prestartup classroom or site training.
 - 4. 1/2 person-day for facility startup.

3.04 SUPPLEMENTS

- A. The supplement listed below, following "END OF SECTION," is a part of this Specification.
 - 1. Supplement 1, Liquid Ammonium Sulfate Metering Pumps Nos. 1, 2, 3, 4.

END OF SECTION

CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-_____**Tag Numbers:** 578-P-02-01, 578-P-02-02, 578-P-02-03, 578-P-02-04Pump Name: Liquid Ammonium Sulfate Feed PumpsManufacturer and Model Number: (1) ProMinent, Sigma Series**SERVICE CONDITIONS**Liquid Pumped (Material and Percent): 38% Ammonium SulfatePumping Temperature (Fahrenheit): Normal: 70 Max 100 Min 32Liquid pH: 5.5Abrasive (Y/N) N Possible Scale Buildup (Y/N): NSuction Pressure (psig): Minimum 0Altitude (ft msl): 0 Area Classification: N/A Location (indoor/outdoor): outdoor**PERFORMANCE REQUIREMENTS**Capacity (US gph): Maximum: 30 Minimum: 3.0Maximum Discharge Pressure (psig): 58Internal Bypass Valve Setting (psig): per mfrRelief Valve Setting (psig/as recommended): per mfrBack Pressure Valve Setting (psig/as recommended): per mfrMax. Stroke Rate (spm): 246**DESIGN AND MATERIALS**Pump Type: Single Diaphragm (Y/N) YWet End Material: PVDFCheck Valve Material: Ceramic Configuration(Single/Double): SingleDiaphragm Material: PFPEDiaphragm Actuation Type: MechanicalStroke Position Adjustment: ManualPump Speed Control: Variable

CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01-_____

Tag Numbers: 578-P-02-01, 578-P-02-02, 578-P-02-03, 578-P-02-04

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 0.5 or less Voltage: 120 Phase: Single
Synchronous Speed (rpm) 1750

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: TEFC

TESTING

Pump Tests: Factory Functional (Y/N) Y Factory Performance (Y/N) Y

Field Functional (Y/N) Y Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) N Other

REMARKS

**DRAWINGS
(BOUND SEPARATELY)**

Southwest Water Reclamation Facility Recharge Well
System Infrastructure

CONSTRUCTION AGREEMENT

for

STIPULATED SUM

between

MANATEE COUNTY (AS OWNER)

and

_____ (AS CONTRACTOR)

**CONSTRUCTION AGREEMENT FOR
STIPULATED SUM
Southwest Water Reclamation Facility Recharge Well System Infrastructure Project**

THIS AGREEMENT (“Agreement”) is made and entered into by and between Manatee County, a political subdivision of the State of Florida, referred to herein as “Owner”, and the firm of _____, incorporated in the State of _____ and registered and licensed to do business in the State of Florida (license # _____), referred to herein as “Contractor.”

WHEREAS, the Owner intends to construct [**Southwest Water Reclamation Facility Recharge Well System Infrastructure**], the aforementioned improvements being hereinafter referred to and defined as the “Project”; and

WHEREAS, in response to Owner’s Invitation for Bid No. 16-1006CD (the “IFB”), Contractor has submitted its Bid (the “Contractor’s Bid”) to provide the aforementioned construction services.

NOW THEREFORE, the Owner and the Contractor, in consideration of the mutual covenants hereinafter set forth, the sufficiency of which is hereby acknowledged, agree as follows:

1. Contract Documents. The Contract Documents consist of this Agreement and attached Exhibits, the attached General Conditions of the Construction Agreement, Supplementary Conditions (if any), Special Conditions (if any), Drawings (the titles of which are attached hereto as Exhibit A), Specifications (the titles of which are attached hereto as Exhibit B), Addenda issued prior to execution of this Agreement, the Invitation for Bid (including any Instructions to Bidders, Scope of Work, Bid Summary, Supplements, and Technical Specifications), any interpretations issued pursuant to the Invitation for Bid, the Contractor’s Bid, permits, notice of intent to award, Notice to Proceed, purchase order(s), any other documents listed in this Agreement, and Modifications [to include written Amendment(s), Change Order(s), Work Directive Change(s) and Field Directive(s)] issued after execution of this Agreement. These form the Agreement, and are as fully a part of the Agreement as if attached or repeated herein. This Agreement represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations or agreements, either written or oral. No other documents shall be considered Contract Documents.

2. Work. The Contractor shall fully execute the Work described in the Contract Documents, except to the extent specifically indicated in the Contract Documents to be the responsibility of others.

3. Date of Commencement and Substantial Completion.

A. Date of Commencement. The date of commencement of the Work shall be the date fixed in a Notice to Proceed issued by the Owner.

B. Contract Time. The Contract Time shall be measured from the date of commencement.

C. Substantial Completion. The Contractor shall achieve Substantial Completion of the entire Work not later than **460** days from the date of commencement.

Time is of the essence in the Contract Documents and all obligations thereunder. If the Contractor fails to achieve Substantial Completion of the Work within the Contract Time and as otherwise required by the Contract Documents, the Owner shall be entitled to retain or recover from the Contractor, as liquidated damages and not as a penalty, the sum of **\$1,742.00** per calendar day, commencing upon the first day following expiration of the Contract Time and continuing until the actual date of Substantial Completion. Such liquidated damages are hereby agreed to be a reasonable estimate of damages the Owner will incur as a result of delayed completion of the Work. The Owner may deduct liquidated damages as described in this paragraph from any unpaid amounts then or thereafter due the Contractor under this Agreement. Any liquidated damages not so deducted from any unpaid amounts due the Contractor shall be payable to the Owner at the demand of the Owner, together with interest from the date of the demand at the maximum allowable rate.

4. Contract Sum.

A. Payment. The Owner shall pay the Contractor the Contract Sum in current funds for the Contractor's performance of the Contract. The Contract Sum shall be _____ Dollars and Zero Cents (\$_____), subject to additions and deductions as provided in the Contract Documents.

B. Alternates. The Contract Sum is based upon the following alternates, if any, which are described in the Contract Documents and are hereby accepted by the Owner.

C. Unit Prices. Unit prices, if any, are reflected in the Contractor's Bid.

5. Payments.

A. Progress Payments.

- (1) Based upon Applications for Payment submitted to the Architect/Engineer by the Contractor and Certificates for Payment issued by the Architect/Engineer, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents.
- (2) The period covered by each Application for Payment shall be one calendar month ending on the last day of the month.
- (3) Payments shall be made by Owner in accordance with the requirements of Section 218.735, Florida Statutes.
- (4) Each Application for Payment shall be based on the most recent schedule of values submitted by the Contractor in accordance with the Contract Documents. The schedule of values shall allocate the entire Contract Sum among the various portions of the Work. The schedule of values shall be

prepared in such form and supported by such data to substantiate its accuracy as the Architect/Engineer may require. This schedule, unless objected to by the Owner or Architect/Engineer, shall be used as a basis for reviewing the Contractor's Applications for Payment.

- (5) Applications for Payment shall indicate the percentage of completion of each portion of the Work as of the end of the period covered by the Application for Payment.
- (6) Subject to other provisions of the Contract Documents, the amount of each progress payment shall be computed as follows:
 - i. Take that portion of the Contract Sum properly allocable to completed Work as determined by multiplying the percentage completion of each portion of the Work by the share of the Contract Sum allocated to that portion of the Work in the schedule of values, less retainage of ten percent (10.00%). Pending final determination of cost to the Owner of changes in the Work, amounts not in dispute shall be included as provided in Section 3.3.B. of the General Conditions;
 - ii. Add that portion of the Contract Sum properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the completed construction (or, if approved in advance by the Owner, suitably stored off the site at a location agreed upon in writing), supported by paid receipts, less retainage of ten percent (10.00%);
 - iii. Subtract the aggregate of previous payments made by the Owner; and
 - iv. Subtract amounts, if any, for which the Architect/Engineer has withheld or nullified an Application for Payment, in whole or in part as provided in Section 3.3.C. of the General Conditions.
- (7) The progress payment amount determined in accordance with Section 5.A(6) shall be further modified under the following circumstances:
 - i. Add, upon Substantial Completion of the Work, a sum sufficient to increase the total payments to the full amount of the Contract Sum, less such amounts as the Architect/Engineer shall determine for incomplete Work, retainage applicable to such work and unsettled claims.
 - ii. Add, if final completion of the Work is thereafter materially delayed through no fault of the Contractor, any additional amounts payable in accordance with Section 3.2.B. of the General Conditions.
- (8) Reduction or limitation of retainage, if any, shall be as follows:

Notwithstanding the foregoing, upon completion of at least 50% of the Work, as determined by the Architect/Engineer and Owner, the Owner shall reduce to five percent (5%) the amount of retainage withheld from each subsequent progress payment.

- (9) Except with the Owner's prior approval, the Contractor shall not make advance payments to suppliers for materials or equipment which have not been delivered and stored at the site.

B. Final Payment. Final Payment, constituting the entire unpaid balance of the Contract Sum, shall be made by the Owner to the Contractor when:

- (1) The Contractor has fully performed the Work except for the Contractor's responsibility to correct Work as provided in Section 2.4.C. of the General Conditions, and to satisfy other requirements, if any, which extend beyond final payment; and
- (2) A final Application for Payment has been approved by the Architect/Engineer.

6. Termination or Suspension.

A. Termination. The Agreement may be terminated by the Owner or the Contractor as provided in Article XIV of the General Conditions.

B. Suspension by Owner. The Work may be suspended by the Owner as provided in Article XIV of the General Conditions.

7. Other Provisions.

A. Substantial Completion Defined. Substantial Completion shall be defined as provided in Article I of the General Conditions. In the event a temporary certificate of occupancy or completion is issued establishing Substantial Completion, the Contractor shall diligently pursue the issuance of a permanent certificate of occupancy or completion.

B. Project Meetings. There shall be a project meeting, at the jobsite or other location acceptable to the parties, on a regularly scheduled basis. The meeting will be attended by a representative of the Contractor, Architect/Engineer and Owner. These representatives shall be authorized to make decisions that are not otherwise contrary to the requirements of this Agreement.

C. Weather. Any rainfall, temperatures below 32 degrees Fahrenheit or winds greater than 25 m.p.h. which actually prevents Work on a given day, shall be considered lost time and an additional day added to the Contract Time, provided no work could be done on

site, and provided written notice has been submitted to the Owner by the Contractor documenting same.

D. Shop Drawings; Critical Submittals. In consideration of the impact of timely review of submittals and shop drawings on the overall progress of the Work, it is hereby agreed that the Owner shall cause his agents and design professionals to accomplish the review of any particular “critical” submittals and/or shop drawings and return same to the Contractor within fourteen (14) days.

E. Applications for Payment. Applications for Payment shall be submitted once monthly at regular intervals and shall include detailed documentation of all costs incurred.

F. Punch List. Within 30 days after obtainment of Substantial Completion, the Owner shall generate a “punch list” of all work items requiring remedial attention by the Contractor. Within 5 days thereafter the Architect/Engineer shall assign a fair value to the punch list items, which sum shall be deducted from the next scheduled progress payment to the Contractor. Upon satisfactory completion of the punch list items, as certified by the Architect/Engineer, the previously deducted sum shall be paid to the Contractor.

G. Closeout documentation. Within 30 days after obtainment of Substantial Completion and before final payment, Contractor shall gather and deliver to Owner all warranty documentation, all manufacturer’s product and warranty literature, all manuals (including parts and technical manuals), all schematics and handbooks, and all as-built drawings.

H. Governing Provisions; Conflicts. In the event of a conflict between this Agreement and the Specifications or as between the General Conditions and the Specifications, the Specifications shall govern.

I. E-Verify. The Contractor’s employment of unauthorized aliens is a violation of Section 274(e) of the Federal Immigration and Employment Act. The Contractor shall utilize the U.S. Department of Homeland Security E-Verify system to verify the employment eligibility of all new employees hired during the term of this Agreement, and shall require the same verification procedure of all Subcontractors.

8. Insurance and Bonding. If and to the extent required by the Invitation for Bid documents, the Contractor shall furnish insurance coverage for (but not necessarily limited to) workers’ compensation, commercial general liability, auto liability, excess liability, and builder’s risk. The Contractor shall furnish to the Owner all appropriate policies and Certificate(s) of Insurance. The Contractor shall also post a Payment and Performance Bond for the Contract Sum, within ten (___) days following notification of intent to award, and otherwise in accordance with the Invitation for Bid documents.

9. Independent Contractor. The Contractor acknowledges that it is functioning as an independent contractor in performing under the terms of this Agreement, and it is not acting as an employee of the Owner.

10. Entire Agreement. This Agreement (inclusive of the Contract Documents incorporated herein by reference) represents the full agreement of the parties.

11. Amendments; Waivers; Assignment.

A. Amendments. This Agreement may be amended only pursuant to an instrument in writing that has been jointly executed by authorized representatives of the parties hereto.

B. Waivers. Neither this Agreement nor any portion of it may be modified or waived orally. However, each party (through its governing body or properly authorized officer) shall have the right, but not the obligation, to waive, on a case-by-case basis, any right or condition herein reserved or intended for the benefit or protection of such party without being deemed or considered to have waived such right or condition for any other case, situation, or circumstance and without being deemed or considered to have waived any other right or condition. No such waiver shall be effective unless made in writing with an express and specific statement of the intent of such governing body or officer to provide such waiver.

C. Assignment. The rights and obligations of either party to this Agreement may be assigned to a third party only pursuant to a written amendment hereto.

12. Validity. Each of the Owner and Contractor represents and warrants to the other its respective authority to enter into this Agreement.

13. Covenant To Defend. Neither the validity of this Agreement nor the validity of any portion hereof may be challenged by any party hereto, and each party hereto hereby waives any right to initiate any such challenge. Furthermore, if this Agreement or any portion hereof is challenged by a third party in any judicial, administrative, or appellate proceeding (each party hereby covenanting with the other party not to initiate, encourage, foster, promote, cooperate with, or acquiesce to such challenge), the parties hereto collectively and individually agree, at their individual sole cost and expense, to defend in good faith its validity through a final judicial determination or other resolution, unless all parties mutually agree in writing not to defend such challenge or not to appeal any decision invalidating this Agreement or any portion thereof.

14. Disclaimer of Third-Party Beneficiaries; Successors and Assigns. This Agreement is solely for the benefit of the parties hereto, and no right, privilege, or cause of action shall by reason hereof accrue upon, to, or for the benefit of any third party. Nothing in this Agreement is intended or shall be construed to confer upon or give any person, corporation, partnership, trust, private entity, agency, or other governmental entity any right, privilege, remedy, or claim under or by reason of this Agreement or any provisions or conditions hereof. This Agreement shall be binding upon, and its benefits and advantages shall inure to, the successors and assigns of the parties hereto.

15. Construction.

A. Headings and Captions. The headings and captions of articles, sections, and paragraphs used in this Agreement are for convenience of reference only and are not intended to define or limit their contents, nor are they to affect the construction of or be taken into consideration in interpreting this Agreement.

B. Legal References. All references to statutory sections or chapters shall be construed to include subsequent amendments to such provisions, and to refer to the successor

provision of any such provision. References to “applicable law” and “general law” shall be construed to include provisions of local, state and federal law, whether established by legislative action, administrative rule or regulation, or judicial decision.

16. Severability. The provisions of this Agreement are declared by the parties hereto to be severable. In the event any term or provision of this Agreement shall be held invalid by a court of competent jurisdiction, such invalid term or provision should not affect the validity of any other term or provision hereof; and all such terms and provisions hereof shall be enforceable to the fullest extent permitted by law as if such invalid term or provision had never been part of this Agreement; provided, however, if any term or provision of this Agreement is held to be invalid due to the scope or extent thereof, then, to the extent permitted by law, such term or provision shall be automatically deemed modified in order that it may be enforced to the maximum scope and extent permitted by law.

17. Governing Law; Venue. This Agreement shall be governed by the laws of the State of Florida. Venue for any petition for writ of certiorari or other court action allowed by this Agreement shall be in the Circuit Court of the Twelfth Judicial Circuit in and for Manatee County, Florida.

18. Attorney’s Fees and Costs. In any claim dispute procedure or litigation arising from this Agreement, each party hereto shall be solely responsible for paying its attorney’s fees and costs.

19. Notices. All notices, comments, consents, objections, approvals, waivers, and elections under this Agreement shall be in writing and shall be given only by hand delivery for which a receipt is obtained, or certified mail, prepaid with confirmation of delivery requested, or by electronic mail with delivery confirmation. All such communications shall be addressed to the applicable addressees set forth below or as any party may otherwise designate in the manner prescribed herein.

To the Owner:

Email: _____

To the Contractor:

Email: _____

Notices, comments, consents, objections, approvals, waivers, and elections shall be deemed given when received by the party for whom such communication is intended at such party’s address herein specified, or such other physical address or email address as such party may have substituted by notice to the other.

20. Exhibits. Exhibits to this Agreement are as follows:

Exhibit A—Title(s) of Drawings

Exhibit B—Title(s) of Specifications

Exhibit C—Affidavit of No Conflict

Exhibit D—Certificate(s) of Insurance

Exhibit E—Payment and Performance Bond

Exhibit F—Standard Forms

- 1—Application for Payment
- 2—Certificate of Substantial Completion
- 3—Final Reconciliation / Warranty / Affidavit
- 4—Change Order

WHEREFORE, the parties hereto have executed this Agreement as of the date last executed below.

Name of Contractor

By: _____

Printed Name: _____

Title: _____

Date: _____

MANATEE COUNTY, a political subdivision
of the State of Florida

By: _____

Printed Name: _____

Title: _____

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GENERAL CONDITIONS
of the
CONSTRUCTION AGREEMENT

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GENERAL CONDITIONS
ARTICLE I
DEFINITIONS

1.1 Definitions. For purposes of the Contract Documents, the following terms shall have the following meanings.

A. Acceptance: The acceptance of the Project into the Owner's operating public infrastructure.

B. Application for Payment: The form approved and accepted by the Owner, which is to be used by Contractor in requesting progress payments or final payment and which is to include such supporting documentation as is required by the Contract Documents.

C. Architect/Engineer: **CH2MHILL, Inc.**, a **Colorado** corporation, registered and licensed to do business in the State of Florida.

D. Change Order: A written order signed by the Owner, the Architect/Engineer and the Contractor authorizing a change in the Project Plans and/or Specifications and, if necessary, a corresponding adjustment in the Contract Sum and/or Contract Time, pursuant to Article V.

E. 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.

F. Contractor's Personnel: The Contractor's key personnel designated by Contractor.

G. Construction Services: The Construction Services to be provided by Contractor pursuant to Section 2.4, in accordance with the terms and provisions of the Contract Documents.

H. Contract Sum: The total compensation to be paid to the Contractor for Construction Services rendered pursuant to the Contract Documents, as set forth in Contractor's Bid, unless adjusted in accordance with the terms of the Contract Documents.

I. Construction Team: The working team established pursuant to Section 2.1.B.

J. Contract Time: The time period during which all Construction Services are to be completed pursuant to the Contract Documents, to be set forth in the Project Schedule.

K. Days: Calendar days except when specified differently. 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.

L. Defective: When modifying the term “Work”, referring to Work that is unsatisfactory, faulty or deficient, or does not conform to the Contract Documents, or that does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or that has been damaged prior to Owner’s approval of final payment (unless responsibility for the protection thereof has been assumed by Owner).

M. 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 a 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.

N. Field Directive: A written order issued by Owner which orders minor changes in the Work not involving a change in Contract Time, to be paid from the Owner’s contingency funds.

O. Final Completion Date: The date upon which the Project is fully constructed and all Work required on the Project and Project Site is fully performed as verified in writing by the Owner.

P. Float or Slack Time: The time available in the Project Schedule during which an unexpected activity can be completed without delaying substantial completion of the Work.

Q. Force Majeure: Those conditions constituting excuse from performance as described in and subject to the conditions described in Article XII.

R. 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.

S. Non-prejudicial Delay: Any delay impacting a portion of the Work within the available total Float or Slack Time and not necessarily preventing Substantial Completion of the Work within the Contract Time.

T. 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 the Work.

U. Owner: Manatee County, a political subdivision of the State of Florida.

V. Owner’s Project Representative: The individual designated by Owner to perform those functions set forth in Section 7.8.

W. Payment and Performance Bond: The Payment and Performance Bond security posted pursuant to Section 2.4.Y to guarantee payment and performance by the Contractor of its obligations hereunder.

X. Permitting Authority: Any applicable governmental authority acting in its governmental and regulatory capacity which is required to issue or grant any permit, certificate, license or other approval which is required as a condition precedent to the commencement or approved of the Work, or any part thereof, including the building permit.

Y. Prejudicial Delay: Any excusable or compensable delay impacting the Work and exceeding the total float available in the Project Schedule, thus preventing completion of the Work within the Contract Time unless the Work is accelerated.

Z. Progress Report: A report to Owner that includes all information required pursuant to the Contract Documents and submitted in accordance with Section 2.4.EE, hereof.

AA. Project: The total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by Owner and by separate contractors. For the purposes of the Contract Documents, the term Project shall include all areas of proposed improvements and all areas which may reasonably be judged to have an impact on the Project.

BB. Project Costs: The costs incurred by the Contractor to plan, construct and equip the Project and included within, and paid as a component of, the Contract Sum.

CC. Project Manager: Subject to the prior written consent of Owner, the individual designated to receive notices on behalf of the Contractor, or such other individual designated by the Contractor, from time to time, pursuant to written notice in accordance with the Contract Documents.

DD. Project Plans and Specifications: The one hundred percent (100%) construction drawings and specifications prepared by the Architect/Engineer, and any changes, supplements, amendments or additions thereto approved by the Owner, which shall also include any construction drawings and final specifications required for the repair or construction of the Project, as provided herein.

EE. Project Schedule: The schedule and sequence of events for the commencement, progression and completion of the Project, developed pursuant to Section 2.3., as such schedule may be amended as provided herein.

FF. Project Site: The site depicted in the Project Plans and Specifications, inclusive of all rights of way, temporary construction easements or licensed or leased sovereign lands.

GG. 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.

HH. Procurement Ordinance: The Manatee County Procurement Code, Chapter 2-26 of the Manatee County Code of Laws, as amended from time to time.

II. Punch List Completion Date: The date upon which all previously incomplete or unsatisfactory items, as identified by the Contractor, the Architect/Engineer and/or the Owner are completed in a competent and workmanlike manner, consistent with standards for Work of this type and with good building practices in the State of Florida.

JJ. Subcontractor: Any individual (other than a direct employee of the Contractor) or organization retained by Contractor to plan, construct or equip the Project pursuant to Article IV.

KK. Substantial Completion and Substantially Complete: The stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use; provided, however, that as a condition precedent to Substantial Completion, the Owner has received all certificates of occupancy or completion and other permits, approvals, licenses, and other documents from any governmental authority which are necessary for the beneficial occupancy of the Project.

LL. Substantial Completion Date: The date on which the Project is deemed to be Substantially Complete, as evidenced by receipt of (i) the Architect/Engineer's certificate of Substantial Completion, (ii) written Acceptance of the Project by the Owner, and (iii) approvals of any other authority as may be necessary or otherwise required.

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

NN. Work: The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all labor, materials, equipment and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

OO. Work Directive Change: A written directive to Contractor, issued on or after the effective date of the Agreement pursuant to Section 5.8 and signed by Owner's 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 responding to emergencies.

ARTICLE II RELATIONSHIP AND RESPONSIBILITIES

2.1 Relationship between Contractor and Owner. The Contractor accepts the relationship of trust and confidence established with Owner pursuant to the Contract Documents.

The Contractor shall furnish its best skill and judgment and cooperate with Owner and Owner's Project Representative in furthering the interests of the Owner. The Contractor agrees to provide the professional services required to complete the Project consistent with the Owner's direction and the terms of the Contract Documents. All services provided hereunder by Contractor, either directly or through Subcontractors, shall be provided in accordance with sound construction practices and applicable professional construction standards.

A. Purpose. The purpose of the Contract Documents is to provide for the provision of construction services for the Project on the Project Site by the Contractor, and construction of the Project by the Contractor in accordance with the Project Plans and Specifications. The further purpose of the Contract Documents is to define and delineate the responsibilities and obligations of the parties to the Contract Documents and to express the desire of all such parties to cooperate together to accomplish the purposes and expectations of the Contract Documents.

B. Construction Team. The Contractor, Owner and Architect/Engineer shall be called the "Construction Team" and shall work together as a team commencing upon full execution of the Contract Documents through Substantial Completion. As provided in Section 2.2, the Contractor and Architect/Engineer shall work jointly through completion and shall be available thereafter should additional services be required. The Contractor shall provide leadership to the Construction Team on all matters relating to construction. The Contractor understands, acknowledges and agrees that the Architect/Engineer shall provide leadership to the Construction Team on all matters relating to design.

C. Response to Invitation for Bid. The Contractor acknowledges that the representations, statements, information and pricing contained in its Bid have been relied upon by the Owner and have resulted in the award of this Project to the Contractor.

2.2 General Contractor Responsibilities. In addition to the other responsibilities set forth herein, the Contractor shall have the following responsibilities pursuant to the Contract Documents:

A. Personnel. The Contractor represents that it has secured, or shall secure, all personnel necessary to perform the Work, none of whom shall be employees of the Owner. Primary liaison between the Contractor and the Owner shall be through the Owner's Project Representative and Contractor's Project Manager. All of the services required herein shall be performed by the Contractor or under the Contractor's supervision, and all personnel engaged in the Work shall be fully qualified and shall be authorized or permitted under law to perform such services.

B. Cooperation with Architect/Engineer. The Contractor's services shall be provided in conjunction with the services of the Architect/Engineer. In the performance of professional services, the Contractor acknowledges that time is critical for Project delivery. The Contractor acknowledges that timely construction utilizing the services of an Architect/Engineer and a Contractor requires maximum cooperation between all parties.

C. Timely Performance. The Contractor shall perform all services as expeditiously as is consistent with professional skill and care and the orderly progress of the

Work, in accordance with the Project Schedule. Verification of estimated Project Schedule goals will be made as requested by the Owner.

D. Duty to Defend Work. In the event of any dispute between the Owner and any Permitting Authority that relates to the quality, completeness or professional workmanship of the Contractor's services or Work, the Contractor shall, at its sole cost and expense, cooperate with the Owner to defend the quality and workmanship of the Contractor's services and Work.

E. Trade and Industry Terminology. 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 or Contractor, or any of their agents or employees from those set forth in the Contract Documents. Computed dimensions shall govern over scaled dimensions.

2.3 Project Schedule. The Contractor, within ten (10) days after being awarded the Contract, shall prepare and submit for the Owner's and Architect/Engineer's information a Contractor's construction schedule for the Work. The schedule shall not exceed time limits current under the Contract Documents, shall be revised at appropriate intervals as required by the conditions of the Work and Project, shall be related to the entire Project to the extent required by the Contract Documents, and shall provide for expeditious and practicable execution of Work.

- A. The Project Schedule shall show a breakdown of all tasks to be performed, and their relationship in achieving the completion of each phase of Work, subject to review of Owner and Architect/Engineer and approval or rejection by Owner. The Project Schedule shall show, at 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 Project Schedule shall include all phases of procurement, approval of shop drawings, proposed Change Orders in progress, schedules for Change Orders, and performance testing requirements. The Project Schedule shall include a construction commencement date and Project Substantial Completion Date, which dates shall accommodate known or reasonably anticipated geographic, atmospheric and weather conditions.

- B. The Project Schedule shall serve as the framework for the subsequent development of all detailed schedules. The Project Schedule shall be used to verify Contractor performance and to allow the Owner's Project Representative to monitor the Contractor's efforts.
- C. The Project Schedule may be adjusted by the Contractor pursuant to Article V. The Owner shall have the right to reschedule Work provided such rescheduling is in accord with the remainder of terms of the Contract Documents.
- D. The Contractor shall prepare a submittal schedule, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, and shall submit the schedule(s) for the Architect/Engineer's approval. The Architect/Engineer's approval shall not be unreasonably delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Architect/Engineer reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.
- E. The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect/Engineer.

2.4 Construction Services. The Contractor shall provide the following Construction Services:

A. Construction of Project. The Contractor shall work from the receipt of a Notice to Proceed through the Substantial Completion of the Project in accordance with the terms of the Contract Documents to manage the construction of the Project. The Construction Services provided by the Contractor to construct the Project shall include without limitation (1) all services necessary and commensurate with established construction standards, and (2) all services described in the Invitation for Bid and the Bid.

B. Notice to Proceed. A Notice to Proceed may be given at any time within thirty (30) days after the effective date of the Agreement. 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 issuance of the Notice to Proceed.

C. Quality of Work. If at any time the labor used or to be used appears 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 its efficiency or to improve the character of its Work, and the Contractor shall conform to such an order. Any such order shall not entitle Contractor to any additional compensation or any increase in Contract Time. The failure of the Owner to demand any increase of such efficiency or any improvement shall not release the Contractor from its obligation to secure the quality of Work or the rate of progress necessary to complete the Work within the limits imposed by the Contract Documents. The Owner may require the Contractor to remove such personnel as the Owner deems incompetent, careless, insubordinate or otherwise objectionable, or whose continued employment on the

Project is deemed to be contrary to the Owner's interest. The Contractor shall provide good quality workmanship and shall promptly correct construction defects without additional compensation. Acceptance of the Work by the Owner shall not relieve the Contractor of the responsibility for subsequent correction of any construction defects.

D. Materials. All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. If required by Architect/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.

E. Accountability for Work. The Contractor shall be solely accountable for its Work, including plans review and complete submittals. The Contractor shall be solely responsible for means and methods of construction.

F. Contract Sum. The Contractor shall construct the Project so that the Project can be built for a cost not to exceed the Contract Sum.

G. Governing Specifications. The Project shall be constructed in accordance with applicable Owner design standards and guidelines. In the absence of specified Owner design standards or guidelines, the Architect/Engineer shall use, and the Contractor shall comply with, the most recent version of the applicable FDOT or AASHTO design standards. In general, the Project shall be constructed by the Contractor in accordance with applicable industry standards. The Contractor shall be responsible for utilizing and maintaining current knowledge of any laws, ordinances, codes, rules, regulations, standards, guidelines, special conditions, specifications or other mandates relevant to the Project or the services to be performed.

H. Adherence to Project Schedule. The development and equipping of the Project shall be undertaken and completed in accordance with the Project Schedule, and within the Contract Time described therein.

I. Superintendent. The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project Site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.

(1) The Contractor, as soon as practicable after award of the Contract, shall furnish in writing to the Owner through the Architect/Engineer the name and qualifications of the proposed superintendent. The Architect/Engineer may reply within 14 days to the Contractor in writing stating (1) whether the Owner or the Architect/Engineer has reasonable objection to the proposed superintendent or (2) that the Architect/Engineer requires additional time to review. Failure of the Architect/Engineer to reply within 14 days shall constitute notice of no reasonable objection.

(2) The Contractor shall not employ a proposed superintendent to whom the Owner or Architect/Engineer has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not be unreasonably withheld or delayed.

J. Work Hours. 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 shall not permit overtime work or the performance of Work on a Saturday, Sunday or legal holiday without Owner's written consent given after prior notice to Architect/Engineer (at least seventy-two (72) hours in advance).

K. Overtime-Related Costs. Contractor shall pay for all additional Architect/Engineering charges, inspection costs and Owner staff time for any overtime work which may be authorized. Such additional 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, such overtime costs may be deducted from Contractor's monthly payment request or Contractor's retainage prior to release of final payment.

L. Insurance, Overhead and Utilities. 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.

M. Cleanliness. The Contractor shall keep the premises and surrounding area free from accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery and surplus materials from and about the Project Site. Contractor shall restore to original conditions all property not designated for alteration by the Contract Documents. If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and Owner shall be entitled to reimbursement from Contractor.

N. Loading. 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.

O. 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:

- (1) All employees on the Work and other persons and organizations who may be affected thereby;
- (2) All the Work and materials and equipment to be incorporated therein, whether in storage on or off the Project Site; and

- (3) Other property at the Project 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.

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 for the public and preservation of the Owner's business, taking into full consideration all local conditions. Contractor's duties and responsibilities for safety and protection with regard to the Work shall continue until such time as all the Work is completed.

P. Emergencies. In emergencies affecting the safety or protection of persons or the Work or property at the Project Site or adjacent thereto, Contractor, without special instruction or authorization from Architect/Engineer or Owner, shall 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 Project 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.

Q. Substitutes. For substitutes not included with the Bid, but submitted after the effective date of the Contract Documents, Contractor shall make written application to Architect/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 Architect/Engineer in evaluating the proposed substitute. Architect/Engineer may require Contractor to furnish at Contractor's expense, additional data about the proposed substitute. In rendering a decision, Owner, Architect/Engineer and Contractor shall have access to any available Float Time in the Project Schedule. In the event that substitute materials or equipment not included as part of the Bid, but proposed after the effective date of the Contract Documents, 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 to adjust the Contract Sum.

- (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 Architect/Engineer if Contractor submits sufficient information to allow Architect/Engineer to determine that the substitute proposed is equivalent to that indicated or required by the Contract Documents.

- (2) Architect/Engineer will be allowed a reasonable time within which to evaluate each proposed substitute. Architect/Engineer will be the sole judge of acceptability and no substitute will be ordered, installed or utilized without Architect/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.
- (3) Contractor shall reimburse Owner for the charges of Architect/Engineer and Architect/Engineer's Consultants for evaluating each proposed substitute submitted after the effective date of the Contract Documents and all costs resulting from any delays in the Work while the substitute was undergoing review.

R. Surveys and Stakes. 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 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 shall 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 shall be held responsible for the preservation of all stakes and marks and if for any reason any of the stakes or marks or batter boards become destroyed or disturbed, they shall be immediately and accurately replaced by the Contractor.

S. Suitability of Project Site. The Contractor has, by careful examination, satisfied itself as to the nature and location of the Work and all other matters which can in any way affect the Work, including, but not limited to details pertaining to borings, as shown on the drawings. Such boring information is not guaranteed to be more than a general indication of the materials likely to be found adjacent to holes bored at the Project Site, approximately at the locations indicated. The Contractor has examined boring data, where available, made its own interpretation of the subsurface conditions and other preliminary data, and has based its Bid on its own opinion of the conditions likely to be encountered. Except as specifically provided in Sections 2.4.U., 5.4 and 5.5, no extra compensation or extension of time will be considered for any Project Site conditions that existed at the time of bidding. No verbal agreement or conversation with any officer, agent or employee of the Owner, before or after the execution of the Agreement, shall affect or modify any of the terms or obligations herein contained.

T. Project Specification Errors. If the Contractor, in the course of the Work, finds that the drawings, specifications or other Contract Documents cannot be followed, the Contractor 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 sole risk of non-payment and delay.

U. Remediation of Contamination: Owner and Contractor recognize that remediation of subsurface conditions may be necessary due to potential hazardous materials contamination. Because the presence or extent of any contamination is not known, Contractor shall include no cost in the Contract Sum, and no time in the Project Schedule, for cost or delays

that might result from any necessary remediation. The Project Schedule will provide a period of time between demolition activities and the start of the next activity to commence any remediation if needed. Contractor shall use all reasonable efforts in scheduling the Project to minimize the likelihood that remediation delays construction. Any hazardous materials remediation Work which Contractor agrees to perform shall be done pursuant to a Change Order or amendment consistent with the following:

- (1) The dates of Substantial Completion shall be equitably adjusted based on delays, if any, incurred in connection with remediation efforts.
- (2) Contractor, and any Subcontractors which have mobilized on the Project Site, shall be paid for demonstrated costs of overhead operations at the Project Site during any period of delay in excess of seven (7) days, except to the extent that Work proceeds concurrently with remediation. The categories of costs to be reimbursed are limited to those reasonably incurred at the jobsite during the delay period (such as trailers or offices, telephones, faxes, and the like); equipment dedicated to the Project and located at the Project Site; salaries and associated costs of personnel dedicated to the Project to the extent that they do not perform Work on other projects; and other jobsite costs that are reasonable and which are incurred during the delay period. Subcontractors and suppliers which have not mobilized are limited to the costs set forth in Section 2.4.U(3).
- (3) Contractor and any Subcontractor or supplier on the Project who is eligible for compensation shall be paid any demonstrated costs of escalation in materials or labor, and reasonable costs of off-site storage of materials identified to the Project, arising as a result of any delay in excess of seven (7) days. Such Contractor, Subcontractors and suppliers are obligated to take all reasonable steps to mitigate escalation costs, such as through early purchase of materials.
- (4) Contractor, for itself and all Subcontractors and suppliers on the Project, hereby agrees that the extension of time for delays under Section 2.4.U(1), and payment of the costs identified in Sections 2.4.U(2) and/or Section 2.4.U(3), are the sole remedies for costs and delays described in this Section, and waives all claims and demands for extended home office overhead (including, but not limited to, "Eichleay" claims), lost profit or lost opportunities, and any special, indirect, or consequential damages arising as a result of delays described in this Section. The Contract Sum shall be adjusted to reflect payment of allowable costs.
- (5) If any delay described in this section causes the time or cost for the Project to exceed the Contract Time or the Contract Sum, then the Owner may terminate the Agreement pursuant to Section 14.2.
- (6) Contractor and any Subcontractor or supplier seeking additional costs under this Section 2.4.U. shall promptly submit estimates or any costs as requested by Owner, and detailed back-up for all costs when payment is sought or whenever reasonably requested by Owner. All costs are

auditable, at Owner's discretion. Bid, estimate and pricing information reasonably related to any request for additional compensation will be provided promptly upon request.

- (7) Contractor shall include provisions in its subcontracts and purchase orders consistent with this Section.

V. Interfacing.

- (1) The Contractor shall take such measures as are necessary to ensure proper construction and delivery of the Project, including but not limited to providing that all procurement of long-lead items, the separate construction Subcontractors, and the general conditions items are performed without duplication or overlap to maintain completion of all Work on schedule. Particular attention shall be given to provide that each bid package clearly identifies the Work included in that particular separate subcontract, it's scheduling for start and completion, and its relationship to other separate contractors.
- (2) Without assuming any design responsibilities of the Architect/Engineer, the Contractor shall include in the Progress Reports required under this Section 2.4 comments on overlap with any other separate subcontracts, omissions, lack of correlation between drawings, and any other deficiencies noted, in order that the Architect/Engineer may arrange for necessary corrections.

W. Job Site Facilities. The Contractor shall arrange for all job site facilities required and necessary to enable the Contractor and Architect/Engineer to perform their respective duties and to accommodate any representatives of the Owner which the Owner may choose to have present on the job.

X. Weather Protection. The Contractor shall provide temporary enclosures of building areas in order to assure orderly progress of the Work during periods when extreme weather conditions are likely to be experienced. The Contractor shall also be responsible for providing weather protection for Work in progress and for materials stored on the Project Site. A contingency plan shall be prepared upon request of the Owner for weather conditions that may affect the construction.

Y. Payment and Performance Bond. Prior to the construction commencement date, the Contractor shall obtain, for the benefit of and directed to the Owner, a Payment and Performance Bond satisfying the requirements of Section 255.05, Florida Statutes, covering the faithful performance by the Contractor of its obligations under the Contract Documents, including but not limited to the construction of the Project on the Project Site and the payment of all obligations arising thereunder, including all payments to Subcontractors, laborers, and materialmen. The surety selected by the Contractor to provide the Payment and Performance Bond shall be approved by the Owner prior to the issuance of such Bond, which approval shall not be unreasonably withheld or delayed provided that the surety is rated A or better by Best's Key Guide, latest edition.

Z. Construction Phase; Building Permit; Code Inspections. 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.

- (1) Building Permit. The Owner and Architect/Engineer shall provide such information to any Permitting Authority as is necessary to obtain approval from the Permitting Authority to commence construction prior to beginning construction. The Contractor shall pull any required building permit, and shall be responsible for delivering and posting the building permit at the Project Site prior to the commencement of construction. The cost of the building permit is included in the Contract Sum. The Owner and Architect/Engineer shall fully cooperate with the Contractor when and where necessary.
- (2) Code Inspections. The Project requires detailed code compliance inspection during construction in disciplines determined by any Permitting Authority. These disciplines normally include, but are not necessarily limited to, structural, mechanical, electrical, plumbing, general building and fire. The Contractor shall notify the appropriate inspector(s) and the Architect/Engineer, no less than 24 hours in advance, when the Work is ready for inspection and before the Work is covered up. All inspections shall be made for conformance with the applicable ordinances and building codes. Costs for all re-inspections of Work found defective and subsequently repaired shall not be included as Project Costs and shall be borne by the Contractor or as provided in the contract between Contractor and Subcontractor.
- (3) Contractor's Personnel. The Contractor shall maintain sufficient off-site support staff and competent full-time staff at the Project Site authorized to act on behalf of the Contractor to coordinate, inspect, and provide general direction of the Work and progress of the Subcontractors. At all times during the performance of the Work, the Owner shall have the right to demand replacement of Contractor Personnel to whom the Owner has reasonable objection, without liability to the Contractor.
- (4) Lines of Authority. To provide general direction of the Work, the Contractor shall establish and maintain lines of authority for its personnel and shall provide this information to the Owner and all other affected parties, such as the code inspectors of any Permitting Authority, the Subcontractors, and the Architect/Engineer. The Owner and Architect/Engineer may attend meetings between the Contractor and his Subcontractors; however, such attendance is optional and shall not diminish either the authority or responsibility of the Contractor to administer the subcontracts.

AA. Quality Control. The Contractor shall develop and maintain a program, acceptable to the Owner and Architect/Engineer, to assure quality control of the construction. The Contractor shall be responsible for and supervise the Work of all Subcontractors, providing

instructions to each when their Work does not conform to the requirements of the Project Plans and Specifications, and the Contractor shall continue to coordinate the Work of each Subcontractor to ensure that corrections are made in a timely manner so as to not affect the efficient progress of the Work. Should a disagreement occur between the Contractor and the Architect/Engineer over the acceptability of the Work, the Owner, at its sole discretion and in addition to any other remedies provided herein, shall have the right to determine the acceptability, provided that such determination is consistent with standards for construction projects of this type and generally accepted industry standards for workmanship in the State of Florida.

BB. Management of Subcontractors. All Subcontractors shall be compensated in accordance with Article IV. The Contractor shall solely control the Subcontractors. The Contractor shall negotiate all Change Orders and Field Orders with all affected Subcontractors and shall review the costs and advise the Owner and Architect/Engineer of their validity and reasonableness, acting in the Owner's best interest. When there is an imminent threat to health and safety, and Owner's Project Representative concurrence is impractical, the Contractor shall act immediately to remove the threats to health and safety and shall subsequently fully inform Owner of all such action taken. The Contractor shall also carefully review all shop drawings and then forward the same to the Architect/Engineer for review and actions. The Architect/Engineer will transmit them back to the Contractor, who will then issue the shop drawings to the affected Subcontractor for fabrication or revision. The Contractor shall maintain a suspense control system to promote expeditious handling. The Contractor shall request the Architect/Engineer to make interpretations of the drawings or specifications requested of him by the Subcontractors and shall maintain a business system to promote timely response. The Contractor shall inform the Architect/Engineer which shop drawings or requests for clarification have the greatest urgency, so as to enable the Architect/Engineer to prioritize requests coming from the Contractor. The Contractor shall advise the Owner and Architect/Engineer when timely response is not occurring on any of the above.

CC. Job Requirements.

- (1) The Contractor shall provide each of the following as a part of its services hereunder:
- (a) Maintain a log of daily activities, including manpower records, equipment on site, weather, delays, major decisions, etc;
 - (b) Maintain a roster of companies on the Project with names and telephone numbers of key personnel;
 - (c) Establish and enforce job rules governing parking, clean-up, use of facilities, and worker discipline;
 - (d) Provide labor relations management and equal opportunity employment for a harmonious, productive Project;
 - (e) Provide and administer a safety program for the Project and monitor for subcontractor compliance without relieving them of responsibilities to perform Work in accordance with best acceptable practice;
 - (f) Provide a quality control program as provided under Section 2.4.C above;
 - (g) Provide miscellaneous office supplies that support the construction efforts which are consumed by its own forces;
 - (h) Provide for travel to and from its home office to the Project Site and to those other places within Manatee County as required by the Project;
 - (i) Verify that tests, equipment, and system start-ups and operating and maintenance instructions are conducted as required and in the presence of the required personnel and provide adequate records of same to the Architect/Engineer;
 - (j) 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 Agreement, Owner/Architect/Engineer's clarifications and interpretations of the Contract Documents, progress reports, as-built drawings, and other project related documents;
 - (k) 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, and provide copies of same to Owner/Architect/Engineer;

- (l) Record names, addresses and telephone numbers of all Contractors, Subcontractors and major suppliers of materials and equipment;
 - (m) Furnish Owner/Architect/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;
 - (n) Consult with Owner/Architect/Engineer in advance of scheduling major tests, inspections or start of important phases of the Work;
 - (o) Verify, during the course of the Work, that certificates, maintenance and operations manuals and other data required to be assembled and furnished are applicable to the items actually installed, and deliver same to Owner/Architect/Engineer for review prior to final Acceptance of the Work; and
 - (p) Cooperate with Owner in the administration of grants.
- (2) The Contractor shall provide personnel and equipment, or shall arrange for separate Subcontractors to provide each of the following as a Project Cost:
- (a) Services of independent testing laboratories, and provide the necessary testing of materials to ensure conformance to contract requirements; and
 - (b) Printing and distribution of all required bidding documents and shop drawings, including the sets required by Permitting Authority inspectors.

DD. As-Built Drawings. The Contractor shall continuously review as-built drawings and mark up progress prints to provide as much accuracy as possible. Prior to, and as a requirement for authorizing final payment to the Contractor due hereunder, the Contractor shall provide to the Owner an original set of marked-up, as-built Project Plans and Specifications and an electronic format of those records showing the location and dimensions of the Project as constructed, which documents shall be certified as being correct by the Contractor and the Architect/Engineer. Final as-built drawings shall be signed and sealed by a registered Florida surveyor.

EE. Progress Reports. The Contractor shall 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.

FF. Contractor's Warranty. The Contractor warrants to the Owner and Architect/Engineer that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements will be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Architect/Engineer, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

- (1) Contractor shall use its best efforts and due diligence to ensure that during the warranty period, those entities or individuals who have provided direct warranties to the Owner as required by the Contract Documents perform all required warranty Work in a timely manner and at the sole cost and expense of such warranty providers. Any such cost or expense not paid by the warranty providers shall be paid by the Contractor, to include any costs and attorney's fees incurred in warranty-related litigation between Contractor and any Subcontractors.
- (2) The Contractor shall secure guarantees and warranties of Subcontractors, equipment suppliers and materialmen, and assemble and deliver same to the Owner in a manner that will facilitate their maximum enforcement and assure their meaningful implementation. The Contractor shall collect and deliver to the Owner any specific written guaranties or warranties given by others as required by subcontracts.
- (3) At the Owner's request, the Contractor shall conduct, jointly with the Owner and the Architect/Engineer, no more than two (2) warranty inspections within three (3) years after the Substantial Completion Date.

GG. Apprentices. If Contractor employs apprentices, their performance of Work shall be governed by and comply with the provisions of Chapter 446, Florida Statutes.

HH. Schedule of Values. Unit prices shall be established for this Contract by the submission of a schedule of values within ten (10) days of receipt of the Notice to Proceed. The schedule shall include quantities and prices of items equaling the Contract Sum and will subdivide the Work into components in sufficient detail to serve as the basis for progress payments during construction. Such prices shall 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.

II. Other Contracts. 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 III COMPENSATION

3.1 Compensation. The Contract Sum 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 Contractor's expense without change in the Contract Sum.

A. Adjustments. The Contract Sum may only be changed by Change Order or by a written amendment. Any claim for an increase or decrease in the Contract Sum 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 fifteen (15) 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. Failure to deliver a claim within the requisite 15-day period shall constitute a waiver of the right to pursue said claim.

B. Valuation. The value of any Work covered by a Change Order or of any claim for an increase or decrease in the Contract Sum shall be determined in one of the following ways (at Owner's discretion):

- (1) In the case of Unit Price Work, in accordance with Section 3.1.C, below;
or
- (2) By mutual acceptance of lump sum; or
- (3) On the basis of the cost of the Work, plus a negotiated Contractor's fee for overhead and profit. Contractor shall submit an itemized cost breakdown together with supporting data.

C. Unit Price Work. The unit price of an item of Unit Price Work shall be subject to re-evaluation and adjustment pursuant to a requested Change Order under the following conditions:

- (1) If the total cost of a particular item of Unit Price Work amounts to 5% or more of the Contract Sum 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
- (2) If there is no corresponding adjustment with respect to any other item of Work; and

- (3) If Contractor believes that it has incurred additional expense as a result thereof; or
- (4) If Owner believes that the quantity variation entitles it to an adjustment in the unit price; or
- (5) If the parties are unable to agree as to the effect of any such variations in the quantity of Unit Price Work performed.

3.2 Schedule of Compensation. All payments for services and material under the Contract Documents shall be made in accordance with the following provisions.

A. Periodic Payments for Services. The Contractor shall be entitled to receive payment for Construction Services rendered pursuant to Section 2.4 in periodic payments which shall reflect a fair apportionment of cost and schedule of values of services furnished prior to payment, subject to the provisions of this Section.

B. Payment for Materials and Equipment. In addition to the periodic payments authorized hereunder, payments may be made for material and equipment not incorporated in the Work but delivered and suitably stored at the Project Site, or another location, subject to prior approval and acceptance by the Owner on each occasion.

C. Credit toward Contract Sum. All payments for Construction Services made hereunder shall be credited toward the payment of the Contract Sum as Contractor's sole compensation for the construction of the Project.

3.3 Invoice and Payment. All payments for services and materials under the Contract Documents shall be invoiced and paid in accordance with the following provisions.

A. Invoices. The Contractor shall submit to the Owner periodic invoices for payment, in a form acceptable to the Owner, which shall include a sworn statement certifying that, to the best of the Contractor's knowledge, information and belief, the construction has progressed to the point indicated, the quality and the Work covered by the invoice is in accord with the Project Plans and Specifications, and the Contractor is entitled to payment in the amount requested, along with the cost reports required pursuant to Article II, showing in detail all monies paid out, Project Costs accumulated, or Project Cost incurred during the previous period. This data shall be attached to the invoice.

B. Additional Information; Processing of Invoices. Should an invoiced amount appear to exceed the Work effort believed to be completed, the Owner may, prior to processing of the invoice for payment, require the Contractor to submit satisfactory evidence to support the invoice. All progress reports and invoices shall be delivered to the attention of the Owner's Project Representative. Invoices not properly prepared (mathematical errors, billing not reflecting actual Work done, no signature, etc.) shall be returned to the Contractor for correction.

C. Architect/Engineer's Approval. Payment for Work completed shall be subject to the Architect/Engineer approving the payment requested by the Contractor and certifying the amount thereof that has been properly incurred and is then due and payable to the

Contractor, and identifying with specificity any amount that has not been properly incurred and that should not be paid. .

D. Warrants of Contractor with Respect to Payments. The Contractor warrants that (1) upon payment of any retainage, materials and equipment covered by a partial payment request will pass to Owner either by incorporation in construction or upon receipt of payment by the Contractor, whichever occurs first; (2) Work, materials and equipment covered by previous partial payment requests shall be free and clear of liens, claims, security interests, or encumbrances, hereinafter referred to as “liens”; and (3) no Work, materials or equipment covered by a partial payment request which has been acquired by the Contractor or any other person performing Work at the Project Site, or furnishing materials or equipment for the Project, shall be subject to an agreement under which an interest therein or an encumbrance thereon is retained by the seller or otherwise imposed by the Contractor or any other person.

E. All Compensation Included. Contractor’s compensation includes full payment for services set forth in the Contract Documents, including but not limited to overhead, profit, salaries or other compensation of Contractor’s officers, partners and/or employees, general operating expenses incurred by Contractor and relating to this Project, including the cost of management, supervision and data processing staff, job office equipment and supplies, and other similar items.

ARTICLE IV SUBCONTRACTORS

4.1 Subcontracts. At the Owner’s request, the Contractor shall provide Owner’s Project Representative with copies of all proposed and final subcontracts, including the general and supplementary conditions thereof.

A. Subcontracts Generally. All subcontracts shall: (1) require each Subcontractor to be bound to Contractor to the same extent Contractor is bound to Owner by the terms of the Contract Documents, as those terms may apply to the portion of the Work to be performed by the Subcontractor, (2) provide for the assignment of the subcontracts from Contractor to Owner at the election of Owner, upon termination of Contractor, (3) provide that Owner will be an additional indemnified party of the subcontract, (4) provide that Owner will be an additional insured on all insurance policies required to be provided by the Subcontractor, except workers’ compensation, (5) assign all warranties directly to Owner, and (6) identify Owner as an intended third-party beneficiary of the subcontract.

(1) A Subcontractor is a person or entity who has a direct contract with Contractor to perform a portion of the Work at the site. The term “Subcontractor” is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term “Subcontractor” does not include a separate contractor or subcontractors of a separate contractor.

(2) A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term “Sub-subcontractor” is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

B. No Damages for Delay. Except when otherwise expressly agreed to by Owner in writing, all subcontracts shall provide:

“LIMITATION OF REMEDIES – NO DAMAGES FOR DELAY. The Subcontractor's exclusive remedy for delays in the performance of the contract caused by events beyond its control, including delays claimed to be caused by the Owner or Architect/Engineer or attributable to the Owner or Architect/Engineer and including claims based on breach of contract or negligence, shall be an extension of its contract time and shall in no way involve any monetary claim.”

Each subcontract shall require that any claims by the Subcontractor for delay must be submitted to the Contractor within the time and in the manner in which the Contractor must submit such claims to the Owner, and that failure to comply with the conditions for giving notice and submitting claims shall result in the waiver of such claims.

C. Subcontractual Relations. The Contractor shall require each Subcontractor to assume all the obligations and responsibilities which the Contractor owes the Owner pursuant to the Contract Documents, by the parties to the extent of the Work to be performed by the Subcontractor. Said obligations shall be made in writing and shall preserve and protect the rights of the Owner and Architect/Engineer, with respect to the Work to be performed by the Subcontractor, so that the subcontracting thereof will not prejudice such rights. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with its sub-subcontractor.

D. Insurance; Acts and Omissions. Insurance requirements for Subcontractors shall be no more stringent than those requirements imposed on the Contractor by the Owner. The Contractor shall be responsible to the Owner for the acts and omissions of its employees, agents, Subcontractors, their agents and employees, and all other persons performing any of the Work or supplying materials under a contract to the Contractor.

4.2 Relationship and Responsibilities. Except as specifically set forth herein with respect to direct materials acquisitions by Owner, nothing contained in the Contract Documents or in any Contract Document does or shall create any contractual relation between the Owner or Architect/Engineer and any Subcontractor. Specifically, the Contractor is not acting as an agent of the Owner with respect to any Subcontractor. The utilization of any Subcontractor shall not relieve Contractor from any liability or responsibility to Owner, or obligate Owner to the payment of any compensation to the Subcontractor or additional compensation to the Contractor.

4.3 Payments to Subcontractors; Monthly Statements. The Contractor shall be responsible for paying all Subcontractors from the payments made by the Owner to Contractor pursuant to Article III, subject to the following provisions:

A. Payment. The Contractor shall, no later than ten (10) days after receipt of payment from the Owner, out of the amount paid to the Contractor on account of such Subcontractor's Work, pay to each Subcontractor the amount to which the Subcontractor is entitled in accordance with the terms of the Contractor's contract with such Subcontractor. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor

to make payments to sub-Subcontractors in a similar manner. After receipt of payment from Owner, if the need should arise to withhold payments to Subcontractors for any reason, as solely determined by Contractor, the Contractor shall promptly restore such monies to the Owner, adjusting subsequent pay requests and Project bookkeeping as required.

B. Final Payment of Subcontractors. The final payment of retainage to Subcontractors shall not be made until the Project has been inspected by the Architect/Engineer or other person designated by the Owner for that purpose, and until both the Architect/Engineer and the Contractor have issued a written certificate that the Project has been constructed in accordance with the Project Plans and Specifications and approved Change Orders. Before issuance of final payment to any Subcontractor without any retainage, the Subcontractor shall submit satisfactory evidence that all payrolls, material bills, and other indebtedness connected with the Project have been paid or otherwise satisfied, warranty information is complete, as-built markups have been submitted, and instruction for the Owner's operating and maintenance personnel is complete. Final payment may be made to certain select Subcontractors whose Work is satisfactorily completed prior to the completion of the Project, but only upon approval of the Owner's Project Representative.

4.4 Responsibility for Subcontractors. As provided in Section 2.4.BB, 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.

4.5 Contingent Assignment of Subcontracts. Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that:

- (1) assignment is effective only after termination of the Contract by the Owner for cause pursuant to Article XIV and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor in writing; and
- (2) assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Agreement.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract. Upon such assignment, if the Work has been suspended for more than thirty (30) days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension. Upon such assignment to the Owner, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

ARTICLE V CHANGES IN WORK

5.1 General. Changes in the Work may be accomplished after execution of the Agreement, and without invalidating the Agreement, by Change Order, Work Directive Change or order for a minor change in the Work, subject to the limitations stated in this Article V and elsewhere in the Contract Documents. A Change Order shall be based upon agreement among the Owner, Contractor and Architect/Engineer; a Work Directive Change requires agreement by the Owner and Architect/Engineer and may or may not be agreed to by the Contractor; an order for a minor change in the Work may be issued by the Architect/Engineer alone. Changes in the Work shall be performed under applicable provisions of the Contract Documents, and the Contractor shall proceed promptly, unless otherwise provided in the Change Order, Work Directive Change or order for a minor change in the Work.

5.2 Minor Changes in the Work. The Owner or Architect/Engineer shall have authority to order minor changes in the Work not involving adjustment in the Contract Sum or extension of the Contract Time and not inconsistent with the intent of the Contract Documents. Such change will be effected by written order signed by the Architect/Engineer and shall be binding on the Owner and Contractor. The Contractor shall abide by and perform such minor changes. Such changes shall be effected by a Field Directive or a Work Directive Change. Documentation of changes shall be determined by the Construction Team, and displayed monthly in the Progress Reports. Because such changes shall not affect the Contract Sum to be paid to the Contractor, they shall not require a Change Order pursuant to Section 5.6.

5.3 Emergencies. In any emergency affecting the safety of persons or property, the Contractor shall act at its discretion to prevent threatened damage, injury, or loss. Any increase in the Contract Sum or extension of time claimed by the Contractor on account of emergency Work shall be determined as provided in Section 5.6. However, whenever practicable, the Contractor shall obtain verbal concurrence of the Owner's Project Representative and Architect/Engineer where the act will or may affect the Contract Sum or Contract Time.

5.4 Concealed Conditions. If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature, that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect/Engineer before conditions are disturbed and in no event later than ten (10) days after first observance of the conditions. The Architect/Engineer will promptly investigate such conditions and, if the Architect/Engineer determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend an equitable adjustment in the Contract Sum or Contract Time, or both. If the Architect/Engineer determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect/Engineer shall promptly notify the Owner and Contractor in writing, stating the reasons. If either party disputes the Architect/Engineer's determination or recommendation, that party may proceed as provided in Article VIII.

5.5 Hazardous Materials. In the event the Contractor encounters on the Project Site material reasonably believed to be hazardous, petroleum or petroleum related products, or other hazardous or toxic substances, except as provided in Section 2.4.U, the Contractor shall immediately stop Work in the area affected and report the condition to the Owner and the

Architect/Engineer in writing. The Work in the affected area shall not thereafter be resumed except by written amendment, if in fact the material or substance has not been rendered harmless. The Work in the affected area shall be resumed when the Project Site has been rendered harmless, in accordance with the final determination by the Architect/Engineer or other appropriate professional employed by Owner. The Contractor shall not be required to perform without its consent any Work relating to hazardous materials, petroleum or petroleum related products, or other hazardous or toxic substances. In the event the Contractor encounters on the Project Site materials believed in good faith to be hazardous or contaminated material, and the presence of such hazardous or contaminated material was not known and planned for at the time the Contractor submitted its Bid, and it is necessary for the Contractor to stop Work in the area affected and delays Work for more than a seven (7) day period, adjustments to the Contract Sum and/or Contract Time shall be made in accordance with this Article V.

5.6 Change Orders; Adjustments to Contract Sum.

A. Change Orders Generally. The increase or decrease in the Contract Sum resulting from a change authorized pursuant to the Contract Documents shall be determined:

- (1) By mutual acceptance of a lump sum amount properly itemized and supported by sufficient substantiating data, to permit evaluation by the Architect/Engineer and Owner; or
- (2) By unit prices stated in the Agreement or subsequently agreed upon; or
- (3) By any other method mutually agreeable to Owner and Contractor.

If Owner and Contractor are unable to agree upon increases or decreases in the Contract Sum and the Architect/Engineer certifies that the work needs to be commenced prior to any such agreement, the Contractor, provided it receives a written Change Order signed by or on behalf of the Owner, shall promptly proceed with the Work involved. The cost of such Work shall then be determined on the basis of the reasonable expenditures of those performing the Work attributed to the change. However, in the event a Change Order is issued under these conditions, the Owner, through the Architect/Engineer, will establish an estimated cost of the Work and the Contractor shall not perform any Work whose cost exceeds that estimated without prior written approval by the Owner. In such case, the Contractor shall keep and present in such form as the Owner may prescribe an itemized accounting, together with appropriate supporting data of the increase in overall costs of the Project. The amount of any decrease in the Contract Sum to be allowed by the Contractor to the Owner for any deletion or change which results in a net decrease in costs will be the amount of the actual net decrease.

5.7 Unit Prices. If unit prices are stated in the Contract Documents or subsequently agreed upon, and if the quantities originally contemplated are so changed in a proposed Change Order that application of the agreed unit prices to the quantities of Work proposed will cause substantial inequity to the Owner or Contractor, the applicable unit prices and Contract Sum shall be equitably adjusted.

5.8 Owner-Initiated Changes. 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 Field Directive, a Change Order, or a

Work Directive Change, as the case may be. 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). A Work Directive Change may not change the Contract Sum 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 Sum or Contract Time.

5.9 Unauthorized Work. Contractor shall not be entitled to an increase in the Contract Sum or an extension of the Contract Time with respect to any Work performed that is not required by the Contract Documents.

5.10 Defective Work. 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, without adjustment to the Contract Sum.

5.11 Estimates for Changes. At any time Architect/Engineer may request a quotation from Contractor for a proposed change in the Work. Within twenty-one (21) calendar days after receipt, Contractor shall submit a written and detailed proposal for an increase or decrease in the Contract Sum or Contract Time for the proposed change. Architect/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 Architect/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.

5.12 Form of Proposed Changes. 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. Standard Owner forms shall be utilized.

5.13 Changes to Contract Time. The Contract Time may only be changed pursuant to a Change Order or a written amendment to the Contract Documents. 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. 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. Failure to deliver a written notice of claim within the requisite 15-day period shall constitute a waiver of the right to pursue said claim.

ARTICLE VI

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ROLE OF ARCHITECT/ENGINEER

6.1 General.

A. Retaining. The Owner shall retain an Architect/Engineer (whether an individual or an entity) lawfully licensed to practice in Florida. That person or entity is identified as the Architect/Engineer in the Agreement and is referred to throughout the Contract Documents as if singular in number.

B. Duties. Duties, responsibilities and limitations of authority of the Architect/Engineer as set forth in the Contract Documents shall not be restricted, modified or extended without written consent of the Owner and Architect/Engineer. Consent shall not be unreasonably withheld.

C. Termination. If the employment of the Architect/Engineer is terminated, the Owner shall employ a successor Architect/Engineer as to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect/Engineer.

6.2 Administration. The Architect/Engineer will provide administration of the Agreement as described in the Contract Documents and will be an Owner's representative during construction until the date the Architect/Engineer approves the final Application for Payment. The Architect/Engineer will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

A. Site Visits. The Architect/Engineer will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work complete, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. Unless specifically instructed by Owner, the Architect/Engineer will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect/Engineer will not have control over, charge of, or responsibility for, the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents.

B. Reporting. On the basis of the site visits, the Architect/Engineer will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and report to the Owner (1) known deviations from the Contract Documents and from the most recent construction schedule submitted by the Contractor, and (2) defects and deficiencies observed in the Work. The Architect/Engineer will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect/Engineer will not have control over or charge of and will not be responsible for acts or omissions of the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

6.3 Interpretation of Project Plans and Specifications. The Architect/Engineer will be the interpreter of the requirements of the Project Plans and Specifications. Upon receipt

of comments or objections by Contractor or Owner, the Architect/Engineer will make decisions on all claims, disputes, or other matters pertaining to the interpretation of the Project Plans and Specifications.

6.4 Rejection of Non-Conforming Work. Upon consultation with Owner, the Architect/Engineer shall have the authority to reject Work which does not conform to the Project Plans and Specifications.

6.5 Correction of Work. The Contractor shall promptly correct all Work rejected by the Architect/Engineer for being defective or as failing to conform to the Project Plans and Specifications, whether observed before or after the Substantial Completion Date and whether or not fabricated, installed, or completed. The Contractor shall bear all costs of correcting such rejected Work, including compensation for Architect/Engineer's additional services made necessary thereby.

6.6 Timely Performance of Architect/Engineer. The Contractor shall identify which requests for information or response from the Architect/Engineer have the greatest urgency and those items which require prioritizing in response by the Architect/Engineer. The Contractor shall also identify the preferred time period for response and shall request a response time which is reasonably and demonstrably related to the needs of the Project and Contractor. In the event that Architect/Engineer claims that Contractor's expectations for a response are unreasonable, Owner shall require Architect/Engineer to communicate such claim to Contractor in writing together with the specific time necessary to respond and the date upon which such response will be made. In the event that Contractor believes that Architect/Engineer is not providing timely services or responses, Contractor shall notify Owner of same in writing not less than two (2) weeks before Contractor believes performance or response time from Architect/Engineer is required without risk of delaying the Project.

ARTICLE VII OWNER'S RIGHTS AND RESPONSIBILITIES

7.1 Project Site; Title. The Owner shall provide the lands upon which the Work under the Contract Documents 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. The Owner hereby represents to the Contractor that it currently has and will maintain up through and including the Substantial Completion Date, good title to all of the real property constituting the Project Site. Owner agrees to resolve, at its expense, any disputes relating to the ownership and use of the Project Site which might arise during the course of construction.

7.2 Project Plans and Specifications; Architect/Engineer. The parties hereto acknowledge and agree that Owner has previously entered into an agreement with Architect/Engineer. Pursuant to the terms of such agreement, the Architect/Engineer, as an agent and representative of Owner, is responsible for the preparation of Project Plans and Specifications which consist of drawings, specifications, and other documents setting forth in detail the requirements for the construction of the Project. All of such Project Plans and Specifications shall be provided either by Owner or the Architect/Engineer, and Contractor shall be under no obligation to provide same and shall be entitled to rely upon the accuracy and completeness of the Project Plans and Specifications provided by the Architect/Engineer and all preliminary drawings prepared in connection therewith. The Contractor will be furnished a reproducible set of all drawings and specifications reasonably necessary for the performance of Contractor's services hereunder and otherwise ready for printing. The Contractor shall be notified of any written modification in the agreement between Owner and Architect/Engineer.

7.3 Surveys; Soil Tests and Other Project Site Information. Owner shall be responsible for providing a legal description and certified land survey of the Project Site in a form and content and with such specificity as may be required by the Architect/Engineer and Contractor to perform their services. To the extent deemed necessary by Owner and Architect/Engineer, and solely at Owner's expense, Owner may engage the services of a geotechnical consultant to perform test borings and other underground soils testing as may be deemed necessary by the Architect/Engineer or the Contractor. Contractor shall not be obligated to provide such surveys or soil tests and shall be entitled to rely upon the accuracy and completeness of the information provided; subject, however, to the provisions of Section 2.4.S hereof. Owner shall provide Contractor, as soon as reasonably possible following the execution of the Contract Documents, all surveys or other survey information in its possession describing the physical characteristics of the Project Site, together with soils reports, subsurface investigations, utility locations, deed restrictions, easements, and legal descriptions then in its possession or control. Upon receipt of all surveys, soils tests, and other Project Site information, Contractor shall promptly advise Owner of any inadequacies in such information and of the need for any additional surveys, soils or subsoil tests. In performing this Work, Contractor shall use the standard of care of experienced contractors and will use its best efforts timely to identify all problems or omissions. Owner shall not be responsible for any delay or damages to the Contractor for any visible or disclosed site conditions or disclosed deficiencies in the Project Site which should have been identified by Contractor and corrected by Owner prior to the execution of the Contract Documents.

7.4 Information; Communication; Coordination. The Owner's Project Representative shall examine any documents or requests for information submitted by the Contractor and shall advise Contractor of Owner's decisions pertaining thereto within a reasonable period of time to avoid unreasonable delay in the progress of the Contractor's services. Contractor shall indicate if any such documents or requests warrant priority consideration. However, decisions pertaining to approval of the Project Schedule as it relates to the date of Substantial Completion, the Project Cost, Contractor's compensation, approving or changing the Contract Sum shall only be effective when approved by Owner in the form of a written Change Order or amendment to the Contract Documents. Owner reserves the right to designate a different Owner's Project Representative provided Contractor is notified in writing of any such change. Owner and Architect/Engineer may communicate with Subcontractors, materialmen, laborers, or suppliers engaged to perform services on the Project, but only for informational purposes. Neither the Owner nor the Architect/Engineer shall attempt to direct the

Work of or otherwise interfere with any Subcontractor, materialman, laborer, or supplier, or otherwise interfere with the Work of the Contractor. Owner shall furnish the data required of Owner under the Contract Documents promptly.

7.5 Governmental Body. The Contractor recognizes that the Owner is a governmental body with certain procedural requirements to be satisfied. The Contractor has and will make reasonable allowance in its performance of services for such additional time as may be required for approvals and decisions by the Owner and any other necessary government agency.

7.6 Pre-Completion Acceptance. 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.

7.7 Ownership and Use of Drawings, Specifications and Other Instruments of Service.

- (1) The Architect/Engineer and the Architect/Engineer's consultants shall be deemed the authors and owners of their respective instruments of service, including the Project Plans and Specifications, and will retain all common law, statutory and other reserved rights, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers shall not own or claim a copyright in the instruments of service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with this Project is not to be constructed as publication in derogation of the Architect/Engineer's or Architect/Engineer's consultants' reserved rights.
- (2) The Contractor, Subcontractors, Sub-subcontractors and material or equipment suppliers are authorized to use and reproduce the drawings and specifications provided to them solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Project Plans and Specifications or other instruments of service. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers may not use the drawings or specifications on other projects or for additions to this Project outside the scope of the Work without the specific written consent of the Owner, Architect/Engineer and the Architect/Engineer's consultants.

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

A. Responsibilities. Except as otherwise instructed in writing by Owner, the Owner's Project Representative will:

- (1) Attend preconstruction conferences; arrange a schedule of progress meetings and other job conferences as required in consultation with Owner/Architect/Engineer and notify those expected to attend in advance; and attend meetings and maintain and circulate copies of minutes thereof;
- (2) Serve as Owner/Architect/Engineer's liaison with Contractor, working principally through Contractor's superintendent, to assist in understanding the intent of the Contract Documents. As requested by Owner/Architect/Engineer, assist in obtaining additional details or information when required at the job site for proper execution of the Work;
- (3) Report to Owner/Architect/Engineer whenever he believes that any Work is unsatisfactory, faulty or defective or does not conform to the Contract Documents;
- (4) Accompany visiting inspectors representing public or other agencies having jurisdiction over the project; record the outcome of these inspections and report to Owner/Architect/Engineer;
- (5) Review applications for payment with Contractor for compliance with the established procedure for their submission and forward them with recommendations to Owner/Architect/Engineer; and
- (6) Perform those duties as set forth elsewhere within the Contract Documents.

B. Limitations. Except upon written instructions of Owner, Owner's Project Representative shall not:

- (1) Authorize any deviation from the Contract Documents or approve any substitute materials or equipment;
- (2) Exceed limitations on Owner/Architect/Engineer's authority as set forth in the Contract Documents;
- (3) Undertake any of the responsibilities of Contractor, Subcontractors or Contractor's superintendent, or expedite the Work;
- (4) 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;
- (5) Advise on or issue directions as to safety precautions and programs in connection with the Work;
- (6) Authorize Owner to occupy the project in whole or in part; or
- (7) Participate in specialized field or laboratory tests.

ARTICLE VIII
RESOLUTION OF DISAGREEMENTS;
CLAIMS FOR COMPENSATION

8.1 Owner to Decide Disputes. The Owner shall reasonably decide all questions and disputes, of any nature whatsoever, that may arise in the execution and fulfillment of the services provided for under the Contract Documents, in accordance with the Procurement Ordinance.

8.2 Finality. The decision of the Owner upon all claims, questions, disputes and conflicts shall be final and conclusive, and shall be binding upon all parties to the Contract Documents, subject to judicial review as provided in Section 8.5 below.

8.3 No Damages for Delay. If at any time Contractor is delayed in the performance of Contractor's responsibilities under the Contract Documents as the result of a default or failure to perform in a timely manner by Owner or Owner's agents or employees, Contractor shall not be entitled to any damages except for compensation specifically authorized in Article III. Contractor's sole remedy will be a right to extend the time for performance. Nothing herein shall preclude Contractor from any available remedy against any responsible party other than Owner. Contractor shall be responsible for liquidated damages for delay pursuant to Section 3 of the Agreement.

8.4 Permitted Claims Procedure. Where authorized or permitted under the Contract Documents, all claims for additional compensation by Contractor, extensions of time affecting the Substantial Completion Date, for payment by the Owner of costs, damages or losses due to casualty, Force Majeure, Project Site conditions or otherwise, shall be governed by the following:

- (1) All claims must be submitted as a request for Change Order in the manner as provided in Article V.
- (2) The Contractor must submit a notice of claim to Owner's Project Representative and to the Architect/Engineer within fifteen (15) days of when the Contractor was or should have been aware of the fact that an occurrence was likely to cause delay or increased costs. Failure to submit a claim within the requisite 15-day period shall constitute a waiver of the right to pursue said claim.
- (3) Within twenty (20) days of submitting its notice of claim, the Contractor shall submit to the Owner's Project Representative its request for Change Order, which shall include a written statement of all details of the claim, including a description of the Work affected.
- (4) After receipt of a request for Change Order, the Owner's Project Representative, in consultation with the Architect/Engineer, shall deliver to the Contractor, within twenty (20) days after receipt of request, its written response to the claim.

- (5) In the event the Owner and Contractor are unable to agree on the terms of a Change Order, the Owner shall have the option to instruct the Contractor to proceed with the Work. In that event, the Owner shall agree to pay for those parts of the Work, the scope and price of which are not in dispute. The balance of the disputed items in the order to proceed will be resolved after completion of the Work, based upon completed actual cost.
- (6) The rendering of a decision by Owner 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.

8.5 Contract Claims and Disputes. After completion of the process set forth in Section 8.4 above, any unresolved dispute under this Agreement shall be decided by the Purchasing Official in accordance with Section 2-26-63 of the Manatee County Code of Laws, subject to an administrative hearing process as provided in Section 2-26-64. The decision of the Board of County Commissioners in accordance with Section 2-26-64 of the Manatee County Code of Laws shall be the final and conclusive County decision subject to exclusive judicial review in circuit court by a petition for certiorari.

8.6 Claims for Consequential Damages. The Contractor and Owner waive claims against each other for consequential damages arising out of or relating to this Contract. This mutual waiver includes:

- (1) damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and
- (2) damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit except anticipated profit arising directly from the work.

This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination in accordance with Article XIV. Nothing contained in this Section 8.6 shall be deemed to preclude an award of liquidated direct damages, when applicable, in accordance with the requirements of the Contract Documents.

ARTICLE IX INDEMNITY

9.1 Indemnity.

A. Indemnification Generally. To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, Architect/Engineer, Architect/Engineer's consultants, and agents and employees of any of them from and against claims, damages, losses and expenses, including but not limited to attorney's fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Contractor, a Subcontractor or anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether such claim, damage, loss or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity which would otherwise exist as to a party or person described in this Section 9.1.

B. Claims by Employees. In claims against any person or entity indemnified under this Section 9.1 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under Section 9.1.A. shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts or other employee benefit acts.

9.2 Duty to Defend. The Contractor shall defend the Owner in any action, lawsuit mediation or arbitration arising from the alleged negligence, recklessness or intentionally wrongful conduct of the Contractor and other persons employed or utilized by the Contractor in the performance of the Work. So long as Contractor, through its own counsel, performs its obligation to defend the Owner pursuant to this Section, Contractor shall not be required to pay the Owner's costs associated with the Owner's participation in the defense.

ARTICLE X

ACCOUNTING RECORDS; OWNERSHIP OF DOCUMENTS

10.1 Accounting Records. Records of expenses pertaining to all services performed shall be kept in accordance with generally accepted accounting principles and procedures.

10.2 Inspection and Audit. The Contractor's records shall be open to inspection and subject to examination, audit, and/or reproduction during normal working hours by the Owner's agent or authorized representative to the extent necessary to adequately permit evaluation and verification of any invoices, payments or claims submitted by the Contractor or any of its payees during the performance of the Work. These records shall include, but not be limited to, accounting records, written policies and procedures, Subcontractor files (including proposals of successful and unsuccessful bidders), original estimates, estimating worksheets, correspondence, Change Order files (including documentation covering negotiated settlements),

and any other supporting evidence necessary to substantiate charges related to the Contract Documents. They shall also include, but not be limited to, those records necessary to evaluate and verify direct and indirect costs (including overhead allocations) as they may apply to costs associated with the Contract Documents. For the purpose of such audits, inspections, examinations and evaluations, the Owner's agent or authorized representative shall have access to said records from the effective date of the Contract Documents, for the duration of Work, and until three (3) years after the date of final payment by the Owner to the Contractor pursuant to the Contract Documents.

10.3 Access. The Owner's agent or authorized representative shall have access to the Contractor's facilities and all necessary records in order to conduct audits in compliance with this Article. The Owner's agent or authorized representative shall give the Contractor reasonable advance notice of intended inspections, examinations, and/or audits.

10.4 Ownership of Documents. Upon completion or termination of the Contract Documents, all records, documents, tracings, plans, specifications, maps, evaluations, reports, transcripts and other technical data, other than working papers, prepared or developed by the Contractor under the Contract Documents shall be delivered to and become the property of the Owner. The Contractor at its own expense may retain copies for its files and internal use.

ARTICLE XI PUBLIC CONTRACT LAWS

11.1 Equal Opportunity Employment.

A. Employment. The Contractor shall not discriminate against any employee or applicant for employment because of race, creed, sex, color, national origin, disability or age, and will take affirmative action to insure that all employees and applicants are afforded equal employment opportunities without discrimination because of race, creed, sex, color, national origin, disability or age. Such action will be taken with reference to, but shall not be limited to, recruitment, employment, job assignment, promotion, upgrading, demotion, transfer, layoff or termination, rates of training or retraining, including apprenticeship and on-the-job training.

B. Participation. No person shall, on the grounds of race, creed, sex, color, national origin, disability or age, be excluded from participation in, be denied the proceeds of, or be subject to discrimination in the performance of the Agreement.

11.2 Immigration Reform and Control Act of 1986. Contractor acknowledges that it is responsible for complying with the provisions of the Immigration Reform and Control Act of 1986, located at 8 U.S.C. Section 1324, et seq., and regulations relating thereto. Failure to comply with the above statutory provisions shall be considered a material breach and shall be grounds for immediate termination of this Agreement.

11.3 No Conflict of Interest. The Contractor warrants that it has not employed or retained any company or person, other than a bona fide employee working solely for the Contractor to solicit or secure the Contract Documents, and that it has not paid or agreed to pay any person, company, corporation, individual, or firm other than a bona fide employee working

solely for the Contractor, any fee, commission, percentage, gift or any other consideration, contingent upon or resulting from the award or making of the Contract Documents.

A. No Interest in Business Activity. By accepting award of this Contract, the Contractor, which shall include its directors, officers and employees, represents that it presently has no interest in and shall acquire no interest in any business or activity which would conflict in any manner with the performance of services required hereunder, including without limitation as described in the Contractor's own professional ethical requirements. An interest in a business or activity which shall be deemed a conflict includes but is not limited to direct financial interest in any of the material and equipment manufacturers, suppliers, distributors, or contractors who will be eligible to supply material and equipment for the Project for which the Contractor is furnishing its services required hereunder.

B. No Appearance of Conflict. The Contractor shall not knowingly engage in any contractual or professional obligations that create an appearance of a conflict of interest with respect to the services provided pursuant to the Contract Documents. The Contractor has provided the Affidavit of No Conflict, incorporated into the Contract Documents as Exhibit "C", as a material inducement for Owner entering into the Contract Documents. If, in the sole discretion of the County Administrator or designee, a conflict of interest is deemed to exist or arise during the term of the County Administrator or designee may cancel this Agreement, effective upon the date so stated in a written notice of cancellation, without penalty to the Owner.

11.4 Truth in Negotiations. By execution of the Contract Documents, the Contractor certifies to truth-in-negotiations and that wage rates and other factual unit costs supporting the compensation are accurate, complete and current at the time of contracting. Further, the original Contract Sum and any additions thereto shall be adjusted to exclude any significant sums where the Owner determines the Contract Sum was increased due to inaccurate, incomplete or non-current wage rates and other factual unit costs. Such adjustments must be made within one (1) year after final payment to the Contractor.

11.5 Public Entity Crimes. The Contractor is directed to the Florida Public Entity Crimes Act, Section 287.133, Florida Statutes, specifically section 2(a), and the Owner's requirement that the Contractor comply with it in all respects prior to and during the term of the Agreement.

ARTICLE XII

FORCE MAJEURE, FIRE OR OTHER CASUALTY

12.1 Force Majeure.

A. Unavoidable Delays. Delays in any performance by any party contemplated or required hereunder due to fire, flood, sinkhole, earthquake or hurricane, acts of God, unavailability of materials, equipment or fuel, war, declaration of hostilities, revolt, civil strife, altercation or commotion, strike, labor dispute, or epidemic, archaeological excavation, lack of or failure of transportation facilities, or any law, order, proclamation, regulation, or ordinance of any government or any subdivision thereof, or for any other similar cause to those enumerated, beyond the reasonable control and which with due diligence could not have been

reasonably anticipated, shall be deemed to be events of Force Majeure and any such delays shall be excused. In the event such party is delayed in the performance of any Work or obligation pursuant to the Contract Documents for any of the events of Force Majeure stated in this Section 12.1, the date for performance required or contemplated by the Contract Documents shall be extended by the number of calendar days such party is actually delayed

B. Concurrent Contractor Delays. If a delay is caused for any reason provided in 12.1.A. or as a result of an extension of time provided by Change Order, and during the same time period a delay is caused by Contractor, the date for performance shall be extended as provided in 12.1.A. but only to the extent the time is or was concurrent.

C. Notice; Mitigation. The party seeking excuse for nonperformance on the basis of Force Majeure shall give written notice to the Owner, if with respect to the Contractor, or to the Contractor if with respect to the Owner, specifying its actual or anticipated duration. Each party seeking excuse from nonperformance on the basis of Force Majeure shall use its best efforts to rectify any condition causing a delay and will cooperate with the other party, except that neither party shall be obligated to incur any unreasonable additional costs and expenses to overcome any loss of time that has resulted.

12.2 Casualty; Actions by Owner and Contractor. During the construction period, if the Project or any part thereof shall have been damaged or destroyed, in whole or in part, the Contractor shall promptly make proof of loss; and Owner and Contractor shall proceed promptly to collect, or cause to be collected, all valid claims which may have arisen against insurers or others based upon such damage or destruction. The Contractor shall diligently assess the damages or destruction and shall prepare an estimate of the cost, expenses, and other charges, including normal and ordinary compensation to the Contractor, necessary for reconstruction of the Project substantially in accordance with the Project Plans and Specifications. Within fifteen (15) days following satisfaction of the express conditions described in subsections (1), (2) and (3) below, the Contractor covenants and agrees diligently to commence reconstruction and to complete the reconstruction or repair of any loss or damage by fire or other casualty to the Project to substantially the same size, floor area, cubic content, and general appearance as prior to such loss or damage:

- (1) Receipt by the Owner or the trustee of the proceeds derived from collection of all valid claims against insurers or others based upon such damage or destruction, and receipt of other sums from any source such that the funds necessary to pay the Project Cost and any additions to the Project Cost necessitated for repair or reconstruction are available;
- (2) Written agreement executed by the Contractor and the Owner, by amendment to the Contract Documents or otherwise, authorizing and approving the repair or reconstruction and any additions to the Project Cost necessitated thereby, including any required adjustment to the Contract Sum; and
- (3) Final approval by the Owner of the Project Plans and Specifications for such repair or reconstruction and issuance of any required building permit.

12.3 Approval of Plans and Specifications. The Owner agrees to approve the plans and specifications for such reconstruction or repair if the reconstruction or repair contemplated by such plans and specifications is economically feasible, and will restore the Project, or the damaged portion thereof, to substantially the same condition as prior to such loss or damage, and such plans and specifications conform to the applicable laws, ordinances, codes, and regulations. The Owner agrees that all proceeds of any applicable insurance or other proceeds received by the Owner or the Contractor as a result of such loss or damage shall be used for payment of the costs, expenses, and other charges of the reconstruction or repair of the Project.

12.4 Notice of Loss or Damage. The Contractor shall promptly give the Owner written notice of any significant damage or destruction to the Project, defined as loss or damage which it is contemplated by Contractor will increase the Contract Sum or extend the Substantial Completion Date, stating the date on which such damage or destruction occurred, the then expectations of Contractor as to the effect of such damage or destruction on the use of the Project, and the then proposed schedule, if any, for repair or reconstruction of the Project. Loss or damage which the Contractor determines will not affect the Contract Sum or Substantial Completion Date will be reported to Owner and Architect/Engineer immediately, and associated corrective actions will be undertaken without delay.

ARTICLE XIII REPRESENTATIONS, WARRANTIES AND COVENANTS

13.1 Representations and Warranties of Contractor. The Contractor represents and warrants to the Owner that each of the following statements is presently true and accurate:

A. The Contractor is a construction company, organized under the laws of the State of _____, authorized to transact business in the State of Florida, with _____ as the primary qualifying agent. Contractor has all requisite power and authority to carry on its business as now conducted, to own or hold its properties, and to enter into and perform its obligations hereunder and under each instrument to which it is or will be a party, and is in good standing in the State of Florida.

B. Each Contract Document to which the Contractor is or will be a party constitutes, or when entered into will constitute, a legal, valid, and binding obligation of the Contractor enforceable against the Contractor in accordance with the terms thereof, except as such enforceability may be limited by applicable bankruptcy, insolvency, or similar laws from time to time in effect which affect creditors' rights generally and subject to usual equitable principles in the event that equitable remedies are involved.

C. There are no pending or, to the knowledge of the Contractor, threatened actions or proceedings before any court or administrative agency, within or without the State of Florida, against the Contractor or any partner, officer, or agent of the Contractor which question the validity of any document contemplated hereunder, or which are likely in any case, or in the aggregate, to materially adversely affect the consummation of the transactions contemplated hereunder, or materially adversely affect the financial condition of the Contractor.

D. The Contractor has filed or caused to be filed all federal, state, local, or foreign tax returns, if any, which were required to be filed by the Contractor, and has paid, or caused to be paid, all taxes shown to be due and payable on such returns or on any assessments levied against the Contractor.

E. Neither Contractor nor any agent or person employed or retained by Contractor has acted fraudulently or in bad faith or in violation of any statute or law in the procurement of this Agreement.

F. The Contractor shall timely fulfill or cause to be fulfilled all of the terms and conditions expressed herein which are within the control of the Contractor or which are the responsibility of the Contractor to fulfill. The Contractor shall be solely responsible for the means and methods of construction.

G. It is recognized that neither the Architect/Engineer, the Contractor, nor the Owner has control over the cost of labor, materials, or equipment, over a Subcontractor's methods of determining bid prices, or over competitive bidding, market, or negotiating conditions.

H. During the term of the Contract Documents, and the period of time that the obligations of the Contractor under the Contract Documents shall be in effect, the Contractor shall cause to occur and to continue to be in effect those instruments, documents, certificates, and events contemplated by the Contract Documents that are applicable to, and the responsibility of, the Contractor.

I. The Contractor shall assist and cooperate with the Owner and shall accomplish the construction of the Project in accordance with the Contract Documents and the Project Plans and Specifications, and will not knowingly violate any laws, ordinances, rules, regulations, or orders that are or will be applicable thereto.

J. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective, and 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 Architect/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.

K. If any Work (including Work of others) that is to be inspected, tested, or approved is covered without written concurrence of Architect/Engineer, it must, if requested by Architect/Engineer, be uncovered for observation. Such uncovering shall be at Contractor's expense unless Contractor has given Architect/Engineer timely notice of Contractor's intention to cover the same and Architect/Engineer has not acted with reasonable promptness in response to such notice. Neither observations by Architect/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.

L. 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 Architect/Engineers, 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 the schedule and shall not be entitled to an extension of the Contract Time or the recovery of delay damages due to correcting or removing defective Work.

M. 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 Architect/Engineer and a Change Order will be issued incorporating the necessary revisions.

N. If within three (3) years after the Substantial Completion Date 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. Failing payment by the Contractor and notwithstanding any other provisions of the Contract Documents to the contrary, Owner shall have the right to bring a direct action in the Circuit Court to recover such costs.

13.2 Representations of the Owner. To the extent permitted by law, the Owner represents to the Contractor that each of the following statements is presently true and accurate:

A. The Owner is a validly existing political subdivision of the State of Florida.

B. The Owner has all requisite corporate or governmental power and authority to carry on its business as now conducted and to perform its obligations under the Contract Documents and each Contract Document contemplated hereunder to which it is or will be a party.

C. The Contract Documents and each Contract Document contemplated hereby to which the Owner is or will be a party has been duly authorized by all necessary action on the part of, and has been or will be duly executed and delivered by, the Owner, and neither the execution and delivery thereof nor compliance with the terms and provisions thereof or

hereof: (a) requires the approval and consent of any other person or party, except such as have been duly obtained or as are specifically noted herein; (b) contravenes any existing law, judgment, governmental rule, regulation or order applicable to or binding on the Owner; or (c) contravenes or results in any breach of, default under, or result in the creation of any lien or encumbrance upon the Owner under any indenture, mortgage, deed of trust, bank loan, or credit agreement, the charter, ordinances, resolutions, or any other agreement or instrument to which the Owner is a party, specifically including any covenants of any bonds, notes, or other forms of indebtedness of the Owner outstanding on the date of the Contract Documents.

D. The Contract Documents and each document contemplated hereby to which the Owner is or will be a party constitutes, or when entered into will constitute, a legal, valid, and binding obligation of the Owner enforceable against the Owner in accordance with the terms thereof, except as such enforceability may be limited by applicable bankruptcy, insolvency, or similar laws from time to time in effect which affect creditors' rights generally, and subject to usual equitable principles in the event that equitable remedies are involved.

E. There are no pending or, to the knowledge of the Owner, threatened actions or proceedings before any court or administrative agency against the Owner which question the validity of the Contract Documents or any document contemplated hereunder, or which are likely in any case or in the aggregate to materially adversely affect the consummation of the transactions contemplated hereunder or the financial or corporate condition of the Owner.

F. The Owner shall use due diligence to timely fulfill or cause to be fulfilled all of the conditions expressed in the Contract Documents which are within the control of the Owner or which are the responsibility of the Owner to fulfill.

G. During the pendency of the Work and while the obligations of the Owner under the Contract Documents shall be in effect, the Owner shall cause to occur and to continue to be in effect and take such action as may be necessary to enforce those instruments, documents, certificates and events contemplated by the Contract Documents that are applicable to and the responsibility of the Owner.

H. The Owner shall assist and cooperate with the Contractor in accomplishing the construction of the Project in accordance with the Contract Documents and the Project Plans and Specifications, and will not knowingly violate any laws, ordinances, rules, regulations, orders, contracts, or agreements that are or will be applicable thereto or, to the extent permitted by law, enact or adopt any resolution, rule, regulation, or order, or approve or enter into any contract or agreement, including issuing any bonds, notes, or other forms of indebtedness, that will result in the Contract Documents or any part thereof, or any other instrument contemplated by and material to the timely and effective performance of a party's obligations hereunder, to be in violation thereof.

ARTICLE XIV TERMINATION AND SUSPENSION

14.1 Termination for Cause by Owner. This Agreement may be terminated by Owner upon written notice to the Contractor should Contractor fail substantially to perform a material obligation in accordance with the terms of the Contract Documents through no fault of

the Owner. In the event Owner terminates for cause and it is later determined by a court of competent jurisdiction that such termination for cause was not justified, then in such event such termination for cause shall automatically be converted to a termination without cause pursuant to Section 14.2.

A. Nonperformance. If the Contractor fails to timely perform any of his obligations under the Contract Documents, including any obligation the Contractor assumes to perform Work with his own forces, or if it persistently or repeatedly refuses or fails, except in case for which extension of time is provided, to supply enough properly skilled workmen or proper materials, or fails, without being excused, to maintain an established schedule (failure to maintain schedule shall be defined as any activity that falls thirty (30) days or more behind schedule) which has been adopted by the Construction Team, or it fails to make prompt payment to Subcontractors for materials or labor, or disregards laws, rules, ordinances, regulations, or orders of any public authority having jurisdiction, or otherwise is guilty of substantial violations of the Agreement the Owner may, after seven (7) days written notice, during which period the Contractor fails to perform such obligation, make good such deficiencies and perform such actions. The Contract Sum, or the actual Cost of the Project, whichever is less, shall be reduced by the cost to the Owner of making good such deficiencies, and the Contractor's compensation shall be reduced by an amount required to manage the making good of such deficiencies. Provided, however, nothing contained herein shall limit or preclude Owner from pursuing additional damages from Contractor as a result of its breach.

B. Insolvency. If the Contractor is adjudged bankrupt, or if it makes a general assignment for the benefit of its creditors, or if a receiver is appointed on account of its insolvency, then the Owner may, without prejudice to any other right or remedy, and after giving the Contractor and its surety, if any, fourteen (14) days written notice, and during which period the Contractor fails to cure the violation, terminate the Agreement. In such case, the Contractor shall not be entitled to receive any further payment. Owner shall be entitled to recover all costs and damages arising as a result of failure of Contractor to perform as provided in the Contract Documents, as well as reasonable termination expenses, and costs and damages incurred by the Owner may be deducted from any payments left owing the Contractor.

C. Illegality. Owner may terminate the Agreement if Contractor disregards laws or regulations of any public body having jurisdiction.

D. Rights of Owner. The Owner may, after giving Contractor (and the Surety, if there is one) seven (7) days written notice, terminate the services of Contractor for cause; exclude Contractor from the Project site and take possession of the Work and of all Contractor's tools, construction equipment and machinery at the Project 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 Project 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 Sum, Contractor shall pay the difference to Owner. Such costs incurred by Owner shall be verified by Owner in writing; but in finishing the Work, Owner shall not be required to obtain the lowest quote for the Work performed. Contractor's obligations to pay the difference between such costs

and such unpaid balance shall survive termination of the Agreement. In such event and notwithstanding any other provisions of the Contract Documents to the contrary, Owner shall be entitled to bring a direct action in the Circuit Court to recover such costs.

14.2 Termination without Cause by Owner. The Owner, through its County Administrator or designee, shall have the right to terminate the Agreement, in whole or in part, without cause upon sixty (60) calendar days written notice to the Contractor. In the event of such termination for convenience, the Owner shall compensate Contractor for payments due through the date of termination, and one subsequent payment to cover costs of Work performed through the date of termination, subject to the terms and conditions of Section 3.1. The Contractor shall not be entitled to any other further recovery against the Owner, including, but not limited to, anticipated fees or profit on Work not required to be performed, or consequential damages or costs resulting from such termination.

A. Release of Contractor. As a condition of Owner's termination rights provided for in this subsection, Contractor shall be released and discharged from all obligations arising by, through, or under the terms of the Contract Documents, and the Payment and Performance Bond shall be released. Owner shall assume and become responsible for the reasonable value of Work performed by Subcontractors prior to termination plus reasonable direct close-out costs, but in no event shall Subcontractors be entitled to unabsorbed overhead, anticipatory profits, or damages for early termination.

B. Waiver of Protest. Contractor hereby waives any right to protest the exercise by Owner of its rights under this Section that may apply under the Procurement Ordinance.

14.3 Suspension without Cause. 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 Sum or an extension of the Contract Time, or both, directly attributable to any suspension if Contractor makes an approved claim therefor.

14.4 Termination Based Upon Abandonment, Casualty or Force Majeure. If, after the construction commencement date (i) Contractor abandons the Project (which for purposes of this paragraph shall mean the cessation of all construction and other activities relating to the Project, excluding those which are necessary to wind down or otherwise terminate all outstanding obligations with respect to the Project, and no recommencement of same within one hundred twenty (120) days following the date of cessation), or (ii) the Project is stopped for a period of thirty (30) consecutive days due to an instance of Force Majeure or the result of a casualty resulting in a loss that cannot be corrected or restored within one hundred twenty (120) days (excluding the time required to assess the damage and complete the steps contemplated under Section 12.2), the Owner shall have the right to terminate the Agreement and pay the Contractor its compensation earned or accrued to date.

14.5 Vacation of Project Site; Delivery of Documents. Upon termination by Owner pursuant to Section 14.2 or 14.4, Contractor shall withdraw its employees and its equipment, if any, from the Project Site on the effective date of the termination as specified in the notice of termination (which effective date shall not be less than two (2) working days after the date of delivery of the notice), regardless of any claim the Contractor may or may not have against the

Owner. Upon termination, the Contractor shall deliver to the Owner all original papers, records, documents, drawings, models and other material set forth and described in the Contract Documents.

14.6 Termination by the Contractor. If, through no act or fault of Contractor, the Work is suspended for a period of more than ninety (90) consecutive days by Owner or under an order of court or other public authority, or Owner fails to act on any Application for Payment or fails to pay Contractor any sum finally determined to be due; then Contractor may, upon fourteen (14) 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 Owner has failed to act on any Application for Payment or Owner has failed to make any payment as aforesaid, Contractor may upon fourteen (14) days written notice to Owner stop the Work until payment of all amounts then due.

Exhibit A
Title(s) of Drawings

1. SWWRF Recharge Well System

Exhibit B
Title(s) of Specifications

1. SWWRF Recharge Well System

Exhibit C
Affidavit of No Conflict

COUNTY OF _____

BEFORE ME, the undersigned authority, this day personally appeared,

_____, a principal with full authority to bind
_____ hereinafter the "Contractor ", who
being first duly sworn, deposes and says:

(a) is not currently engaged or will not become engaged in any obligations, undertakings or contracts that will require the Contractor to maintain an adversarial role against the County or that will impair or influence the advice, recommendations or quality of work provided to the County; and

(b) has provided full disclosure of all potentially conflicting contractual relationships and full disclosure of contractual relationships deemed to raise a question of conflict(s); and

(c) has provided full disclosure of prior work history and qualifications that may be deemed to raise possible question of conflict(s).

Affiant makes this affidavit for the purpose of inducing Manatee County, a political subdivision of the State of Florida, to enter into this Agreement for

Signature

SUBSCRIBED to and sworn before me this ____ day of _____, 2014.

Notary Public

My commission expires: _____

Personally Known _____ or Produced Identification _____
Type of Identification Produced _____

Exhibit D
Contractor's Certificate(s) of Insurance

Exhibit E
Contractor's Payment and Performance Bond

**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. 16-1006CD with the County for the project titled Southwest Water Reclamation Facility Recharge Well Infrastructure, 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. 16-1006CD, between Principal and County for construction of

Southwest Water Reclamation Facility Recharge Well Infrastructure,
(Title of Project)

the Contract being made a part of this bond by reference, at 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

Company Name

Signature

Print Name & Title

(Corporate Seal)

SURETY

Company Name

Signature

Print Name & Title

(Corporate Seal)

AGENT or BROKER

Company Name

Address

Telephone

Licensed Florida Insurance Agent? ☐ Yes ☐ No

License #: _____

State of: _____

County of: _____

City of: _____

Exhibit F
Standard Forms

APPLICATION FOR PAYMENT				Request No.: _____ Project No.: _____	
Project: _____				Purchase Order No.: _____	
From: _____ To: _____				County Bid No.: _____	
				Consultant: _____	

CONTRACT PAYMENT SUMMARY						
Original Contract Amount:				\$	-	
Change Order(s):				\$	-	
Change order summary:						
Number	Date Approved	Additive	Deductive			
SUBTOTALS:		\$	-			\$
Net change order subtotal (Additive less Deductive):				\$	-	
Current Contract Amount (CCA): (Original Amount + Change Order(s))				\$	-	
	Previous Status	Total WIP				
Value of the Work in Place (WIP)	\$	-	\$			-
Value of Stored Materials	\$	-	\$			-
Total Earned (\$ and % of CCA)	\$	-	\$			-
Retainage (\$ and % of CCA)	\$	-	\$			-
Net Earned (Total earned minus retainage)				\$	-	
TOTAL PREVIOUS PAYMENTS				\$	-	
AMOUNT DUE THIS PAYMENT (Net Earned minus Previous Payments)				\$	-	

CONTRACTOR'S AFFIDAVIT OF NOTICE	
CERTIFICATE: The undersigned CONTRACTOR certifies that all items and amounts shown on this Application for Payment are on account of work performed, materials supplied and/or materials stored on site and paid for by Contractor in accordance with the Contract Documents with due consideration for previous Payment(s), if any, received by the Contractor from the County, and that the Amount Due this Payment shown is now due.	
NOTARY:	CONTRACTOR:
State of Florida, County of _____	_____
	Name of person authorized to sign Affidavit of Notice
Sworn to (or affirmed) and subscribed before me	
this _____ day of _____ by	_____
	TITLE

(Name of person giving notice)	Contractor name, address and telephone no.:

_____	_____
(Signature of Notary Public - State of Florida)	_____
Print, Type or Stamp Commissioned Name of	_____
Notary Public:	_____
Personally Known _____ or Produced Identification _____	_____
Type of Identification Produced: _____	

VERIFICATION, RECOMMENDATION, CONCURRENCES AND APPROVALS		
	(Signatures)	(Date)
Quantities verified by:	_____	_____
Consultant/Engineer:	_____	_____
Project Management:	_____	_____
Department Head:	_____	_____
Payment approved by the		
Board of County Commissioners:	_____	_____
Attested to by the Clerk of Circuit Court:	_____	_____

**FINAL RECONCILIATION, WARRANTY PERIOD DECLARATION
AND CONTRACTOR'S AFFIDAVIT**

Project Title:

Date Submitted:

Contractor Data:

Name:

Address:

City/State/Zip:

Project No:

Warranty (months):

This Final Reconciliation is for the work performed for Manatee County by the above named contractor, hereinafter called CONTRACTOR, pursuant to the contract dated _____ as amended, and acts as an addendum thereto.

It is agreed that all quantities and prices in the attached Final Pay Estimate No. _____ are correct and that the amount of \$ _____ including retainage is due to the CONTRACTOR, that no claims are outstanding as between the parties, and that the above stated sum represents the entirety of monies owed the CONTRACTOR.

It is further agreed that the warranty period for CONTRACTOR'S work pursuant to the Contract is from _____ to _____

As (title) _____ for CONTRACTOR, I have authority to bind said CONTRACTOR, and as such make this final reconciliation, declaration and affidavit for the purpose of inducing Manatee County to make final payment to CONTRACTOR for work done at/upon _____ under said contract:

CONTRACTOR has paid all social security and withholding taxes accrued in connection with the construction project.

CONTRACTOR has paid all workers' compensation and other insurance premiums incurred in connection with this construction project.

CONTRACTOR has paid for all required permits in connection with this construction project.

All laborers, material, men, suppliers, subcontractors and service professionals who worked for and/or supplied materials, equipment and/or services to the CONTRACTOR under this construction contract have been paid in full.

(Affiant Signature)

NOTARY:

State of Florida, County of _____, Sworn to (or affirmed) and subscribed before me this _____ day of _____, _____, by _____ (person giving notice).

Signature of Notary Public - State of Florida: _____

Print, Type or Stamp Commissioned Name of Notary Public:

Personally Known ☐ or Produced Identification ☐

Type of Identification Produced _____

<h1 style="margin: 0;">CONTRACT CHANGE ORDER</h1> <p style="margin: 0;">(For Adjustment Amounts Less Than \$1,000,000.)</p> <p>PROJECT: _____</p>		<p>Change Order No.: _____</p> <hr/> <p>Contract Amount: (Present Value) _____</p> <hr/> <p>Project Number: _____</p>	
NO. OF ITEM	DESCRIPTION OF ITEM AND CHANGE	DECREASE	INCREASE
1	<p>BY EXECUTION OF THIS CHANGE ORDER THE CONTRACTOR AGREES THAT ALL CLAIMS FOR ADDITIONAL CONTRACT TIME AND FEES FOR THE ITEMS IN THIS CHANGE ORDER HAVE BEEN SATISFIED.</p>		
		TOTAL DECREASE:	TOTAL INCREASE:
<p>Contractor: _____</p> <p>Address: _____</p> <p>City / State: _____</p> <p>Contractor Signature: _____ Date _____</p>		<p>THE NET CHANGE OF ADJUSTS THE CURRENT CONTRACT AMOUNT FROM TO</p> <hr/> <p>____ CALENDAR DAYS ARE ADDED TO THE SCHEDULE WHICH CHANGES THE FINAL COMPLETION DATE TO MONTH, DAY, YEAR.</p>	
RECOMMENDATION, CONCURRENCES AND APPROVALS			
<p>SIGNATURES</p>		<p>DATE</p>	
<p>Consultant / Engineer</p> <p>_____</p>		<p>_____</p>	
<p>Project Manager:</p> <p>_____</p>		<p>_____</p>	
<p>Division Manager:</p> <p>_____</p>		<p>_____</p>	
<p>Manatee County Purchasing</p> <p>_____</p>		<p>_____</p>	
<p>Jeff Streitmatter III, P.E., Project Management Division Manager</p> <p>_____</p>		<p>_____</p>	
<p>Melissa M. Wendel, CPPO, Purchasing Official</p> <p>Authority to execute this contract per Manatee County Code, Chapter 2-26,</p> <p>and per the delegation by the County Administrator effective 1/26/2009</p>		<p>_____</p>	

JUSTIFICATION FOR CHANGE	Change Order No : Project Number:
<div>1. NECESSITY FOR CHANGE:</div> <div></div> <div>2. Is change an alternate bid? (If yes, explain)</div> <div>3. Does change substantially alter the physical size of the project? (If yes, explain)</div> <div>4 Effect of this change on other "Prime" contractors?</div> <div>5 Has the Surety and insurance company been notified, if applicable? CONTRACTOR RESPONSIBILITY</div>	

