INVITATION FOR BID
IFB #13-1674CD
DIGESTER MODIFICATIONS AT THE SOUTHWEST WATER RECLAMATION FACILITY

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

NON-MANDATORY INFORMATION CONFERENCE
In order to insure that all prospective Bidders have sufficient information and understanding of the County's needs, an Information Conference will be held on: **Thursday, August 22, 2013 at 10:00 AM** at the **Southwest Water Reclamation Facility, 5101 65th Street West, Bradenton, FL 34210.** Attendance is not mandatory, but is highly encouraged.

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

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

TIME AND DATE DUE: **September 13, 2013 at 3:00 PM**

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

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

AUTHORIZED FOR RELEASE:

Table of Contents
IFB #13-1674CD

SECTION 00010

INFORMATION TO BIDDERS

A.01 OPENING LOCATION

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

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

A.02 SEALED & MARKED

One original and two copies of your **signed Bid** shall be submitted in one **sealed** package, clearly marked on the outside **"Sealed Bid #13-1674CD- Digester Modifications at the Southwest Water Reclamation Facility"** with your company name.

Address package to:

Manatee County Purchasing Division
1112 Manatee Avenue West, Suite 803
Bradenton, Florida 34205

A.03 SECURING OF DOCUMENTS

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

A.04 BID DOCUMENTS

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

A.04 BID DOCUMENTS (Continued)

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

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

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

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

A.05 MODIFICATION OF BID SPECIFICATIONS

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

A.06 DEADLINE FOR CLARIFICATION REQUESTS

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

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

A.07 CLARIFICATION & ADDENDA

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

A.07 CLARIFICATION & ADDENDA (Continued)

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

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

A.08 LOBBYING

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

A.09 UNBALANCED BIDDING PROHIBITED

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

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

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

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

A.09 UNBALANCED BIDDING PROHIBITED (Continued)

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

A.10 FRONT END LOADING OF BID PRICING PROHIBITED

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

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

A.11 WITHDRAWAL OF OFFERS

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

A.12 IRREVOCABLE OFFER

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

A.13 BID EXPENSES

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

A.14 RESERVED RIGHTS

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

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

A.15 APPLICABLE LAWS

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

A.16 COLLUSION

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

A.16 COLLUSION (Continued)

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

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

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

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

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

A.17 CODE OF ETHICS

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

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

A.18 BID FORMS

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

A.19 LEGAL NAME

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

A.20 PUBLIC CONTRACTING AND ENVIRONMENTAL CRIMES

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

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

A.21 DISCOUNTS

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

A.22 TAXES

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

A.23 DESCRIPTIVE INFORMATION

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

A.24 AMERICANS WITH DISABILITIES ACT

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

A.25 EQUAL EMPLOYMENT OPPORTUNITY CLAUSE

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

A.26 MBE/WBE

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

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

A.27 MATHEMATICAL ERRORS

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

A.28 DISCLOSURE

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

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

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

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

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

END OF SECTION A

SECTION 00020
BASIS OF AWARD

B.01 BASIS OF AWARD

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

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

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

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

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

B.02 SUBCONTRACTORS

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

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

B.03 QUALIFICATIONS OF BIDDERS

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

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

B.04 PREPARATION OF CONTRACT

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

B.05 INSPECTION OF SITE

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

END OF SECTION B

SECTION 00030

GENERAL TERMS AND CONDITIONS OF THE CONTRACT

C.01 CONTRACT FORMS

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

C.02 ASSIGNMENT OF CONTRACT

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

C.03 COMPLETION OF WORK

The Work will be completed and ready for final inspection within the specified calendar days from the date the Contract time commences to run. Only one Bid shall be considered based on **190 calendar days**. Only one Award shall be made.

C.04 LIQUIDATED DAMAGES

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

C.05 PAYMENT

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

C.05 PAYMENT (Continued)

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

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

Time allowed for development of punch list:

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

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

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

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

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

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

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

C.05 PAYMENT (Continued)

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

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

C.06 RETAINAGE

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

C.07 WARRANTY AND GUARANTEE PROVISIONS

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

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

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

C.08 ROYALTIES AND PATENTS

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

C.09 AUTHORIZED PRODUCT REPRESENTATION

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

C.10 REGULATIONS

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

C.11 CANCELLATION

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

C.12 INDEMNIFICATION

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

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

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

C.14 INSURANCE

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

a. Workers' Compensation/Employers' Liability

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

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

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

b. Commercial General Liability

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

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

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

c. Business Auto Policy

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

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

C.14 INSURANCE (Continued)

d. County's Protective Liability Coverage

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

e. Property Insurance

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

f. Installation Floater

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

g. Certificates of Insurance and Copies of Policies

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

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

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

C.14 INSURANCE (Continued)

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

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

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

C.15 BID BOND/CERTIFIED CHECK

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

C.16 PERFORMANCE AND PAYMENT BONDS

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

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

C.16 PERFORMANCE AND PAYMENT BONDS (Continued)

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

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

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

C.17 NO DAMAGES FOR DELAY

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

C.18 NO INTEREST

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

C.19 CONSTRUCTION OF CONTRACT

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

C.20 BE GREEN

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

END OF SECTION C

SECTION 00100
BID SUMMARY

D.01 THE WORK

The Work included in this Bid consists of furnishing of all labor, materials, equipment and incidentals required to install County furnished jet aeration equipment on four digesters, Contractor furnished and installed electrical and instrumentation controls for four complete operating jet aeration systems on four digesters, Contractor furnished and installed HVAC system for the existing generator building, and Contractor labor to perform selective demolition services of digester tanks #2 and #4 at the Southwest Water Reclamation Facility in accordance with this Invitation for Bid.

The selective demolition work for digester tanks #2 and #4 shall be perfromed after the complete installation of jet aeration and electrical equipment for digester tanks #1 and #3 and are fully operational.

The selective demolition work of digester tanks #2 and #4 shall consist of, but is not limited to, tank cleaning services, remove/demolish all equipment on top of tanks, remove/demolish tanks' roofs, remove/demolish all tanks' internals, remove/demolish all piping systems that are not required for tank operation, remove/demolish all miscellaneous electrical items and ancillary equipment not required for tank operation.

The price for the tank cleaning portion of digester tanks #2 and #4 of the project shall include all labor, hoses, high powered vaccum trucks, pressure washer, all required personal protection equipment.

The Contractor shall adhere to confined space safety protocols by using trained and certified confined space personnel and providing and posting a confined space permit while on site, in accordance with OSHA 29 CFR 1910.

Location:
Manatee County Utilities
Southwest Water Reclamation Facility
5101 65th Street West
Bradenton, FL 34210.

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

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

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

D.02 SUBCONTRACTORS, SUPPLIERS AND OTHERS

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

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

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

D.03 BIDS

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

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

D.04 EXAMINATION OF BID DOCUMENTS AND SITE

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

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

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

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

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

D.05 MATERIALS AND WORKMANSHIP

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

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

D.06 REGULATIONS AND MATERIAL DISPOSAL

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

D.07 PROJECT CLOSE-OUT

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

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

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

D.08 DISCRETIONARY WORK

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

D.09 PROGRESS REQUIREMENTS

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

END OF SECTION D

SECTION 00150

MANATEE COUNTY LOCAL PREFERENCE LAW AND VENDOR REGISTRATION

E.01 Vendor Registration

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

END OF SECTION E

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

A. Authorized Representative

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

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

Business Phone Number:_____

Email Address: _____

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

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

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

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

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

Signature of Affiant_____

STATE OF FLORIDA
COUNTY OF_____

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

(Notary Seal) Signature of Notary:_____

Name of Notary: (Typed or Printed)_____

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

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

SECTION 00300

BID FORM

(SUBMIT IN TRIPLICATE)

For: IFB #13-1674CD- DIGESTER MODIFICATIONS AT THE SOUTHWEST WATER RECLAMATION FACILITY

TOTAL BID PRICE (BID "A"): _____
Based on a Completion Time of 190 calendar days

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

We, the undersigned, hereby declare that we have carefully reviewed the Bid documents, and with full knowledge and understanding of the aforementioned herewith submit this Bid, meeting each and every specification, term, and condition contained in the Invitation for Bids, in its entirety.

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

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

BIDDER'S NAME: _____

MAILING ADDRESS: _____

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

EMAIL ADDRESS: _____

FL CONTRACTOR LICENSE#_____

LICENSE IN THE NAME OF: _____

STATE OF INCORPORATION_____ (if applicable)

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

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

AUTHORIZED SIGNATURE(S): _____

Name and Title of Above Signer(s): _____

BID FORM

(Submit in Triplicate) Section 00300

SWWRF DIGESTER MODIFICATIONS

Bid "A" Based on Completion Time of 190 Calendar Days

ITEM NO.	DESCRIPTION	EST. QTY.	U/M	UNIT PRICE	EXTENDED PRICE
1	MOBILIZATION	1	LS	$	$
2	DEMOLITION AND CLEANING OF DIGESTERS #2 AND #4	2	LS	$	$
3	INSTALLATION OF COUNTY FURNISHED JET AERATION EQUIPMENT, INCLUDING FURNISHING AND INSTALLING PIPES, VALVES, PIPE SUPPORTS, CONCRETE WORK, AND HANDRAILS	4	LS	$	$
4	FURNISH AND INSTALL ELECTRICAL SYSTEM FOR COMPLETE OPERATING JET AERATION SYSTEMS	1	LS	$	$
5	FURNISH AND INSTALL INSTRUMENTATION AND CONTROL SYSTEM FOR COMPLETE OPERATING JET AERATION SYSTEMS	1	LS	$	$
6	FURNISH AND INSTALL HVAC SYSTEM FOR EXISTING GENERATOR BUILDING	1	LS	$	$
7	DEMOBILIZATION AND SITE CLEANUP	1	LS	$	$
	DISCRETIONARY WORK (USED ONLY WITH COUNTY APPROVAL)				$85,000.00
	TOTAL PRICE FOR BID "A" - Based on Completion Time of 190 Calendar Days				$

Bidder Name: _____

Authorized Signature: _____

SWORN STATEMENT

THE FLORIDA TRENCH SAFETY ACT

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

1. This Sworn Statement is submitted with IFB No**. 13-1674CD**
2. This Sworn Statement is submitted by_____ whose business address is_____ and, if applicable, its Federal Employer Identification Number (FEIN) is_____. If the entity has no FEIN, include the Social Security Number of the individual signing this sworn statement _____.
3. Name of individual signing this Sworn Statement is: _____, Whose relationship to the above entity is: _____.
4. The Trench Safety Standards that will be in effect during the construction of this project shall include, but are not limited to: Laws of Florida, Chapters 90-96, TRENCH SAFETY ACT, and OSHA RULES AND REGULATIONS 29 CFR 1926.650 Subpart P, effective October 1, 1990.
5. The undersigned assures that the entity will comply with the applicable Trench Safety Standards and agrees to indemnify and hold harmless the County and Engineer, and any of their agents or employees from any claims arising from the failure to comply with said standard.
6. The undersigned has appropriated the following costs for compliance with the applicable standards:

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

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

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

_____
(AUTHORIZED SIGNATURE / TITLE)

SWORN to and subscribed before me this _____ day of _____, 20_____.
(Impress official seal)

Notary Public, State of Florida: _____

My commission expires: _____

SECTION 00430

CONTRACTOR'S QUESTIONNAIRE

(Submit in Triplicate)

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

THIS QUESTIONNAIRE MUST BE COMPLETED AND SUBMITTED WITH YOUR BID

1. License #: _____

   License Issued to: _____

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

   Company Name: _____

   _____

   Company's Physical Address

   _____

   City

   _____State of Incorporation, if applicable _____ (Zip Code)

   (_____) _____Telephone Number; (___) _____Fax Number

   Email Address: _____

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

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

   _____

   _____

   _____

   _____

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

   _____

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

   _____Years holding a Certified General Contractors License

   _____

   _____

   _____Years experience performing this type of project

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

BIDDER: _____

4. (Continued)

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

   _____

   _____

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

   _____

   _____

   _____

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

   _____

   _____

   _____

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

   _____

   _____

   _____

   _____

   _____

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

   _____

   _____

   _____

BIDDER: _____

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

_____

_____

_____

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

_____

_____

_____

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

_____

_____

_____

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

_____

_____

_____

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

_____

_____

_____

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

_____

_____

_____

BIDDER: _____

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

Surety's Name: _____

Surety's Address: _____

Surety's Address: _____

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

_____

_____

_____

_____

Phone: (_____) _____

Email_____

BIDDER: _____

SECTION 00491

PUBLIC CONTRACTING AND ENVIRONMENTAL CRIMES CERTIFICATION

SWORN STATEMENT PURSUANT TO ARTICLE V,
MANATEE COUNTY PURCHASING ORDINANCE

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

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

_____

[Print individual's name and title]

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

whose business address is _____

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

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

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

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

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

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

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

(Cont'd.)

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

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

_____
[Signature]

STATE OF FLORIDA
COUNTY OF _____

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

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

_____ My commission expires _____
Notary Public Signature

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

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

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

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

ARTICLE 1. WORK

CONTRACTOR shall furnish all labor, materials, supplies, and other items required to complete the Work for **IFB #13-1674CD DIGESTER MODIFICATIONS AT THE SOUTHWEST WATER RECLAMATION FACILITY** in strict accordance with Contract documents and any duly authorized subsequent addenda thereto, all of which are made a part hereof.

ARTICLE 2. COMPENSATION

As compensation to the CONTRACTOR, the COUNTY shall pay and the CONTRACTOR will accept as full consideration for the performance of all Work required by **IIFB #13-1674CD DIGESTER MODIFICATIONS AT THE SOUTHWEST WATER RECLAMATION FACILITY**, subject to additions and deductions as provided therein, the sum of **$XXXXXX** for Bid "**A**" based on a completion time of **190** calendar days.

ARTICLE 3. LIQUIDATED DAMAGES

Time is of the essence in this Agreement. As of the date of this Agreement, the damages that will be suffered by the County in the event of the Contractor's failure to timely complete the Work are impossible to determine. In lieu thereof, it is agreed that if the Contractor fails to achieve substantial completion of the Work within 190 calendar days of issuance of the Notice to Proceed (accounting, however, for any extensions of

time granted pursuant to approved change orders), the Contractor shall pay to the County, as liquidated damages (and not as a penalty), the sum of $1148 per calendar day for each day beyond 190 days until the Contractor achieves substantial completion. The County shall have the option of withholding said liquidated damages from any pay application(s) thereafter submitted by the Contractor. Alternatively, the Contractor shall immediately pay said sums to the County upon the County's demand for same.

ARTICLE 4. ENGINEER

The County of Manatee, Public Works Department, is responsible as the COUNTY and CH2MHill hereinafter referred to as "ENGINEER," designed this project and is responsible for technical/engineering reviews and decisions. The ENGINEER is a member of the COUNTY'S project management team which is collectively responsible in ensuring the Work is completed in accordance with the Contract documents.

All communications involving this project will be addressed to: Anthony Benitez, P.E., Project Engineer II, Public Works Department and to the Engineer of Record, Thomas V. Waldeck, CH2MHill. All invoicing will be addressed to the attention of: Anthony Benitez (address noted below) with invoice copies sent to Thomas V. Waldeck, (address noted below).

Manatee County Public Works Dept.
IFB# 13-1674CD
Attention: Anthony Benitez, PE
Project Engineer II
1022 26th Avenue East
Bradenton, Florida 34208
Phone (941) 708-7450 ext. 7333

CH2MHill
IFB# 13-1674CD
Attn: Thomas V. Waldeck
Project Manager
4350 West Cypress Street
Tampa, Florida 33607
Phone (813) 281-7745

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

ARTICLE 5. CONTRACTOR'S REPRESENTATIONS

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

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

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

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

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

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

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

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

ARTICLE 6. CONTRACT DOCUMENTS

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

6.1 This Agreement and Bid document **IFB #13-1674CD**

6.2 Public Construction Bond Form and Insurance Certificate(s)

6.3 Drawings/Plans (not attached)

6.4 Addendum number ?? to ?? inclusive

6.5 CONTRACTOR'S Bid Form

6.6 Reports

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

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

ARTICLE 7. MISCELLANEOUS

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

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

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

AGREEMENT

IFB #13-1674CD

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

CONTRACTOR

By: _____

_____
Print Name & Title of Signer

Date: _____

COUNTY OF MANATEE, FLORIDA

By: _____
Melissa M. Wendel, CPPO
Purchasing Official

Date: _____

MANATEE COUNTY GOVERNMENT
PUBLIC CONSTRUCTION BOND

Bond No. _____
(Enter bond number)

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

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

_____

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

WHEREAS, the Contractor has entered into Contract No. IFB #13-1674CD with the County for the project titled Digester Modifications at the Southwest Water Reclamation Facility, with conditions and provisions as are further described in the aforementioned Contract, which Contract is by reference made a part hereof for the purposes of explaining this bond.

THE CONDITION OF THIS BOND is that if Principal:

1. Performs Contract No. IFB #13-1674CD, between Principal and County for construction of

Digester Modifications at the Southwest Water Reclamation Facility, the Contract being made a part of this bond by reference, at
(Title of Project)

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

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

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

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

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

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

DATED ON _____.

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

AGENT or **BROKER**

Company Name

Address

Telephone

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

License #: _____

State of: _____

County of: _____

City of: _____

SECTION 00700
GENERAL CONDITIONS

ARTICLE 1. DEFINITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ARTICLE 2. PRELIMINARY MATTERS

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

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

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

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

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

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

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

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

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

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

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

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

3.3.1 A Formal Written Amendment

3.3.2 A Change Order

3.3.3 Administrative Contract Adjustment (ACA)

3.3.4 A Work Directive Change

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

3.4.1 Discretionary Work – Field Directive

3.4.2 Engineer's approval of a Shop Drawing or sample

ARTICLE 4. CONTRACTOR'S RESPONSIBILITIES

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ARTICLE 5. OWNER'S RESPONSIBILITIES

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

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

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

ARTICLE 6. CHANGES IN THE WORK

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

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

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

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

ARTICLE 7. CHANGE OF CONTRACT PRICE

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

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

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

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

7.3.2 By mutual acceptance of lump sum.

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

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

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

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

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

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

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

ARTICLE 8. CHANGE OF CONTRACT TIME

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

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

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

ARTICLE 9. WARRANTY, TEST/INSPECTION, CORRECTION

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

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

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

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

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

ARTICLE 10. SUSPENSION/TERMINATION OF WORK

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

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

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

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

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

ARTICLE 11. CONTRACT CLAIMS

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

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

ARTICLE 12. RESIDENT PROJECT REPRESENTATIVE - DUTIES, RESPONSIBILITIES

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

12.2 Resident Project Representative will:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

12.2.17 Report immediately the occurrence of any accident.

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

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

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

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

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

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

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

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

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

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

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

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

12.3.7 Shall not participate in specialized field or laboratory tests.

ARTICLE 13. APPRENTICES

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

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

END OF SECTION

MAILING LABEL

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

MAILING LABEL TO AFFIX TO OUTSIDE OF SEALED BID PACKAGE:

SEALED BID - DO NOT OPEN

CONTRACTOR: _____

SEALED BID NO: 13-1674CD

BID TITLE: DIGESTER MODIFICATIONS AT THE SOUTHWEST WATER RECLAMATION FACILITY

DUE DATE/TIME: _____ @ _____

SECTION A: COMPLIANCE WITH FEDERAL LAWS

A.01 FEDERAL REQUIREMENTS FOR CONSTRUCTION PROJECTS

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

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

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

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

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

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

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

ATTACHMENT A
Federal Prevailing Wage Decisions

FEDERAL PREVAILING WAGE

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

(SEE ATTACHED)

General Decision Number: FL130165 03/08/2013 FL165

Superseded General Decision Number: FL20120165

State: Florida

Construction Type: Heavy

County: Manatee County in Florida.

HEAVY CONSTRUCTION PROJECTS (Including Sewer and Water Lines)

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

* ELEC0915-003 12/01/2012

	Rates	Fringes
ELECTRICIAN	$ 25.13	34%+$0.25

ENGI0925-008 01/01/2012

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

IRON0397-006 07/01/2012

	Rates	Fringes
IRONWORKER, STRUCTURAL	$ 27.67	12.59

LABO0517-002 05/01/2008

	Rates	Fringes
LABORER: Grade Checker	$ 17.20	5.47

PAIN0088-008 07/01/2008

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

SUFL2009-161 06/24/2009

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

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

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

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

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

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

Union Identifiers

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

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

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

Non-Union Identifiers

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

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

WAGE DETERMINATION APPEALS PROCESS

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

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

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

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

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

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

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

The request should be accompanied by a full statement of the

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

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

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

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

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END OF GENERAL DECISION

ATTACHMENT B
Payroll Form WH-347

U.S. Department of Labor
Wage and Hour Division

PAYROLL

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

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

U.S. Wage and Hour Division

Rev. Dec. 2008

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

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

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

Public Burden Statement

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

(over)

Date _____

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

do hereby state:

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

_____ on the
(Contractor or Subcontractor)

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

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

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

_____ from the full
(Contractor or Subcontractor)

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

_____

_____

_____

_____

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

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

(4) That:

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

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

(b) WHERE FRINGE BENEFITS ARE PAID IN CASH

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

(c) EXCEPTIONS

EXCEPTION (CRAFT)	EXPLANATION

REMARKS:

NAME AND TITLE	SIGNATURE

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

CONTRACT DOCUMENTS

FOR THE CONSTRUCTION

OF

SWWRF DIGESTER MODIFICATIONS

PREPARED FOR:

MANATEE COUNTY UTILITIES
MANATEE COUNTY, FL

VOLUME 1 OF 2
SPECIFICATIONS

For Information regarding this project contact:

THOMAS WALDECK, P.E.
4350 West Cypress Street
Suite #600
Tampa, FL 33607-4178
+1 (813) 874-6522 x57745

CH2MHILL

CH2M HILL
Project No. 457133
ISSUE FOR BID
APRIL 2013

ISSUED FOR BID

MANATEE COUNTY UTILITIES

MANATEE COUNTY, FL

TECHNICAL SPECIFICATIONS

for the construction of the

SWWRF DIGESTER MODIFICATIONS

Contract No. _____

****

****

CH2M HILL
Tampa, FL
June 2013

Project No. 457133 Copy No._____

TABLE OF CONTENTS

Pages

Pages

Pages

Pages

DIVISIONS 41 THROUGH 49 (NOT USED)

DRAWINGS (BOUND SEPARATLEY)

END OF SECTION

TECHNICAL

SPECIFICATIONS

SECTION 01 04 50 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 01 05 00 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 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

A. The completed Work will provide Owner with digester modifications for a fully operational sludge holding tank facility and includes:

1. Demolition of equipment and roofs in two digesters tanks to convert them to aerated sludge holding tanks.
   a. Clean tanks.
   b. Remove/demolish all equipment on top of the tank.
   c. Remove/demolish tanks' roofs.
   d. Remove/demolish all tanks' internals.
   e. Remove/demolish all piping systems that are not required for tank operation.
   f. Remove/Demolish all miscellaneous electrical items such as conduit, conductors, electrical boxes, switches, instruments, panels, and all other ancillary equipment not required for plant operation
2. Installation of jet aeration equipment including sludge holding tank blowers, sludge pumps, and aeration and mixing jets for four sludge holding tanks.
   a. Install Owner furnished products, including four sets of blower, pumps and jet assemblies.
   b. Furnish and install pipes, valves, pipe supports, etc to complete four fully operational jet mixing/aeration systems.
   c. Structural work including concrete fill, concrete pads, pipe supports, pipe encasements, and handrails.
3. Electrical, instrumentation and controls, and civil works for four complete operating jet aeration systems.
4. Furnishing and installation of a HVAC system for the existing generator building and installing electrical and I&C equipment in the building.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 15 00 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.

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. Painting.
17. 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 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 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 - DEMOLITION AND CLEANING OF DIGESTERS #2 AND #4

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the demolition and cleaning of digesters #2 and #4, all as shown on the Contract Drawings and/or called for in the Contract Specifications, ready for approval and acceptance by the County. 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 - INSTALLATION OF COUNTY FURNISHED JET AERATION EQUIPMENT, INCLUDING FURNISHING AND INSTALLING PIPES, VALVES, PIPE SUPPORTS, CONCRETE WORK, AND HANDRAILS

Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the installation of the county furnished jet aeration equipment within the site identified including dewatering, excavation, including rock as necessary, bedding, backfill, concrete, materials, piping, valves, all site work including sodding, 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 any off-site material required to establish finish grade and the removal and off-site disposal of any unsuitable excavated material or debris. 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 ELECTRICAL SYSTEM FOR COMPLETE OPERATING JET AERATION SYSTEMS

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 electrical system, including all materials and equipment necessary for complete and fully operable jet aeration systems, 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. 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 INSTRUMENTATION AND CONTROL SYSTEM FOR COMPLETE OPERATING JET AERATION SYSTEMS

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 instrumentation and control system, including all materials and equipment necessary for complete and fully operable jet aeration systems, 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. 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 - FURNISH AND INSTALL HVAC SYSTEM FOR EXISTING GENERATOR BUILDING

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 HVAC system for existing generator building, including all 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. Measurement for periodic payments of this lump sum bid item will be in accordance with the approved Schedule of Values, to be supplied by the Contractor in accordance with the Contract Documents.

BID ITEM NO.7 - 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 - DISCRETIONARY 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.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Schedule of Values.
2. Application for Payment.
3. Final Application for Payment.

1.02 SCHEDULE OF VALUES

A. Prepare a separate Schedule of Values for each schedule of the Work under the Agreement in accordance to Section 01 37 00 Schedule of Values.

B. Upon request of Engineer, provide documentation to support the accuracy of the Schedule of Values.

C. Lump Sum Work:

1. Reflect specified alternates, as applicable.
2. List bonds and insurance premiums, mobilization, demobilization, preliminary and detailed progress schedule preparation, equipment testing, facility startup, and contract closeout separately.
3. Break down by Division 2 through 49.

D. An unbalanced or front-end loaded schedule will not be acceptable.

E. Summation of the complete Schedule of Values representing all the Work shall equal the Contract Price.

1.03 APPLICATION FOR PAYMENT

A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of Contractor.

B. Use detailed Application for Payment Form provided by Owner.

C. Provide separate form for each schedule as applicable.

D. Include accepted Schedule of Values for each schedule or portion of lump sum Work and the unit price breakdown for the Work to be paid on a unit priced basis.

E. Include separate line item for each Change Order and Work Change Directive executed prior to date of submission. Provide further breakdown of such as requested by Engineer.

F. Preparation:

1. Round values to nearest dollar.
2. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable, and such supporting data as may be requested by Engineer.

1.04 PAYMENT

A. Payment for all Lump Sum Work shown or specified in Contract Documents is included in the Contract Price. Payment will be based on a percentage complete basis for each line item of the accepted Schedule of Values.

1.05 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:

1. Loading, hauling, and disposing of rejected material.
2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
3. Rejected loads of material, including material rejected after it has been placed by reason of failure of Contractor to conform to provisions of Contract Documents.
4. Material not unloaded from transporting vehicle.
5. Defective Work not accepted by Owner.
6. Material remaining on hand after completion of Work.

1.06 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings and preliminary operation and maintenance data is acceptable to Engineer.

B. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 13
PROJECT COORDINATION

PART 1 GENERAL

1.01 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.
2. Coordinate the Work of these Contract Documents with work of others as specified in General Conditions.
3. Include sequencing constraints specified herein as a part of Progress Schedule.

1.02 OWNER-FURNISHED PRODUCTS

A. Refer to Section 01 62 50, Owner-Furnished Products.

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 PROJECT MILESTONES

A. General: Include the Milestones specified herein as a part of the Progress Schedule required under Section 01 32 00, Construction Progress Documentation.

1.09 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. Construct Work in the following stages to allow for Owner's continuous occupancy and for uninterrupted operation during construction. The following sequence is not all inclusive and is intended to provide the Contractor with suggestions on construction sequence. The Contractor shall be responsible for planning the construction sequence, and presenting a detailed plan for review and approval by the Owner. The following is a proposed sequence of construction to keep the plant operational.

1. Tanks 1 and 3 will be demolished by Others. Do not take tanks 2 and 4 out of operation or demolish any equipment that will interfere with the operation of tanks 2 and 4 while tanks 1 and 3 are being demolished.
2. After tanks 1 and 3 are demolished, install all equipment in these tanks including the blowers, pumps, and jet aeration system and associated electrical and controls to make tanks 1 and 3 operational as sludge holding tanks.
3. At this time tanks 1 and 3 shall have the ability to receive sludge, transfer sludge between the two tanks, decant supernatant and discharge effluent to the belt filter presses.

4. After tanks 1 and 3 are operational, tanks 2 and 4 may be taken out of operation and the remaining construction completed.
5. As part of the sequence of construction, the Contractor shall review existing piping and valves and indicate what will be keep operational or modified to ensure continued operation.

F. Process or Facility Shutdown:

1. Provide 7 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.

G. Maintain bypass piping required to keep Owner's belt filter press operations on line. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.

H. 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.

I. 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.

1.10 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 Article Construction Photographs.
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.

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 31 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 GENERAL

A. Engineer will schedule physical arrangements for meetings throughout progress of the Work, prepare meeting agenda with regular participant input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 5 days after each meeting to participants and parties affected by meeting decisions.

1.02 PRECONSTRUCTION CONFERENCE

A. Contractor shall be prepared to discuss the following subjects, as a minimum:

1. Required schedules.
2. Status of Bonds and insurance.
3. Sequencing of critical path work items.
4. Progress payment procedures.
5. Project changes and clarification procedures.
6. Use of Site, access, office and storage areas, security and temporary facilities.
7. Major product delivery and priorities.
8. Contractor’s safety plan and representative.

B. Attendees will include:

1. Owner’s representatives.
2. Contractor’s office representative.
3. Contractor’s resident superintendent.
4. Contractor’s quality control representative.
5. Subcontractors’ representatives whom Contractor may desire or Engineer may request to attend.
6. Engineer’s representatives.
7. Others as appropriate.

1.03 PRELIMINARY SCHEDULES REVIEW MEETING

A. As set forth in General Conditions and Section 01 32 00, Construction Progress Documentation.

1.04 PROGRESS MEETINGS

A. Engineer will schedule regular progress meetings at Site, conducted biweekly to review the Work progress, Progress Schedule, Schedule of Submittals, Application for Payment, contract modifications, and other matters needing discussion and resolution.

B. Attendees will include:

1. Owner's representative(s), as appropriate.
2. Contractor, Subcontractors, and Suppliers, as appropriate.
3. Engineer's representative(s).
4. Others as appropriate.

1.05 PREINSTALLATION MEETINGS

A. When required in individual Specification sections, convene at Site prior to commencing the Work of that section.

B. Require attendance of entities directly affecting, or affected by, the Work of that section.

C. Notify Engineer 5 days in advance of meeting date.

D. Provide suggested agenda to Engineer to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

1.06 FACILITY STARTUP MEETINGS

A. Schedule and attend a minimum of two facility startup meetings. The first of such meetings shall be held prior to submitting Facility Startup Plan, as specified in Section 01 91 14, Equipment Testing and Facility Startup, and shall include preliminary discussions regarding such plan.

B. Agenda items shall include, but not be limited to, content of Facility Startup Plan, coordination needed between various parties in attendance, and potential problems associated with startup.

C. Attendees will include:

1. Contractor.
2. Contractor's designated quality control representative.
3. Subcontractors and equipment manufacturer's representatives whom Contractor deems to be directly involved in facility startup.

4. Engineer’s representatives.
5. Owner’s operations personnel.
6. Others as required by Contract Documents or as deemed necessary by Contractor.

1.07 OTHER MEETINGS

A. In accordance with Contract Documents and as may be required by Owner and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Preliminary Progress Schedule: Submit at least 7 days prior to preconstruction conference.
2. Detailed Progress Schedule:
   a. Submit initial Detailed Progress Schedule within 21 days after Effective Date of the Agreement.
   b. Submit an Updated Progress Schedule at each update, in accordance with Article Detailed Progress Schedule.
3. Submit with Each Progress Schedule Submission:
   a. Contractor's certification that Progress Schedule submission is actual schedule being utilized for execution of the Work.
   b. Progress Schedule: four legible copies.
   c. Narrative Progress Report: Same number of copies as specified for Progress Schedule.
4. Prior to final payment, submit a final Updated Progress Schedule.

1.02 PRELIMINARY PROGRESS SCHEDULE

A. In addition to basic requirements outlined in General Conditions, show a detailed schedule, beginning with Notice to Proceed, for minimum duration of 120 days, and a summary of balance of Project through Final Completion.

B. Show activities including, but not limited to the following:

1. Notice to Proceed.
2. Permits.
3. Submittals, with review time. Contractor may use Schedule of Submittals specified in Section 01 33 00, Submittal Procedures.
4. Early procurement activities for long lead equipment and materials.
5. Initial Site work.
6. Earthwork.
7. Specified Work sequences and construction constraints.
8. Contract Milestone and Completion Dates.
9. Owner-furnished products delivery dates or ranges of dates.
10. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.

11. System startup summary.
12. Project close-out summary.
13. Demobilization summary.

C. Update Preliminary Progress Schedule monthly as part of progress payment process. Failure to do so may result in the Owner withholding all or part of the monthly progress payment until the Preliminary Progress Schedule is updated in a manner acceptable to Engineer.

D. Format: In accordance with Article Progress Schedule— Critical Path Network**.**

1.03 DETAILED PROGRESS SCHEDULE

A. In addition to requirements of General Conditions, submit Detailed Progress Schedule beginning with Notice to Proceed and continuing through Final Completion.

B. Show the duration and sequences of activities required for complete performance of the Work reflecting means and methods chosen by Contractor.

C. When accepted by Engineer, Detailed Progress Schedule will replace Preliminary Progress Schedule and become Baseline Schedule. Subsequent revisions will be considered as Updated Progress Schedules.

D. Format: In accordance with Article Progress Schedule— Critical Path Network.

E. Update biweekly to reflect actual progress and occurrences to date, including weather delays.

1.04 PROGRESS SCHEDULE—CRITICAL PATH NETWORK

A. General: Comprehensive computer-generated schedule using CPM, generally as outlined in Associated General Contractors of America (AGC) 580, “Construction Project Planning and Scheduling Guidelines.” If a conflict occurs between the AGC publication and this Specification, this Specification shall govern.

B. Contents:

1. Schedule shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.
2. Identify Work calendar basis using days as a unit of measure.
3. Show complete interdependence and sequence of construction and Project-related activities reasonably required to complete the Work.

4. Identify the Work of separate stages and other logically grouped activities, and clearly identify critical path of activities.
5. Reflect sequences of the Work, restraints, delivery windows, review times, Contract Times and Project Milestones set forth in the Agreement and Section 01 31 13, Project Coordination.
6. Include as applicable, at a minimum:
    a. Obtaining permits, submittals for early product procurement, and long lead time items.
    b. Mobilization and other preliminary activities.
    c. Initial Site work.
    d. Specified Work sequences, constraints, and Milestones, including Substantial Completion date(s) Subcontract Work.
    e. Major equipment design, fabrication, factory testing, and delivery dates.
    f. Delivery dates for Owner-furnished products, as specified in Section 01 11 00, Summary of Work.
    g. Sitework.
    h. Concrete Work.
    i. Structural steel Work.
    j. Architectural features Work.
    k. Conveying systems Work.
    l. Equipment Work.
    m. Mechanical Work.
    n. Electrical Work.
    o. Instrumentation and control Work.
    p. Interfaces with Owner-furnished equipment.
    q. Other important Work for each major facility.
    r. Equipment and system startup and test activities.
    s. Project closeout and cleanup.
    t. Demobilization.
7. No activity duration, exclusive of those for Submittals review and product fabrication/delivery, shall be less than 1 day nor more than 14 days, unless otherwise approved.
8. Activity duration for Submittal review shall not be less than review time specified unless clearly identified and prior written acceptance has been obtained from Engineer.

C. Network Graphical Display:

1. Plot or print on paper not greater than 30 inches by 42 inches or smaller than 22 inches by 34 inches, unless otherwise approved.
2. Title Block: Show name of Project, Owner, date submitted, revision or update number, and the name of the scheduler. Updated schedules shall indicate data date.
3. Identify horizontally across top of schedule the time frame by year, month, and day.

4. Identify each activity with a unique number and a brief description of the Work associated with that activity.
5. Indicate the critical path.
6. Show, at a minimum, the controlling relationships between activities.
7. Plot activities on a time-scaled basis, with the length of each activity proportional to the current estimate of the duration.
8. Plot activities on an early start basis unless otherwise requested by Engineer.
9. Provide a legend to describe standard and special symbols used.

D. Schedule Report:

1. On 8-1/2-inch by 11-inch white paper, unless otherwise approved.
2. List information for each activity in tabular format, including at a minimum:
   a. Activity Identification Number.
   b. Activity Description.
   c. Original Duration.
   d. Remaining Duration.
   e. Early Start Date (Actual start on Updated Progress Schedules).
   f. Early Finish Date (Actual finish on Updated Progress Schedules).
   g. Late Start Date.
   h. Late Finish Date.
   i. Total Float.
3. Sort reports, in ascending order, as listed below: Activity number sequence with predecessor and successor activity.

1.05 PROGRESS OF THE WORK

A. Updated Progress Schedule shall reflect:

1. Progress of Work to within 5 working days prior to submission.
2. Approved changes in Work scope and activities modified since submission.
3. Delays in Submittals or resubmittals, deliveries, or Work.
4. Adjusted or modified sequences of Work.
5. Other identifiable changes.
6. Revised projections of progress and completion.
7. Report of changed logic.

B. Produce detailed subschedules during Project, upon request of Owner or Engineer, to further define critical portions of the Work such as facility shutdowns.

C. If Contractor fails to complete activity by its latest scheduled completion date and this Failure is anticipated to extend Contract Times (or Milestones), Contractor shall, within 7 days of such failure, submit a written statement as to how Contractor intends to correct nonperformance and return to acceptable current Progress Schedule. Actions by Contractor to complete the Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times.

D. Owner may order Contractor to increase plant, equipment, labor force or working hours if Contractor fails to:

1. Complete a Milestone activity by its completion date.
2. Satisfactorily execute Work as necessary to prevent delay to overall completion of Project, at no additional cost to Owner.

1.06 NARRATIVE PROGRESS REPORT

A. Format:

1. Organize same as Progress Schedule.
2. Identify, on a cover letter, reporting period, date submitted, and name of author of report.

B. Contents:

1. Number of days worked over the period, work force on hand, construction equipment on hand (including utility vehicles such as pickup trucks, maintenance vehicles, stake trucks).
2. General progress of Work, including a listing of activities started and completed over the reporting period, mobilization/demobilization of subcontractors, and major milestones achieved.
3. Contractor’s plan for management of Site (e.g., lay down and staging areas, construction traffic), utilization of construction equipment, buildup of trade labor, and identification of potential Contract changes.
4. Identification of new activities and sequences as a result of executed Contract changes.
5. Documentation of weather conditions over the reporting period, and any resulting impacts to the work.
6. Description of actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact.
7. Changes to activity logic.
8. Changes to the critical path.
9. Identification of, and accompanying reason for, any activities added or deleted since the last report.
10. Steps taken to recover the schedule from Contractor-caused delays.

1.07 SCHEDULE ACCEPTANCE

A. Engineer's acceptance will demonstrate agreement that:

1. Proposed schedule is accepted with respect to:
   a. Contract Times, including Final Completion and all intermediate Milestones are within the specified times.
   b. Specified Work sequences and constraints are shown as specified.
   c. Specified Owner-furnished Equipment or Material arrival dates, or range of dates, are included.
   d. Access restrictions are accurately reflected**.**
   e. Startup and testing times are as specified.
   f. Submittal review times are as specified.
   g. Startup testing duration is as specified and timing is acceptable.
2. In all other respects, Engineer's acceptance of Contractor's schedule indicates that, in Engineer's judgment, schedule represents reasonable plan for constructing Project in accordance with the Contract Documents. Engineer's review will not make any change in Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the Contract Documents will not thereby indicate acceptance of that change, unless Contractor has explicitly called the nonconformance to Engineer's attention in submittal. Schedule remains Contractor's responsibility and Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct Project in accordance with the Contract Documents.

B. Unacceptable Preliminary Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process, during which time Contractor shall update schedule on a monthly basis to reflect actual progress and occurrences to date.

C. Unacceptable Detailed Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process.

D. Narrative Report: All changes to activity duration and sequences, including addition or deletion of activities subsequent to Engineer's acceptance of Baseline Progress Schedule, shall be delineated in Narrative Report current with proposed Updated Progress Schedule.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 DEFINITIONS

A. Action Submittal: Written and graphic information submitted by Contractor that requires Engineer's approval.

B. Informational Submittal: Information submitted by Contractor that requires Engineer's review and determination that submitted information is in accordance with the Conditions of the Contract.

1.02 PROCEDURES

A. Direct submittals to Engineer at the following, unless specified otherwise.

1. Available at preconstruction conference.

B. Transmittal of Submittal:

1. Contractor shall:
   a. Review each submittal and check for compliance with Contract Documents.
   b. Stamp each submittal with uniform approval stamp before submitting to Engineer.
      1) Stamp to include Project name, submittal number, Specification number, Contractor's reviewer name, date of Contractor's approval, and statement certifying submittal has been reviewed, checked, and approved for compliance with Contract Documents.
      2) Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
2. Complete, sign, and transmit with each submittal package, one Transmittal of Contractor's Submittal form attached at end of this section.
3. Identify each submittal with the following:
   a. Numbering and Tracking System:
      1) Sequentially number each submittal.
      2) Resubmission of submittal shall have original number with sequential alphabetic suffix.

b. Specification section and paragraph to which submittal applies.
c. Project title and Engineer's project number.
d. Date of transmittal.
e. Names of Contractor, Subcontractor or Supplier, and manufacturer as appropriate.

4. Identify and describe each deviation or variation from Contract Documents.

C. Format:

1. Do not base Shop Drawings on reproductions of Contract Documents.
2. Package submittal information by individual specification section. Do not combine different specification sections together in submittal package, unless otherwise directed in specification.
3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.
4. Index with labeled tab dividers in orderly manner.

D. Timeliness: Schedule and submit in accordance Schedule of Submittals, and requirements of individual specification sections.

E. Processing Time:

1. Time for review shall commence on Engineer's receipt of submittal.
2. Engineer will act upon Contractor's submittal and transmit response to Contractor not later than 30 days after receipt, unless otherwise specified.
3. Resubmittals will be subject to same review time.
4. No adjustment of Contract Times or Price will be allowed as a result of delays in progress of Work caused by rejection and subsequent resubmittals.

F. Resubmittals: Clearly identify each correction or change made.

G. Incomplete Submittals:

1. Engineer will return entire submittal for Contractor's revision if preliminary review deems it incomplete.
2. When any of the following are missing, submittal will be deemed incomplete:
   a. Contractor's review stamp; completed and signed.
   b. Transmittal of Contractor's Submittal; completed and signed.
   c. Insufficient number of copies.

H. Submittals not required by Contract Documents:

1. Will not be reviewed and will be returned stamped “Not Subject to Review.”
2. Engineer will keep one copy and return submittal to Contractor.

1.03 ACTION SUBMITTALS

A. Prepare and submit Action Submittals required by individual specification sections.

B. Shop Drawings:

1. Copies: Six.
2. Identify and Indicate:
   a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
   b. Equipment and Component Title: Identical to title shown on Drawings.
   c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
   d. Project-specific information drawn accurately to scale.
3. Manufacturer’s standard schematic drawings and diagrams as follows:
   a. Modify to delete information that is not applicable to the Work.
   b. Supplement standard information to provide information specifically applicable to the Work.
4. Product Data: Provide as specified in individual specifications.
5. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.

C. Samples:

1. Copies: Two, unless otherwise specified in individual specifications.
2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
   a. Manufacturer name.
   b. Model number.
   c. Material.
   d. Sample source.

3. Manufacturer's Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.
4. Full-size Samples:
   a. Size as indicated in individual specification section.
   b. Prepared from same materials to be used for the Work.
   c. Cured and finished in manner specified.
   d. Physically identical with product proposed for use.

D. Action Submittal Dispositions: Engineer will review, comment, stamp, and distribute as noted:

1. Approved:
   a. Contractor may incorporate product(s) or implement Work covered by submittal.
   b. Distribution:
      1) One copy furnished Owner.
      2) One copy furnished Resident Project Representative.
      3) One copy retained in Engineer's file.
      4) Remaining copies returned to Contractor appropriately annotated.
2. Approved as Noted:
   a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
   b. Distribution:
      1) One copy furnished Owner.
      2) One copy furnished Resident Project Representative.
      3) One copy retained in Engineer's file.
      4) Remaining copies returned to Contractor appropriately annotated.
3. Partial Approval, Resubmit as Noted:
   a. Make corrections or obtain missing portions, and resubmit.
   b. Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
   c. Distribution:
      1) One copy furnished Owner.
      2) One copy furnished Resident Project Representative.
      3) One copy retained in Engineer's file.
      4) Remaining copies returned to Contractor appropriately annotated.

4. Revise and Resubmit:
    a. Contractor may not incorporate product(s) or implement Work covered by submittal.
    b. Distribution:
        1) One copy furnished Resident Project Representative.
        2) One copy retained in Engineer's file.
        3) Remaining copies returned to Contractor appropriately annotated.

1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Copies: Submit six copies, unless otherwise indicated in individual specification section.
2. Refer to individual specification sections for specific submittal requirements.
3. Engineer will review each submittal. If submittal meets conditions of the Contract, Engineer will forward copy to appropriate parties. If Engineer determines submittal does not meet conditions of the Contract and is therefore considered unacceptable, Engineer will retain one copy and return remaining copy with review comments to Contractor, and require that submittal be corrected and resubmitted.

B. Certificates:

1. General:
    a. Provide notarized statement that includes signature of entity responsible for preparing certification.
    b. Signed by officer or other individual authorized to sign documents on behalf of that entity.
2. Welding: In accordance with individual specification sections.
3. Installer: Prepare written statements on manufacturer's letterhead certifying installer complies with requirements as specified in individual specification section.
4. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual specification sections.
6. Manufacturer's Certificate of Compliance: In accordance with Section 01 43 33, Manufacturers' Field Services.
7. Manufacturer's Certificate of Proper Installation: In accordance with Section 01 43 33, Manufacturers' Field Services.

C. Construction Photographs: In accordance with Section 01 31 13, Project Coordination, and as may otherwise be required in Contract Documents.

D. Closeout Submittals: In accordance with Section 01 77 00, Closeout Procedures.

E. Contractor-design Data (related to temporary construction):

1. Written and graphic information.
2. List of assumptions.
3. List of performance and design criteria.
4. Summary of loads or load diagram, if applicable.
5. Calculations.
6. List of applicable codes and regulations.
7. Name and version of software.
8. Information requested in individual specification section.

F. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual specification section.

G. Operation and Maintenance Data: As required in Section 01 78 23, Operation and Maintenance Data.

H. Payment:

1. Application for Payment: In accordance with Section 01 29 00, Payment Procedures.
2. Schedule of Values: In accordance with Section 01 29 00, Payment Procedures.

I. Quality Control Documentation: As required in Section 01 45 16.13, Contractor Quality Control.

J. Schedules:

1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule as specified in Section 01 32 00, Construction Progress Documentation.
    a. Show for each, at a minimum, the following:
        1) Specification section number.
        2) Identification by numbering and tracking system as specified under Paragraph Transmittal of Submittal.
        3) Estimated date of submission to Engineer, including reviewing and processing time.

b. On a monthly basis, submit updated Schedule of Submittals to Engineer if changes have occurred or resubmittals are required.

2. Progress Schedules: In accordance with Section 01 32 00, Construction Progress Documentation.

K. Special Guarantee: Supplier's written guarantee as required in individual specification sections.

L. Statement of Qualification: Evidence of qualification, certification, or registration as required in Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals.

M. Submittals Required by Laws, Regulations, and Governing Agencies:

1. Promptly submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
2. Transmit to Engineer for Owner's records one copy of correspondence and transmittals (to include enclosures and attachments) between Contractor and governing agency.

N. Test, Evaluation, and Inspection Reports:

1. General: Shall contain signature of person responsible for test or report.
2. Factory:
   a. Identification of product and specification section, type of inspection or test with referenced standard or code.
   b. Date of test, Project title and number, and name and signature of authorized person.
   c. Test results.
   d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
   e. Provide interpretation of test results, when requested by Engineer.
   f. Other items as identified in individual specification sections.
3. Field:
   a. As a minimum, include the following:
      1) Project title and number.
      2) Date and time.
      3) Record of temperature and weather conditions.
      4) Identification of product and specification section.
      5) Type and location of test, Sample, or inspection, including referenced standard or code.
      6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.

7) If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
8) Provide interpretation of test results, when requested by Engineer.
9) Other items as identified in individual specification sections.

O. Testing and Startup Data: In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

P. Training Data: In accordance with Section 01 43 33, Manufacturers' Field Services.

1.05 SUPPLEMENTS

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

1. Forms: Transmittal of Contractor's Submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

CH2MHILL

TRANSMITTAL OF CONTRACTOR'S SUBMITTAL

(ATTACH TO EACH SUBMITTAL)

DATE: _____

TO: _____ _____ _____ _____ _____ **FROM**: _____ Contractor _____ _____ _____	Submittal No.: _____ ☐ New Submittal ☐ Resubmittal Project: _____ Project No.: _____ Specification Section No.: _____ **(Cover only one section with each transmittal)** Schedule Date of Submittal: _____

SUBMITTAL TYPE:	☐ Shop Drawing	☐ Sample	☐ Informational

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to Contract	
				No	Yes

Contractor hereby certifies that (i) Contractor has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By: _____

Contractor (Authorized Signature)

SECTION 01 37 00 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 01 38 00 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 01 41 00 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 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in Article 3 of the General Conditions, and as may otherwise be required herein and in the individual Specification sections.

B. Work specified by reference to published standard or specification of government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.

C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.

D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.

E. Where both a standard and a brand name are specified for a product in Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.

F. Copies of standards and specifications of technical societies:

1. Copies of applicable referenced standards have not been bound in these Contract Documents.
2. Where copies of standards are needed by Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Contractor’s personnel, Subcontractors, Owner, and Engineer.

1.02 ABBREVIATIONS

A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1.	AA	Aluminum Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ABMA	American Bearing Manufacturers' Association
6.	ACI	American Concrete Institute
7.	AEIC	Association of Edison Illuminating Companies
8.	AGA	American Gas Association
9.	AGMA	American Gear Manufacturers' Association
10.	AI	Asphalt Institute
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	APA – The Engineered Wood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AHRI	Air-Conditioning, Heating, and Refrigeration Institute
21.	ASA	Acoustical Society of America
22.	ASABE	American Society of Agricultural and Biological Engineers
23.	ASCE	American Society of Civil Engineers
24.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
25.	ASME	American Society of Mechanical Engineers
26.	ASNT	American Society for Nondestructive Testing
27.	ASSE	American Society of Sanitary Engineering
28.	ASTM	ASTM International
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPI	American Wood Preservers' Institute
32.	AWS	American Welding Society
33.	AWWA	American Water Works Association

34.	BHMA	Builders Hardware Manufacturers' Association
35.	CBM	Certified Ballast Manufacturer
36.	CDA	Copper Development Association
37.	CGA	Compressed Gas Association
38.	CISPI	Cast Iron Soil Pipe Institute
39.	CMAA	Crane Manufacturers' Association of America
40.	CRSI	Concrete Reinforcing Steel Institute
41.	CS	Commercial Standard
42.	CSA	Canadian Standards Association
43.	CSI	Construction Specifications Institute
44.	DIN	Deutsches Institut für Normung e.V.
45.	DIPRA	Ductile Iron Pipe Research Association
46.	EIA	Electronic Industries Alliance
47.	EJCDC	Engineers Joint Contract Documents' Committee
48.	ETL	Electrical Test Laboratories
49.	FAA	Federal Aviation Administration
50.	FCC	Federal Communications Commission
51.	FDA	Food and Drug Administration
52.	FEMA	Federal Emergency Management Agency
53.	FIPS	Federal Information Processing Standards
54.	FM	FM Global
55.	Fed. Spec.	Federal Specifications (FAA Specifications)
56.	FS	Federal Specifications and Standards (Technical Specifications)
57.	GA	Gypsum Association
58.	GANA	Glass Association of North America
59.	HI	Hydraulic Institute
60.	HMI	Hoist Manufacturers' Institute
61.	IBC	International Building Code
62.	ICBO	International Conference of Building Officials
63.	ICC	International Code Council
64.	ICEA	Insulated Cable Engineers' Association
65.	IFC	International Fire Code
66.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
67.	IESNA	Illuminating Engineering Society of North America
68.	IFI	Industrial Fasteners Institute
69.	IGMA	Insulating Glass Manufacturer's Alliance
70.	IMC	International Mechanical Code
71.	INDA	Association of the Nonwoven Fabrics Industry
72.	IPC	International Plumbing Code
73.	ISA	International Society of Automation
74.	ISO	International Organization for Standardization

75.	ITL	Independent Testing Laboratory
76.	JIC	Joint Industry Conferences of Hydraulic Manufacturers
77.	MIA	Marble Institute of America
78.	MIL	Military Specifications
79.	MMA	Monorail Manufacturers' Association
80.	MSS	Manufacturer's Standardization Society
81.	NAAMM	National Association of Architectural Metal Manufacturers
82.	NACE	NACE International
83.	NBGQA	National Building Granite Quarries Association
84.	NEBB	National Environmental Balancing Bureau
85.	NEC	National Electrical Code
86.	NECA	National Electrical Contractor's Association
87.	NEMA	National Electrical Manufacturers' Association
88.	NESC	National Electrical Safety Code
89.	NETA	InterNational Electrical Testing Association
90.	NFPA	National Fire Protection Association
91.	NHLA	National Hardwood Lumber Association
92.	NICET	National Institute for Certification in Engineering Technologies
93.	NIST	National Institute of Standards and Technology
94.	NRCA	National Roofing Contractors Association
95.	NRTL	Nationally Recognized Testing Laboratories
96.	NSF	NSF International
97.	NSPE	National Society of Professional Engineers
98.	NTMA	National Terrazzo and Mosaic Association
99.	NWWDA	National Wood Window and Door Association
100.	OSHA	Occupational Safety and Health Act (both Federal and State)
101.	PCI	Precast/Prestressed Concrete Institute
102.	PEI	Porcelain Enamel Institute
103.	PPI	Plastic Pipe Institute
104.	PS	Product Standards Section-U.S. Department of Commerce
105.	RMA	Rubber Manufacturers' Association
106.	RUS	Rural Utilities Service
107.	SAE	SAE International
108.	SDI	Steel Deck Institute
109.	SDI	Steel Door Institute
110.	SJI	Steel Joist Institute
111.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
112.	SPI	Society of the Plastics Industry
113.	SSPC	The Society for Protective Coatings

114.	STI/SPFA	Steel Tank Institute/Steel Plate Fabricators Association
115.	SWI	Steel Window Institute
116.	TEMA	Tubular Exchanger Manufacturers' Association
117.	TCA	Tile Council of North America
118.	TIA	Telecommunications Industry Association
119.	UBC	Uniform Building Code
120.	UFC	Uniform Fire Code
121.	UL	Underwriters Laboratories Inc.
122.	UMC	Uniform Mechanical Code
123.	USBR	U.S. Bureau of Reclamation
124.	WCLIB	West Coast Lumber Inspection Bureau
125.	WI	Wood Institute
126.	WWPA	Western Wood Products Association

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 43 33
MANUFACTURERS' FIELD SERVICES

PART 1 GENERAL

1.01 DEFINITIONS

A. Person-Day: One person for 8 hours within regular Contractor working hours.

1.02 SUBMITTALS

A. Informational Submittals:

1. Training Schedule: Submit, in accordance with requirements of this Specification, not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.
2. Lesson Plan: Submit, in accordance with requirements of this Specification, proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.

1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment manufacturer to issue the certifications required of the manufacturer. Additional qualifications may be specified in the individual specification section.

B. Representative subject to acceptance by Owner and Engineer. No substitute representatives will be allowed unless prior written approval by such has been given.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Furnish manufacturers' services, when required by an individual specification section, to meet the requirements of this section.

B. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, or when a minimum time is not specified, time required to perform specified services shall be considered incidental.

C. Schedule manufacturer' services to avoid conflict with other onsite testing or other manufacturers' onsite services.

D. Determine, before scheduling services, that conditions necessary to allow successful testing have been met.

E. Only those days of service approved by Engineer will be credited to fulfill specified minimum services.

F. When specified in individual specification sections, manufacturer's onsite services shall include:

1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
3. Providing, on a daily basis, copies of manufacturers' representatives field notes and data to Engineer.
4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Engineer.
5. Resolution of assembly or installation problems attributable to or associated with respective manufacturer's products and systems.
6. Assistance during functional and performance testing, and facility startup and evaluation.
7. Training of Owner's personnel in the operation and maintenance of respective product as required.

3.02 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

A. When so specified, a Manufacturer's Certificate of Compliance, a copy of which is attached to this section, shall be completed in full, signed by entity supplying the product, material, or service, and submitted prior to shipment of product or material or execution of the services.

B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

C. Such form shall certify proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.

D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

3.03 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

A. When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by equipment manufacturer's representative.

B. Such form shall certify signing party is a duly authorized representative of manufacturer, is empowered by manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to ensure equipment is complete and operational.

3.04 TRAINING

A. General:

1. Furnish manufacturers' representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information specified in Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.

B. Training Schedule:

1. List specified equipment and systems that require training services and show:
   a. Respective manufacturer.
   b. Estimated dates for installation completion.
   c. Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.
4. Coordinate with Section 01 32 00, Construction Progress Documentation, and Section 01 91 14, Equipment Testing and Facility Startup.

C. Lesson Plan: When manufacturer or vendor training of Owner personnel is specified, prepare a lesson plan for each required course containing the following minimum information:

1. Title and objectives.
2. Recommended attendees (such as, managers, engineers, operators, maintenance).
3. Course description, outline of course content, and estimated class duration.
4. Format (such as, lecture, self-study, demonstration, hands-on).
5. Instruction materials and equipment requirements.
6. Resumes of instructors providing training.

D. Prestartup Training:

1. Coordinate training sessions with Owner's operating personnel and manufacturers' representatives and with submission of operation and maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
2. Complete at least 14 days prior to beginning of facility startup.

E. Post-startup Training: If required in Specifications, furnish and coordinate training of Owner's operating personnel by respective manufacturer's representatives.

3.05 SUPPLEMENTS

A. The supplements listed below, following "End of Section", are part of this Specification.

1. Form: Manufacturer's Certificate of Compliance.
2. Form: Manufacturer's Certificate of Proper Installation.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

Comments: _____

_____

_____

_____

_____

_____

I hereby certify that the above-referenced product, material, or service called for by the Contract for the named Project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the Contract requirements, and are in the quantity shown.

Date of Execution: _____, 20___

Manufacturer: _____

Manufacturer's Authorized Representative *(print)*: _____

_____

(Authorized Signature)

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Nursery and Landscape Association (ANLA): American Standards for Nursery Stock.
2. Federal Emergency Management Agency (FEMA).
3. National Fire Prevention Association (NFPA): 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.
4. Telecommunications Industry Association (TIA): 568-C, Commercial Building Telecommunications Cabling Standard.
5. U.S. Department of Agriculture (USDA): Urban Hydrology for Small Watersheds.
6. U.S. Weather Bureau: Rainfall-Frequency Atlas of the U.S. for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years.

1.02 SUBMITTALS

A. Informational Submittals:

1. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
2. Temporary Utility Submittals: Sanitary.
3. Temporary Control Submittals: Plan for disposal of waste materials and intended haul routes.

1.03 MOBILIZATION

A. Mobilization shall include, but not be limited to, these principal items:

1. Obtaining required permits.
2. Moving Contractor’s field office and equipment required for first month operations onto Site.
3. Installing temporary construction power, wiring, and lighting facilities.
4. Providing onsite communication facilities, including telephones.
5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
6. Arranging for erection of Contractor’s work and storage yard.

7. Posting OSHA required notices and establishing safety programs and procedures.
8. Having Contractor's superintendent at Site full time.

B. Use area designated for Contractor's temporary facilities as shown on Drawings.

1.04 PROTECTION OF WORK AND PROPERTY

A. Comply with Owner's safety rules while on Owner's property.

B. Keep Owner informed of serious onsite accidents and related claims.

C. Use of Explosives: No blasting or use of explosives will be allowed onsite.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEMPORARY UTILITIES

A. Power:

1. Electric power will be available at or near Site. Determine type and amount available and make arrangements for obtaining temporary electric power service, metering equipment, and pay costs for electric power used during Contract period, except for portions of the Work designated in writing by Engineer as substantially complete.
2. Cost of electric power will be borne by Contractor.

B. Lighting: Provide temporary lighting to meet applicable safety requirements to allow erection, application, or installation of materials and equipment, and observation or inspection of the Work.

C. Water:

1. Include costs to connect and transport water to construction areas in Contract Price.
2. Owner will provide a place of temporary connection for construction water at Site. Provide temporary facilities and piping required to bring water to point of use and remove when no longer needed. Install an acceptable metering device and pay for water used at Owner's current rate.
3. Provide and bear costs of necessary water required for testing equipment, tanks or basins, and piping prior to Substantial Completion, unless otherwise specifically stated in Specifications for equipment, systems, or facilities to be tested.

D. Provide means to prevent water used for testing from flowing back into source pipeline.

E. Sanitary and Personnel Facilities: Provide and maintain facilities for Contractor's employees, Subcontractors, and other onsite employers' employees. Service, clean, and maintain facilities and enclosures.

F. Telephone Service:

1. Contractor: Arrange and provide onsite telephone service for use during construction. Pay costs of installation and monthly bills.

G. Fire Protection: Furnish and maintain on Site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of NFPA 241.

3.02 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.
2. Maintain in continuous service existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made.
3. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate activities with owner of said utility and perform work to their satisfaction.
4. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
5. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
6. In areas where Contractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.

7. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance: Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
8. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
9. Maintain original Site drainage wherever possible.

B. Existing Structures:

1. Where Contractor contemplates removal of small structures such as mailboxes, signposts, and culverts that interfere with Contractor's operations, obtain approval of property owner and Engineer.
2. Move mailboxes to temporary locations accessible to postal service.
3. Replace items removed in their original location and a condition equal to or better than original.

C. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.

D. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

E. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain foundations and parts of the Work free from water.

3.03 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning: Of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.
3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.

4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as need no longer exists.

B. Noise Control:

1. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.
2. Noise Control Plan: Propose plan to mitigate construction noise and to comply with noise control ordinances, including method of construction, equipment to be used, and acoustical treatments.

C. Water Pollution Control:

1. Prior to commencing excavation and construction, obtain Owner's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and dewatering pump discharges.
2. Comply with Section 01 57 13, Temporary Erosion and Sedimentation Control, for stormwater flow and surface runoff.
3. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities as specified in Section 01 57 13, Temporary Erosion and Sedimentation Control, to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

3.04 STORAGE YARDS AND BUILDINGS

A. Coordinate requirements with Section 01 61 00, Common Product Requirements.

B. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

C. Temporary Storage Buildings:

1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.

2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
3. Store combustible materials (paints, solvents, fuels) in a well-ventilated and remote building meeting safety standards.

3.05 ACCESS ROADS

A. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.

B. Provide gravel, crushed rock, or other stabilization material to permit access by all motor vehicles at all times.

C. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.

D. Upon completion of construction, restore ground surface disturbed by access road construction to original grade.

3.06 PARKING AREAS

A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner's operations, or construction operations.

B. Provide parking facilities for personnel working on Project. No employee or equipment parking will be permitted on Owner's existing paved areas, except as specifically designated for Contractor's use.

3.07 VEHICULAR TRAFFIC

A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Ensure the least possible obstruction to traffic and normal commercial pursuits.

B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.

C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

D. Road Closures: Maintain satisfactory means of exit for persons residing or having occasion to transact business along route of the Work. If it is necessary to close off roadway or alley providing sole vehicular access to property for periods greater than 2 hours, provide written notice to each owner so affected 3 days prior to such closure. In such cases, closings of up to 4 hours may be allowed. Closures of up to 10 hours may be allowed if a week's written notice is given and undue hardship does not result.

E. Maintenance of traffic is not required if Contractor obtains written permission from Owner and tenant of private property, or from authority having jurisdiction over public property involved, to obstruct traffic at designated point.

F. In making street crossings, do not block more than one-half the street at a time. Whenever possible, widen shoulder on opposite side to facilitate traffic flow. Provide temporary surfacing on shoulders as necessary.

G. Maintain top of backfilled trenches before they are paved, to allow normal vehicular traffic to pass over. Provide temporary access driveways where required. Cleanup operations shall follow immediately behind backfilling.

H. When flaggers and guards are required by regulation or when deemed necessary for safety, furnish them with approved orange wearing apparel and other regulation traffic control devices.

I. Notify fire department and police department before closing street or portion thereof. Notify said departments when streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings or dead-end streets, in excess of 300 linear feet, without written permission from fire department. Conduct operations with the least interference to fire equipment access, and at no time prevent such access. Furnish Contractor's night emergency telephone numbers to police department.

J. Coordinate traffic routing with that of others working in same or adjacent areas.

3.08 CLEANING DURING CONSTRUCTION

A. In accordance with General Conditions, as may be specified in other Specification sections, and as required herein.

B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up and dispose of debris.

C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least weekly, dispose of such waste materials, debris, and rubbish offsite.

D. At least weekly, brush sweep entry drive, roadways, and other streets and walkways affected by the Work and where adjacent to the Work.

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 58 00 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.

Location Map

WE HOPE TO KEEP ANY INCONVENIENCE TO A MINIMUM. HOWEVER, IF YOU HAVE ANY PROBLEMS, PLEASE CONTACT THE FOLLOWING:

A. Contractor
Contractor Address
Contractor Phone (Site Phone)

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 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 DEFINITIONS

A. Products:

1. New items for incorporation in the Work, whether purchased by Contractor or Owner for the Project, or taken from previously purchased stock, and may also include existing materials or components required for reuse.
2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
3. Items identified by manufacturer's product name, including make or model designation, indicated in manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.02 DESIGN REQUIREMENTS

A. Where Contractor design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with the requirements shown on structural Drawings.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 17-feet above sea level.

B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 30 degrees F to 100 degrees F.

1.04 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.

C. Extra Materials, Special Tools, Test Equipment, and Expendables:

1. Furnish as required by individual Specifications.
2. Schedule:
    a. Ensure that shipment and delivery occurs concurrent with shipment of associated equipment.
    b. Transfer to Owner shall occur immediately subsequent to Contractor's acceptance of equipment from Supplier.
3. Packaging and Shipment:
    a. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
    b. Prominently displayed on each package, the following:
        1) Manufacturer's part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
        2) Applicable equipment description.
        3) Quantity of parts in package.
        4) Equipment manufacturer.
4. Deliver materials to Site.
5. Notify Engineer upon arrival for transfer of materials.
6. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.

D. Request a minimum 7-day advance notice of shipment from manufacturer. Upon receipt of manufacturer's advance notice of shipment, promptly notify Engineer of anticipated date and place of Jet Mixing/Aeration equipment arrival.

E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.

1.05 DELIVERY AND INSPECTION

A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.

C. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from Site and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.06 HANDLING, STORAGE, AND PROTECTION

A. Handle and store products in accordance with manufacturer's written instructions and in a manner to prevent damage. Store in approved storage yards or sheds provided in accordance with Section 01 50 00, Temporary Facilities and Controls. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.

B. Manufacturer's instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.

D. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust damage. Connect and operate continuously space heaters furnished in electrical equipment.

E. Store fabricated products above ground on blocking or skids, and prevent soiling or staining. Store loose granular materials in well-drained area on solid surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

F. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.

G. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.

H. Hazardous Materials: Prevent contamination of personnel, storage area, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide manufacturer's standard materials suitable for service conditions, unless otherwise specified in the individual Specifications.

B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance specifications.

C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer's services, and implement same or similar process instrumentation and control functions in same or similar manner.

D. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.

E. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.

F. Equipment, Components, Systems, and Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.

G. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.

H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.

I. 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.

J. Equipment Finish:

1. Provide manufacturer's standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with gray finish as approved by Owner.

K. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.

L. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.

2.02 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible; oil drains with bronze or stainless steel valves and fill-plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.03 SOURCE QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by Engineer, notify Engineer not less than 14 days prior to scheduled test date, unless otherwise specified.

B. Calibration Instruments: Bear the seal of a reputable laboratory certifying instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).

C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 EXECUTION

3.01 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor’s control.

3.02 INSTALLATION

A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. No shimming between machined surfaces is allowed.

C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Repaint painted surfaces that are damaged prior to equipment acceptance.

E. Do not cut or notch any structural member or building surface without specific approval of Engineer.

F. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions, and as may be specified. Retain a copy of manufacturers' instruction at Site, available for review at all times.

3.03 FIELD FINISHING

A. In accordance with Section 09 90 00, Painting and Coating, and individual Specification sections.

3.04 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

3.05 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

END OF SECTION

SECTION 01 62 50
INSTALLATION OF OWNER-FURNISHED PRODUCTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work necessary to inspect and unload, store and protect, assemble and install, conduct and coordinate testing, complete and ready for operation, the Owner-furnished products identified hereinafter.

1.02 RELATED SECTIONS

A. Coordinate this section with Sections 44 45 18, Jet Aeration/Mixing Systems for Sludge Holding Tanks and 44 42 56.10, Horizontal End-Suction Centrifugal Pumps. Perform field functional performance test on installed jet aeration/mixing systems (including the horizontal end-suction pumps) as specified in this section.

1.03 DEFINITIONS

A. Manufacturer: Where “manufacturer” is referred to in this section, it refers to the parties under separate contract with the Owner for furnishing the material or equipment products purchased by the Owner. Such party may be referred to as “Contractor for Owner-furnished products,” or “Owner-furnished equipment Contractor,” in other sections.

B. Transfer: “Transfer” of Owner-furnished products to the Contractor refers to the time when manufacturers’ instructions for unloading, handling, storage, and protection have been received; products have been delivered to the jobsite and jointly inspected; any damage or loss has been reported in writing to the Engineer and the Engineer has accepted such products as ready for unloading, storage, and protection by the Contractor.

1.04 PRODUCTS FURNISHED BY OWNER

A. The Contractor shall install the below listed Owner-furnished products: Four Jet Aeration/Mixing Systems, each consisting of one blower package, one horizontal end-suction centrifugal pump, one aeration header assembly with supports, and one backflushing system.

1.05 CONTRACTOR'S RESPONSIBILITY FOR COMPLETE SYSTEM

A. Contractor shall have complete responsibility for necessary storing, handling, installing, adjusting, maintaining, testing, and operation startup of Owner-furnished products. Contractor shall provide and coordinate the construction of interconnecting structures, equipment, piping, electrical and instrumentation work, and appurtenances to achieve installation and operation of the Owner-furnished products as shown and specified, and as required to provide a complete and functional system.

B. Startup Coordination: The Contractor shall assume all responsibilities for the startup of Owner-furnished equipment. This coordination shall include, but not be limited to, the following:

1. Scheduling all startup and testing requirements with suppliers and subcontractors.
2. Coordination with Owner's Representatives.
3. Providing qualified startup and testing personnel.
4. 15-day notification requesting Owner's Representatives to witness startup.
5. Furnish corrected Shop Drawings and Record Drawings of the reflecting all-approved field changes.
6. Provide necessary tools, meters, equipment required for adequate testing and startup.

C. In the event the Contractor fails to adequately perform the test and startup to the Owner's satisfaction, the Owner reserves the right to complete the testing and startup and deduct the cost from the Contractor's Contract balance. In the event the remaining funds are not adequate, the Contractor agrees to reimburse the Owner for all additional expenses that the Owner incurs during the testing and the startup of the Owner's furnished equipment.

1.06 MANUFACTURER'S RESPONSIBILITY FOR PRODUCTS

A. The Manufacturer will be Responsible for Providing the Following:

1. Manufacturer support during installation, testing, and startup.
2. Temporary storage prior to delivery (if necessary).
3. Factory testing and certification of test results.
4. Notification 15 calendar days prior to shipment and 48 hours prior to delivery.
5. Instruction manual, including installation and storage instructions.

1.07 INFORMATION FURNISHED BY OWNER

A. Vendor/manufacturer Shop Drawings of the Owner-furnished products will be made available after Contract Award for Contractor's use in performing the Work under this Section.

B. Manufacturer's installation, operation, and maintenance instructions for the Owner-furnished products will be made available for Contractor's use.

C. The Contractor shall review these submittals as they relate to the installation of this material and other integrated work.

1.08 SEQUENCING AND SCHEDULING

A. Contractor shall verify availability of Owner-furnished products by contacting the Engineer before making final arrangements for, or committing resources to the unloading, handling, storage, protection, or installation of such products. No additional time or compensation will be considered, unless Contractor has made every effort to monitor delivery schedules of Owner-furnished products.

PART 2 PRODUCTS

2.01 GENERAL

A. Contractor shall provide products required to complete the work under this Section, except where specifically specified as "Owner-furnished."

2.02 MISCELLANEOUS PRODUCTS

A. General: Contractor shall furnish incidental products, such as gaskets, supports, bolts, and lubricants, as shown and as required for field testing and proper operation of equipment installed under this Section. Products shall conform to applicable sections of these Specifications for the intended service.

PART 3 EXECUTION

3.01 GENERAL

A. Installation work shall conform with manufacturer's recommended procedures, instructions, and Shop Drawings, as accepted by the Engineer.

B. Contractor shall receive, unload, transport to its place of installation, inspect, store, handle, and protect Owner-furnished products as specified in Division 1, General Requirements.

C. Contractor shall maintain complete inventory on all Owner-furnished products after their transfer to Contractor.

3.02 INSPECTION PRIOR TO UNLOADING

A. Prior to transfer of Owner-furnished products to the Contractor, Contractor and the Engineer shall jointly inspect the condition of each product.

1. Contractor shall record in writing the products transferred to the Contractor's care.
2. Damage to or loss of equipment and materials shall be immediately reported to the Engineer.
3. After completion of inspection, unload products in accordance with manufacturer's instructions for unloading, or as specified. Do not unload damaged or incomplete products to be returned to manufacturer for replacement, except as necessary to expedite return shipment.
4. Do not unload products to be returned to manufacturer for repair or replacement, unless necessary to expedite return shipping.

3.03 STORAGE AND PROTECTION

A. The Owner will have the Owner-furnished equipment delivered to the Site for storage. If Contractor wants the equipment stored elsewhere until installation, storage shall be arranged and paid for by Contractor.

B. Following transfer of Owner-furnished products and until final acceptance of the completed work, Contractor shall protect and maintain products to prevent damage in accordance with manufacturer's instructions and as specified below:

1. Store products such as pipe and reinforcing steel off the ground in approved storage yards.
2. Store items subject to damage by the elements, vandalism, or theft in secure buildings.
3. Provide environmentally controlled storage facilities for items requiring environmental control for protection.
4. Storage yards and storage building shall conform to requirements of Division 1, General Requirements.

C. Damage to or loss of products after the date of their transfer to Contractor shall be repaired to original condition or replaced with new identical products as reviewed and accepted by the Engineer.

D. Damage to or loss of products unloaded to expedite return shipment for repair or replacement shall be repaired to original condition, or replaced with new identical products as reviewed and accepted by the Engineer.

3.04 GENERAL INSTALLATION

A. Contractor shall provide supervision, labor, tools, construction equipment, incidental materials, and necessary services required to install and test the Owner-furnished products.

B. Installation of equipment shall not begin prior to satisfactory completion of the supporting structures.

C. Refer to Division 1, General Requirements, for procedures prior to equipment startup.

3.05 REFERENCES

A. The references listed below, following “End of Section,” are Specification sections of the Owner furnished products.

1. Section 44 42 56.10, Horizontal End Suction Centrifugal Pumps.
2. Section 44 45 18, Jet Mixing/Aeration Systems for Sludge Holding Tanks.

END OF SECTION

SECTION 44 42 56.10
HORIZONTAL END SUCTION CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. The pumps shall be furnished as part of the Jet Mixing/Aeration System in accordance to Section 44 45 18, Jet Mixing/Aeration Systems for Sludge Holding Tanks.

1.02 REFERENCES

A. The following Specification sections are referenced in this section:

1. Section 01 00 01, General Requirements.
2. Section 26 20 00, Low Voltage AC Induction Motors.
3. Section 40 99 90, Package Control System.
4. Section 44 45 18, Jet Mixing/Aeration Systems for Sludge Holding Tanks.

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

1. American Bearing Manufacturers' Association (ABMA).
2. Hydraulic Institute Standards.
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
4. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.

d. Detailed Structural, Mechanical, and Electrical Drawings showing equipment dimensions, size, and locations of connections and weights of associated equipment.
e. Power and control wiring diagrams, including terminals and numbers.
f. Complete motor nameplate data, as defined by NEMA, motor manufacturer. See Section 26 20 00, Low Voltage AC Induction Motors for additional motor submittal requirements.
g. Factory finish system data sheets.

B. Informational Submittals:

1. Factory Functional Test Reports.
2. Manufacturer's Certification of Compliance that factory finish system is identical to the requirements specified herein.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Suggested spare parts list to maintain the equipment in service for a period of 5 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 Data: As specified in Section 01 00 01, General Requirements.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 00 01, General Requirements.

1.05 EXTRA MATERIALS

A. Furnish for this set of pumps:

1. Complete set bearings.
2. Complete set gaskets and O-ring seals.
3. Complete set of shaft sleeves.
4. Complete set keys, dowels, pins, etc.
5. Complete mechanical seal.
6. Impeller.
7. Impeller shaft.
8. Impeller wear ring.
9. Head shaft.
10. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.03 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. OSHA-approved coupling guard for direct coupled or belt driven pumps.

D. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter.

2.04 FACTORY FINISHING

A. Prepare, and prime, and finish coat in accordance with Section 44 45 18, Jet Mixing/Aeration Systems for Sludge Holding Tanks.

2.05 SOURCE QUALITY CONTROL

A. Factory Test Report: Include test data sheets, curve test results, certified correct by a registered professional engineer.

B. Functional Test: Perform manufacturer’s standard, test on each equipment. Include vibration test, as follows:

1. Dynamically balance rotating parts of each pump and its driving unit before final assembly.
2. Limits:
   a. Driving Unit Alone: Less than 80 percent of NEMA MG 1 limits.
   b. Complete Rotating Assembly Including Coupling, Drive Unit, and Motor: Less than 90 percent of limits established in the Hydraulic Institute Standards.

C. Performance Test:

1. In accordance with Hydraulic Institute Standards.
2. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.

D. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

E. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions by others.

3.02 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump by others with the assistance of the manufacturer.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Vibration Test:
   a. Test with unit installed and in normal operation, and discharging to the connected piping systems at rates between low discharge head and high discharge head conditions specified, and with actual building structures and foundations provided shall not develop vibration exceeding 80 percent of the limits specified in HIS 9.6.4.
   b. If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units which cannot be adjusted or modified to conform as specified shall be replaced.
3. Flow Output: Measured by plant instrumentation and storage volumes.

B. Performance Test:

1. Conduct on each pump by others with the assistance of the manufacturer.
2. Perform under simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.
4. Test Log: Record the following:
   a. Total head.
   b. Capacity.
   c. Horsepower requirements.

d. Flow measured by factory instrumentation and storage volumes.
e. Average distance from suction well water surface to pump discharge centerline for duration of test.
f. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
g. Calculated velocity head at the discharge flange.
h. Field head.
i. Driving motor voltage and amperage measured for each phase.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 2 person-days for installation assistance and inspection, two trips.
2. 2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation, two trips.
3. 1 person-day for prestartup classroom or Site training.
4. 2 person-days for facility startup, two trips.

B. See Section 01 00 01, General Requirements.

3.04 SUPPLEMENTS

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

1. Pump Data Sheet.

END OF SECTION

HORIZONTAL END SUCTION CENTRIFUGAL PUMP DATA SHEET,
44 42 56.10-1

Tag Numbers: 830-PMP-002-001, 830-PMP-005-001, 830-PMP-008-001, and 830-PMP-011-001

Pump Name: Sludge Holding Tank Liquid Motive Pumps

Manufacturer and Model Number: (1) Fairbanks Morse
(2) Sulzer
(3) Or Engineer Approved Equal

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Waste Activated Sludge

Pumping Temperature (Fahrenheit): Normal: 70 Max: 86 Min: 50

Specific Gravity at 60 Degrees F: 1 Viscosity Range: 1

pH: 5-8

Abrasive (Y/N): N Possible Scale Buildup (Y/N): N

Total suspended solids (mg/L): 18,000

Largest diameter solid pump can pass (inches): 3

Min. NPSH Available (Ft. Absolute): 32

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT

Capacity (US gpm): Rated: 6,600, or per Jet Mixing/Aeration System For Sludge Holding Tanks Supplier, See Section 44 45 18, Jet Mixing/Aeration Systems For Sludge Holding Tanks

Total Dynamic Head (Ft): Rated: 21, or per Jet Mixing Aeration System Supplier

Min. Hydraulic Efficiency (%): 60

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS

ANSI (Y/N): Y Standard (Y/N) _____ Design: Frame-mounted (Y/N): Y
Close-Coupled Casing (Y/N): N Back Pullout (Y/N): N

Discharge Orientation: Up Rotation (view from end coupling): _____

Casing Materials: Cast Iron

Case Wear Ring (Y/N): Y Material: per manufacturer

Impeller: Type: Cast Iron Material: per manufacturer

Impeller Wear Ring (Y/N): Y Material: per manufacturer

Shaft Material: Stainless Steel Shaft Sleeve Material: Stainless Steel

Shaft Seal: _____ Packing (Y/N): N Material: _____

Mechanical (Y/N): Y Type: Chesterton 442 or John Crane 37FS with Tungsten Carbide faces

Lubrication: N/A

ABMA L-10 Bearing Life (Hrs): 100,000 Lubrication: Oil

Coupling: _____ Falk (Y/N) Y_____ Fast (Y/N) _____
Spring-Grid (Y/N) _____
Gear Type (Y/N) __ Spacer (Y/N) _____ Manufacturer _____
Standard (Y/N) _____
Baseplate: Design: _____ Material: Carbon Steel_____
Drive Type: Direct-Coupled: Y_____ Belt: N_____ Adjustable Speed: N_____
Other: _____

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 50 or less_____Voltage: 460__ Phase: 3 Synchronous Speed (rpm): ____

Service Factor: 1.15_____ Inverter Duty (Y/N): N_____

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.
Enclosure: DIP ____ EXP ____ ODP ____ TEFC X CISD-TEFC ____ TENV ____ WPI ____ WPII ____ SUBM ____
Mounting Type: Horizontal_____ Nonreverse Ratchet (Y/N) Y_____

REMARKS: Provide winding thermostat and space heater._____
_____
_____
_____

SECTION 44 45 18
JET MIXING/AERATION SYSTEMS FOR SLUDGE HOLDING TANKS

PART 1 GENERAL

EQUIPMENT AND COMPONENT NUMBERS

Tag Number	Equipment Name
830-PMP-002-01	Liquid Motive Pump No.1
830-PMP-005-01	Liquid Motive Pump No.2
830-PMP-008-01	Liquid Motive Pump No.3
830-PMP-0011-01	Liquid Motive Pump No.4
830-BLR-003-01	Sludge Holding Blower No.1
830-BLR-004-01	Sludge Holding Blower No.2
830-BLR-007-01	Sludge Holding Blower No.3
830-BLR-0010-01	Sludge Holding Blower No.4

Aerated Sludge Holding Tanks

1.01 WORK OF THIS SECTION

A. This section covers the Work necessary to detail, manufacture, deliver to the jobsite, and to provide field service to assist startup and test the jet mixing/aeration systems associated with the Sludge Holding Tanks, including all equipment and services as specified herein.

B. The manufacturer shall provide four liquid motive pumps, four blower packages, and four aeration headers and associated pipe supports. Others will install the components according to the manufacturer's instructions.

C. Interconnecting pipes and associated pipe supports, valves, concrete slabs, and tank floor penetrations, are not part of the equipment manufacturer's scope of supply.

D. Jet aeration/mixing system components shall be supplied by a single manufacturer to assure single source responsibility for the performance of the system. The manufacturer shall assume complete responsibility for conformance of the jet mixing/aeration system with these Specifications.

E. The manufacturer shall ensure compliance with the Specifications and compliance with required performance.

1.02 REFERENCES

A. The following Specification sections are referenced in this section:

1. Section 01 00 01, General Requirements.
2. Section 26 20 00, Low Voltage AC Induction Motors.
3. Section 40 99 90, Package Control System.
4. Section 44 42 56.10, Horizontal End Suction Centrifugal Pumps.

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

1. AGMA, American Gear Manufacturers Association.
2. ASME, American Society of Mechanical Engineers.
3. ASTM, American Society of Testing and Materials.
4. ANSI, American National Standards Institute.
5. IEEE, Institute of Electrical and Electronics Engineers.
6. NEC, National Electrical Code.
7. NEMA, National Electrical Manufacturer’s Association.
8. OSHA, Occupational Safety and Health Act.
9. SSPC: Steel Structures Painting Council.
    a. SP10, Near-White Blast Cleaning.

1.03 DEFINITIONS

A. AOR = Actual Oxygen Requirement under field operating conditions.

B. MDFT = Minimum Dry Film Thickness Per Coat, mils.

C. Mil: Thousandth of an inch.

D. SP: Surface Preparation.

E. SOR = Standard oxygen requirement.

F. ICFM = Blower inlet at site conditions of 100 degrees F, 85 percent RH, 14.5 psia.

G. SCFM = Standard blower rate at 14.7 psia, 68 degrees F and 36 percent RH.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction. Identify the largest diameter solids that the nozzles can pass.
   c. Complete Drawings, details, and construction drawings for the enclosure for the blowers. The submittal shall also include data documenting that the specified noise attenuation requirements shall be met.
   d. Process calculations documenting the AOR, SOR, SCFM, ICFM blower, liquid motive pump, and aeration header selection for the Sludge Holding Tanks.
   e. Structural calculations documenting the structural wall thickness of the header provides the factors of safety specified in this section.
   f. Detailed Mechanical and Electrical Drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
   g. Power and control wiring diagrams, including terminals and numbers.
   h. Outside utility requirements for each component including water, drains, and power.
   i. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications. See Section 26 20 00, Low Voltage AC Induction Motors for additional motor submittal requirements.
   j. Factory finish system.
   k. Certification that FRP piping meets the ASTM standards specified.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer’s printed installation instructions.
3. Manufacturer’s Certificate of Proper Installation.
4. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
6. Operation and Maintenance Data: Operation and Maintenance Manual as specified in Section 01 00 01, General Requirements.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Product delivery, storage, and handling, shall comply with Section 01 00 01, General Requirements.

1.06 SPARE PARTS AND SPECIAL TOOLS

A. Provide spare spares and special tools in accordance with Section 01 00 01, General Requirements, and as follows:

1. Furnish the following for each set of blowers:
   a. One complete set of gaskets and seals.
   b. One set of V-belts.
   c. Four filter elements.
   d. One case of blower oil.
   e. One complete set of any special tools required to dismantle the pumps or blowers.

1.07 SPECIAL COORDINATION

A. The design shown on the Drawings of the Sludge Holding Tanks is based on the one of the named manufacturers and use of a backflush system. The other named manufacturers may provide a backflush with air. The air backflush system will have piping arrangement in and out of the Sludge Holding Tanks different from what's shown on the Drawings.

PART 2 PRODUCTS

2.01 GENERAL

A. Each jet mixing/aeration system shall consist of an aeration header (specified herein), rotary positive displacement blower, and a solids handling end suction pump. Inlet filter, inlet silencer, discharge silencer, inlet and discharge sleeve type expansion joints, check valve, and pressure relief valve shall be provided for each blower.

B. The system shall include all necessary safety devices, such as machinery guards and similar items required by OSHA, and other federal, state, and local health and safety regulations.

C. Motors shall comply with the standards specified in Section 26 20 00, Low-Voltage AC Induction Motors, of these Specifications.

D. The use of manufacturer's model or catalog numbers herein is for the purpose of establishing item quality and configuration desired.

2.02 MANUFACTURERS

A. Siemens.

B. Mass Transfer Systems.

C. Fluidyne.

2.03 SERVICE CONDITIONS

A. The equipment specified herein shall be suitable for installation outdoors, for exposure to continuous 100 percent relative humidity conditions, for operation in ambient air temperature from minus 4 to 38 degrees C.

B. Site Elevation: 17 feet.

C. Sludge Holding Tanks: Sludge to be mixed/aerated will be waste activated sludge (WAS) from a municipal wastewater treatment plant with the following characteristics:

1. Solids Concentration: 14,000 to 18,000 mg/L.
2. pH: 5.5 to 8.0.
3. WAS Temperature Range: 22 to 30 degrees C.

D. Sludge Holding Tanks: The liquid depth in the Sludge Holding Tanks during normal operation will fluctuate between elevations 22.00 and 42.00. The base slabs of the tanks are sloped between elevations 14.50 and 17.00 as shown on drawing. The design of the system shall take into account the sloped tank bottoms, the depth of submergence of the header and the 4 foot available suction head on the Liquid Motive Pumps.

E. Each system shall be capable of mixing and aerating to a maximum elevation of 42.00.

2.04 SPECIAL DESIGN CRITERIA FOR NOISE REDUCTION

A. The blowers provided for the Aerated Sludge Holding Tanks shall be provided with a special sound attenuating enclosure that will limit the sound to a maximum level of 80 dBA from each blower when measured at a distance of 3 feet.

B. The manufacturer may augment the sound attenuation capability of the enclosures with sound insulating blankets on the blower discharge silencer, or other sound attenuating devices. The manufacturer shall supply all means necessary to ensure that the maximum sound level is not exceeded.

C. The enclosure shall include appropriate ventilation to prevent heat from building up in the enclosure.

2.05 DESIGN CRITERIA FOR AERATED SLUDGE HOLDING TANKS

A. The jet mixing/aeration system shall be capable of aerating and mixing the WAS within each 75 feet diameter Sludge Holding Tank with the dimensions as shown on the Drawings.

B. The system will normally be operated with the air on. However, the system shall be also capable of completely mixing the tank contents with the air off.

C. The aeration system shall be sized based on the following criteria or manufacturer's actual test data, whichever is more conservative:

Parameter	Basin T-70-1	Basin T-70-2	Basin T-70-3	Basin T-70-4
Minimum SOR (lb./day)	7600	7600	7600	7600

D. The jet aeration/mixing system shall operate continuously or intermittently on demand.

E. The mixing system(s) shall maintain solids in uniform suspension throughout each tank. The mixing system(s) shall completely mix the contents of the tanks so that the variations in WAS concentrations between any two sampling points in the tank do not exceed plus or minus 10 percent of the mean value.

F. Noise suppression devices shall be provided such that the noise level measured at 3 feet from each blower shall not exceed 80 dBA.

2.06 SYSTEM COMPONENTS

A. Major System Components of Aerated Sludge Holding Tank Mixing System:

1. Headers: Four aeration headers with jet aerators, complete, including supports and in-basin piping.
2. Blowers: Four rotary positive displacement blowers. Each rotary positive displacement blower shall include inlet filter, inlet silencer, discharge silencer, discharge sleeve type expansion joints, check valve, pressure relief valve, base plate, V-belt drive and motor, and sound attenuating enclosure.
3. Liquid Motive Pumps: The manufacturer shall provide solids handling end-suction pumps.

2.07 EQUIPMENT DESCRIPTION

A. Aeration Headers:

1. Aeration headers shall be comprised of a liquid duct, an air duct, and aerator assemblies. Header shall be constructed such that the liquid duct, air duct, and jet aerator assemblies comprise one self-contained unit. Header shall be shipped in sections of length that are sufficient for installation in the Sludge Holding Tanks as shown on the Drawings.
2. The liquid duct shall be a cylindrical member having a plurality of liquid nozzle entry orifices which are longitudinally spaced along its perimeter, and aligned in a common horizontal plane. The inner surface of the liquid duct shall be smooth and free of protrusions which might collect stringy material.
3. The air duct shall also be a cylindrical member which is parallel to and above the liquid duct. The air duct shall be joined to, and supported by, the air manifolds, and additional support points as necessary. The air duct shall have a plurality of air manifold entry orifices longitudinally spaced along its perimeter, in corresponding number to, and in vertical alignment with the liquid nozzle entry orifices of the liquid duct. The provision of a separate air entry manifold with a fixed orifice for each jet assembly shall ensure uniform air distribution.
4. The liquid and air ducts shall be machine filament wound fiberglass reinforced plastic pipe. Liquid and air ducts shall be fabricated in strict conformance with ASTM D2996. Hand filament wound FRP piping, PVC, or other thermoplastics are not acceptable.
5. The aeration header shall be designed for an appropriate internal operating pressure plus a 5 to 1 safety factor. The header shall also be designed for an appropriate external pressure (vacuum) rating for the header flush out service conditions.
6. Each jet aerator assembly shall consist of an inner liquid nozzle, and an outer air/liquid delivery nozzle. The inner and outer nozzles shall be aligned on a common centerline, joined together, and laminated to form a single unit. The jet aerator assembly shall be joined to the liquid duct and the air manifold and laminated for strength to form a single integrated unit. The matting surface of the jet aerator assembly shall match the contour of the liquid duct and be stepped to match the liquid nozzle entry orifices of the liquid duct to ensure proper alignment, and provide a smooth contoured liquid flow path. No portion of the liquid nozzle or aerator assembly shall protrude into the liquid duct.
7. Both inner and outer nozzles shall be of nonclog design, free from all protrusions which might collect stringy material. The nozzles shall be able to pass solids with diameter up to 2.2 inches. Inner and outer nozzles shall be fabricated of isophthalic, corrosion-resistant laminating resin, reinforced with glass fibers, and a surfacing material of a commercial grade chemical-resistant glass having a coupling agent. The interior of each air and liquid nozzle shall contain a “coabrasion” liner

to specifically achieve optimum abrasion resistance. Each nozzle shall contain a specific liner separate from the structural fiberglass wall of the nozzle. The liner shall be constructed of a glass laminate utilizing a minimum of two layers of 0.010-inch synthetic, apertured “Nexus” or “C glass” veil. The interior liner shall be a resin-rich surface layer containing no more than 20 percent by weight of synthetic veil, and shall be free from cracks and crazing. The liner shall be staged separately from the structural fiberglass laminate, but shall contain the same resin as the substrate structural wall, and be surface prepared to form a singular integrated laminate with the structural wall to prevent delamination of dissimilar materials. All construction shall be in accordance with the American Voluntary Standard PS 15-60.

8. The air manifolds, shall be enclosed conduits which convey the compressed air from the air duct to the jet aerator assembly. The air manifolds shall be fabricated of an isophthalic, corrosion-resistant laminating resin, reinforced with glass fibers, and a surfacing material of commercial grade chemical-resistant glass having a coupling agent. Air manifolds shall be fabricated in accordance with NBS PS 15-69.

B. Backflushing System: A positive flush-out system utilizing a pumped, out-of-basin cross-over pipe configuration and valve arrangement or an air backflushing system shall be provided.

C. Air Piping: By others.

D. Liquid Piping: By others.

E. Supports:

1. All necessary supports for the aeration headers shall be provided as part of the system.
2. Fabricated of Type 316 stainless steel for corrosion resistance.
3. Supports shall consist of a contoured saddle and a supporting base. The base shall be anchored with anchor bolts and grouted in-place, if necessary. The saddle shall be provided with a Buna-N rubber pad to avoid abrasion. A contoured clamp with an accompanying Buna-N rubber pad shall hold the piping to the saddle. Fastening hardware shall be Type 316 stainless steel.

F. Blowers and Accessories:

1. Blowers shall be rotary positive displacement type designed to provide the oxygen transfer requirements for the ambient and water temperature ranges specified, manufactured by Aerzen, Roots, or Kaeser.

2. Blower Selection: The following design points for the blowers are based on information available during the design period. The manufacturer shall perform process calculations based on the Service Conditions and Design Criteria and confirm these selections.
3. Sludge Holding Tank Blowers: Shall be selected such that each blower shall deliver the rated total air requirement (nominally set at 940 scfm but shall be designed by the manufacturer). Motor shall be 75 horsepower, 1,800 rpm, 460 volts, 3-phase, 60-Hz, TEFC horizontal motor. Provide motors in accordance with Section 26 20 00, Low-Voltage AC Induction Motors. Provide winding thermostat and space heater for the motors. If a different horsepower, air flow rate, or pressure is required to meet the design conditions, the approval of the Engineer must be obtained.
4. Blowers shall be furnished completely packaged with all accessories, tested and ready for operation.
5. Each blower shall have a design rating for continuous service.
6. Lubrication: The timing gears and the bearings shall be splash oil lubricated from oil slingers mounted on the driving shaft and dipping in the oil. Sight glasses for oil level observation shall be provided. Grease lubricated bearings are not acceptable.
7. Expansion Joints: Provide flanged sleeved cylindrical type, three ply bias fiberglass reinforced silicone rubber connectors for blower discharge connections. Furnish units which are suitable for the operating pressure and temperature.
8. Equipment Base: Base shall be built so that the blower and motor are mounted to provide for fully automatic tensioning of the V-belt drive. The base shall be plate steel. All welds are to be continuous and full penetration.
9. Drive: Provide V-belt drive assembly consisting of sheaves, quick detachable bushings, V-belts, and sliding motor base. Provide drive assembly with a 1.4 service factor based on motor nameplate horsepower.
10. Guard: Provide OSHA style belt guard to enclose drive and belts. Design guard for easy removal. Guard shall be constructed to allow visual inspection of the drive system without removing the guard.
11. Inlet Filter: Provide each blower with a suitably sized air filter for the required flow rates.
12. Inlet Silencer: Provide a heavy duty, all welded, noise attenuation unit constructed of carbon steel sheet and plate and featuring an acoustically treated outlet for pulse control. Provide suitable supports for rigidly mounting silencer horizontally to the blower package base.
13. Pressure Relief Valve: Provide spring type relief valve with proper sizing and springs for set point pressure.
14. Check Valves: Blower discharge check valves shall be full-bore swing check type with stainless steel body, disc and shaft.

G. Liquid Motive Pumps and Accessories:

1. Liquid Motive Pumps: Shall be selected so that each pump can deliver 6,600 gpm at 21 feet total dynamic head with a 50 hp motor. If a different horsepower, flow, or head is required, the approval of the Engineer is required.
   a. Specific criteria for solids handling end suction pump are provided in Section 44 42 56.10, Horizontal End Suction Centrifugal Pumps, and Pump Data Sheet.

2.08 INSTRUMENTATION AND CONTROLS

A. General: See Section 40 99 90, Package Control Systems, for general instrumentation and control requirements. All instrumentation, control, and electrical components provided under this section, including panel fabrication and color coding of lights and switches, shall comply with the requirements of Section 40 99 90, Package Control Systems.

B. Special Requirements:

1. Provide field mounted surge suppression on all analog signals. Refer to Section 40 99 90, Package Control Systems.
2. Provide the following instrumentation as shown on the Drawing. Refer to Section 40 99 90, Package Control Systems for instrument selection requirements.
   a. Temperature Indicators 830-TI-003-01, 830-TI-004-01, 830-TI-007-01, 830-TI-010-01.
      1) Range: 32 – 300 degrees F.
   b. Temperature Switches 830-TSH-003-02, 830-TSH-004-02, 830-TSH-007-02, 830-TSH-010-02.
      1) Setpoint by the manufacturer.
   c. Pressure Gauges 830-PI-003-01, 830-PI-004-01, 830-PI-007-01, 830-PI-010-01.
      1) Range: 0 - 50 psig.
   d. Pressure Switches 830-PSH-003-01, 830-PSH-004-01, 830-PSH-007-01, 830-PSH-010-01.
      1) Single set point, adjustable deadband 5-54 psig. Initial setpoint at 30 psig.

2.09 ACCESSORIES

A. Equipment Identification Plate: Provide in accordance with Section 01 00 01, General Requirements. 16-guage stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. Anchor bolts of sufficient size and quantity shall be provided for mounting of all manufacturer supplied equipment and piping in the basin. Anchor bolts shall be Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter..

2.10 FACTORY FINISHING

A. Prepare, prime, and finish coat blowers and pumps with the follow system.

1. SP-10, Near-white blast cleaning.
2. 1 coat 2.5 MDFT epoxy primer for ferrous metal: anticorrosive, converted epoxy primer containing rust-inhibitive pigments.
3. 1 coat 4 MDFT high-build epoxy: polyamidoamine epoxy, minimum 69 percent volume solids, capability of 4 to 8 MDFT per coat.
4. 1 coat 3 MDFT polyurethane enamel: two-component, aliphatic or acrylic based polyurethane; high floss finish.

2.11 SOURCE QUALITY CONTROL

A. Factory Tests and Adjustments: Test all equipment for proper alignment, operation and intended function.

B. Function Test: Perform manufacturer’s standard motor test on equipment.

PART 3 EXECUTION

3.01 SHIPMENT, HANDLING, AND STORAGE

A. Insofar as is practical, the equipment shall be factory assembled. The parts and assemblies that are of necessity shipped unassembled, shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final assembly in the field. Generally, machined and unpainted ferrous metal parts shall be protected from the elements by the application of a strippable protective coating.

B. Weight, handling instructions, type of storage required, and instructions for protective maintenance during storage shall be included with each shipment to the construction site.

3.02 INSTALLATION

A. Installation will be by others with the manufacturer’s assistance.

3.03 FIELD FINISHING

A. Touchup painting will be by others. Manufacturer shall provide touchup paint.

3.04 FIELD QUALITY CONTROL

A. Functional Test: Conduct on each tank by the installer with the assistance of the manufacturer.

1. Manufacturer's representative shall inspect installation, check for lubrication and minor adjustments, provide certification that the system components have been installed correctly and are ready for operation.

B. Performance Test: Conduct on each tank by the installer with the assistance of the manufacturer.

1. Mixing Test: Demonstrate conformance with requirements listed below.
   a. Sample points will be located at up to two points on top of each tank.
   b. Samples will be collected at three separate depths at each location. The depths will be the same for each sample point.
   c. Owner shall perform residue test on each sample mean value of suspended solids concentrations will be used to demonstrate conformance with requirements.
   d. All testing and sampling shall conform to procedures established in the latest edition of Standard Methods for Examination of Water and Wastewater.
   e. The mixing system(s) shall be required to pass the performance test within the range of solids concentrations stated in Article Service Conditions. The TSS concentration of each of the twelve samples shall be within plus or minus 10 percent of the average.
2. If the mixing system on either tank fails to pass the performance test, the manufacturer and installer shall be responsible for adjusting and/or modifying the mixing system and retesting the equipment until a passing test is achieved.

3.05 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Project Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 4 person-days for installation assistance and inspection, two trips minimum.
2. 4 person-days for Function Testing, and Manufacturer's Certificate of Proper Installation, two trips minimum.
3. 1 person-day for Prestartup Classroom and Onsite Training.
4. 8 person-days for Startup and Performance Testing, two trips minimum.

B. Manufacturer's Representative shall make separate trips to the Project Site to complete the above services. The minimum number of trips required is six.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Submit prior to application for final payment.
   a. Record Documents: As required in General Conditions.
   b. Approved Shop Drawings and Samples: As required in the General Conditions.
   c. Special bonds, Special Guarantees, and Service Agreements.
   d. Consent of Surety to Final Payment: As required in General Conditions.
   e. Releases or Waivers of Liens and Claims: As required in General Conditions.
   f. Releases from Agreements.
   g. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
   h. Extra Materials: As required by individual Specification sections.

1.02 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in the Work has occurred.

4. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.

1.03 RELEASES FROM AGREEMENTS

A. Furnish Owner written releases from property owners or public agencies where side agreements or special easements have been made, or where Contractor's operations have not been kept within the Owner's construction right-of-way.

B. In the event Contractor is unable to secure written releases:

1. Inform Owner of the reasons.
2. Owner or its representatives will examine the Site, and Owner will direct Contractor to complete the Work that may be necessary to satisfy terms of the side agreement or special easement.
3. Should Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from Contract Price, or require Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
4. When Owner is satisfied that the Work has been completed in agreement with Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if: (i) Contractor's failure to obtain such statement is due to grantor's refusal to sign, and this refusal is not based upon any legitimate Claims that Contractor has failed to fulfill terms of side agreement or special easement, or (ii) Contractor is unable to contact or has had undue hardship in contacting grantor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Times, secure from Engineer at no cost to Contractor, one complete set of Contract Documents. Drawings will be full size.
2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.

3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by Engineer.

C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
    a. Color Coding:
        1) Green when showing information deleted from Drawings.
        2) Red when showing information added to Drawings.
        3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by “cloud” drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
    a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
    b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
    c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
    d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
    e. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Engineer’s written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
    a. Clearly identify the item by accurate note such as “cast iron drain,” “galv. water,” and the like.

b. Show, by symbol or note, vertical location of item (“under slab,” “in ceiling plenum,” “exposed,” and the like).
c. Make identification so descriptive that it may be related reliably to Specifications.

3.02 FINAL CLEANING

A. At completion of the Work or of a part thereof and immediately prior to Contractor’s request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor’s notice of completion, clean entire Site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner.
2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
4. Broom clean exterior paved driveways and parking areas.
5. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
6. Rake clean all other surfaces.
7. Leave water courses, gutters, and ditches open and clean.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Detailed information for the preparation, submission, and Engineer's review of Operations and Maintenance (O&M) Data, as required by individual Specification sections.

1.02 DEFINITIONS

A. Preliminary Data: Initial and subsequent submissions for Engineer's review.

B. Final Data: Engineer-accepted data, submitted as specified herein.

C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.03 SEQUENCING AND SCHEDULING

A. Equipment and System Data:

1. Preliminary Data:
   a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
   b. Submit prior to shipment date.
2. Final Data: Submit Instructional Manual Formatted data not less than 30 days prior to equipment or system field functional testing.

B. Materials and Finishes Data:

1. Preliminary Data: Submit at least 15 days prior to request for final inspection.
2. Final Data: Submit within 10 days after final inspection.

1.04 DATA FORMAT

A. Prepare preliminary data in the form of an instructional manual. Prepare final data on electronic media.

B. Instructional Manual Format:

1. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
2. Size: 8-1/2 inches by 11 inches, minimum.
3. Cover: Identify manual with typed or printed title “OPERATION AND MAINTENANCE DATA” and list:
    a. Project title.
    b. Designate applicable system, equipment, material, or finish.
    c. Identity of separate structure as applicable.
    d. Identify volume number if more than one volume.
    e. Identity of equipment number and Specification section.
4. Spine:
    a. Project title.
    b. Identify volume number if more than one volume.
5. Title Page:
    a. Contractor name, address, and telephone number.
    b. Subcontractor, Supplier, installer, or maintenance contractor’s name, address, and telephone number, as appropriate.
        1) Identify area of responsibility of each.
        2) Provide name and telephone number of local source of supply for parts and replacement.
6. Table of Contents:
    a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
    b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
7. Paper: 20-pound minimum, white for typed pages.
8. Text: Manufacturer’s printed data, or neatly typewritten.
9. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
10. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

C. Data Compilation Format:

1. Compile all Engineer-accepted preliminary O&M data into a hard-copy, hard-bound set.
2. Each set shall consist of the following:
    a. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
    b. Cover: Identify each volume with typed or printed title “OPERATION AND MAINTENANCE DATA, VOLUME NO. ___ OF ___”, and list:
        1) Project title.

2) Contractor's name, address, and telephone number.
3) If entire volume covers equipment or system provided by one Supplier include the following:
a) Identity of general subject matter covered in manual.
b) Identity of equipment number and Specification section.

c. Provide each volume with title page and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.

d. Table of contents neatly typewritten, arranged in a systematic order:
1) Include list of each product, indexed to content of each volume.
2) Designate system or equipment for which it is intended.
3) Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.

e. Section Dividers:
1) Heavy, 80 pound cover weight, tabbed with numbered plastic index tabs.
2) Fly-Leaf:
a) For each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment.
b) List with Each Product:
(1) Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
(2) Identify area of responsibility of each.
(3) Provide local source of supply for parts and replacement.
c) Identity of separate structure as applicable.

f. Assemble and bind material, as much as possible, in same order as specified in the Contract Documents.

D. Furnish the final, complete O&M Manual in electronic format on a CD-ROM. Use the latest version of Microsoft Word, Excel, and Adobe PDF formats. The Owner shall have the ability to modify the Adobe PDF format files.

1. Text, photos, and Drawings shall all be placed on clearly marked CD-ROMs in a current version of Adobe PDF file System. A single Adobe PDF file may be used if the total number of pages in the manual does not exceed 50. For manuals with more than 50 pages (text and graphics), each subsection should be a separate Adobe PDF file.
2. The electronic form of the manual shall be provided with a linked Table of Contents, which will serve as the primary navigational aid for the user, from inside an Internet browser.

3. Each Adobe PDF file shall have at least five keywords assigned to it, based on its individual subject material. If an entire manual (less than 50 pages) is contained in one Adobe PDF file, then sufficient keywords should be used to ensure that "searching" for a particular subsection will be successful. (Example: if "calibration" is a subsection, then the word calibrate and/or calibration should be added to the keyword list.) If each subsection is a separate Adobe PDF file, then keywords should be designed to lead the user to all commonly used terms of the text.
4. Cataloging or indexing should not be done. All manuals will be indexed when aggregated in the complete plant O&M Manual.
5. Each Adobe PDF file should be configured in the same way so that users are presented with a standard interface for all manuals, regardless of Equipment Supplier. To accomplish this, follow this procedure for each Adobe PDF file provided:
    a. From the main menu, select File, then open the subject Adobe PDF file.
    b. With the file open, select File, Document Properties, Summary (current version of Adobe Acrobat). Enter the Title, Subject, Author, and Keywords for this file. Make these consistent and descriptive of subject document. Binding should be Left Edge.
    c. Select File, Document Properties, Open Options:
        1) Initial View: Page only.
        2) Page Number: One.
        3) Magnification: Fit Width.
        4) Page Layout: Single page.
        5) Window Options: Resize window to initial page, center window on screen.
        6) User Interface Options: None.

1.05 SUBMITTALS

A. Informational:

1. Data Outline: Submit two copies of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
2. Preliminary Data:
    a. Submit two copies for Engineer's review.
    b. If data meets conditions of the Contract:
        1) One copy will be returned to Contractor.
        2) One copy will be forwarded to Resident Project Representative.
    c. If data does not meet conditions of the Contract:
        1) All copies will be returned to Contractor with Engineer's comments (on separate document) for revision.
        2) Engineer's comments will be retained in Engineer's file.

3) Resubmit two copies revised in accordance with Engineer's comments.

3. Final Data: Submit two copies in format specified herein.

1.06 DATA FOR EQUIPMENT AND SYSTEMS

A. Content For Each Unit (or Common Units) and System:

1. Product Data:
   a. Include only those sheets that are pertinent to specific product.
   b. Clearly annotate each sheet to:
      1) Identify specific product or part installed.
      2) Identify data applicable to installation.
      3) Delete references to inapplicable information.
   c. Function, normal operating characteristics, and limiting conditions.
   d. Performance curves, engineering data, nameplate data, and tests.
   e. Complete nomenclature and commercial number of replaceable parts.
   f. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
   g. Spare parts ordering instructions.
   h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).
2. As-installed, color-coded piping diagrams.
3. Charts of valve tag numbers, with the location and function of each valve.
4. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
   a. Format:
      1) Provide reinforced, punched, binder tab; bind in with text.
      2) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
      3) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
      4) Identify Specification section and product on Drawings and envelopes.
   b. Relations of component parts of equipment and systems.
   c. Control and flow diagrams.
   d. Coordinate drawings with Project record documents to assure correct illustration of completed installation.

5. Instructions and Procedures: Within text, as required to supplement product data.
    a. Format:
        1) Organize in consistent format under separate heading for each different procedure.
        2) Provide logical sequence of instructions for each procedure.
        3) Provide information sheet for Owner's personnel, including:
            a) Proper procedures in event of failure.
            b) Instances that might affect validity of guarantee or Bond.
    b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
    c. Operating Procedures:
        1) Startup, break-in, routine, and normal operating instructions.
        2) Test procedures and results of factory tests where required.
        3) Regulation, control, stopping, and emergency instructions.
        4) Description of operation sequence by control manufacturer.
        5) Shutdown instructions for both short and extended duration.
        6) Summer and winter operating instructions, as applicable.
        7) Safety precautions.
        8) Special operating instructions.
    d. Maintenance and Overhaul Procedures:
        1) Routine maintenance.
        2) Guide to troubleshooting.
        3) Disassembly, removal, repair, reinstallation, and re-assembly.
6. Guarantee, Bond, and Service Agreement: In accordance with Section 01 77 00, Closeout Procedures.

B. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
    a. Function, normal operating characteristics, and limiting conditions.
    b. Performance curves, engineering data, nameplate data, and tests.
    c. Complete nomenclature and commercial number of replaceable parts.
    d. Interconnection wiring diagrams, including control and lighting systems.
2. Circuit Directories of Panelboards:
3. Electrical service.
4. Control requirements and interfaces.
5. Communication requirements and interfaces.
6. List of electrical relay settings, and control and alarm contact settings.

7. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
8. As-installed control diagrams by control manufacturer.
9. Operating Procedures:
    a. Routine and normal operating instructions.
    b. Startup and shutdown sequences, normal and emergency.
    c. Safety precautions.
    d. Special operating instructions.
10. Maintenance Procedures:
    a. Routine maintenance.
    b. Guide to troubleshooting.
    c. Adjustment and checking.
    d. List of relay settings, control and alarm contact settings.
11. Manufacturer's printed operating and maintenance instructions.
12. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

C. Maintenance Summary:

1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
2. Format:
    a. Use Maintenance Summary Form bound with this section or electronic facsimile of such.
    b. Each Maintenance Summary may take as many pages as required.
    c. Use only 8-1/2-inch by 11-inch size paper.
    d. Complete using typewriter or electronic printing.
3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
    a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
    b. "Unit" is the unit of measure for ordering the part.
    c. "Quantity" is the number of units recommended.
    d. "Unit Cost" is the current purchase price.

1.07 DATA FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:
    a. Catalog number, size, and composition.
    b. Color and texture designations.

c. Information required for reordering special-manufactured products.

2. Instructions for Care and Maintenance:
   a. Manufacturer's recommendation for types of cleaning agents and methods.
   b. Cautions against cleaning agents and methods that are detrimental to product.
   c. Recommended schedule for cleaning and maintenance.

B. Content for Moisture Protection and Weather Exposed Products:

1. Manufacturer's data, giving full information on products:
   a. Applicable standards.
   b. Chemical composition.
   c. Details of installation.
2. Instructions for inspection, maintenance, and repair.

1.08 SUPPLEMENTS

A. The supplements listed below, following "End of Section", are part of this Specification.

1. Forms: Maintenance Summary Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

   a. Name_____ Telephone No. _____

   b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

SECTION 01 91 14
EQUIPMENT TESTING AND FACILITY STARTUP

PART 1 GENERAL

1.01 DEFINITIONS

A. Facility: Entire Project, or an agreed-upon portion, including all of its unit processes.

B. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets manufacturer's installation, calibration, and adjustment requirements and other requirements as specified.

C. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.

D. Unit Process: As used in this section, a unit process is a portion of the facility that performs a specific process function, such as Jet Mixing/Aeration System.

E. Facility Performance Demonstration:

1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, both manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
2. Such demonstration is for the purposes of (i) verifying to Owner entire facility performs as a whole, and (ii) documenting performance characteristics of completed facility for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

1.02 SUBMITTALS

A. Informational Submittals:

1. Facility Startup and Performance Demonstration Plan.
2. Functional and performance test results.
3. Completed Unit Process Startup Form for each unit process.
4. Completed Facility Performance Demonstration/Certification Form.

1.03 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following:

1. Step-by-step instructions for startup of each unit process and the complete facility.
2. Unit Process Startup Form (sample attached), to minimally include the following:
    a. Description of the unit process, including equipment numbers/nomenclature of each item of equipment and all included devices.
    b. Detailed procedure for startup of the unit process, including valves to be opened/closed, order of equipment startup, etc.
    c. Startup requirements for each unit process, including water, power, chemicals, etc.
    d. Space for evaluation comments.
3. Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
    a. Description of unit processes included in the facility startup.
    b. Sequence of unit process startup to achieve facility startup.
    c. Description of computerized operations, if any, included in the facility.
    d. Contractor certification facility is capable of performing its intended function(s), including fully automatic operation.
    e. Signature spaces for Contractor and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Facility Startup Meetings: Schedule, in accordance with requirements of Section 01 31 19, Project Meetings, to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and Owner involvement.

B. Contractor’s Testing and Startup Representative:

1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.

C. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.

D. Provide Subcontractor and equipment manufacturers’ staff adequate to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.

E. Owner will:

1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
2. Operate process units and facility with support of Contractor.
3. Provide labor and materials as required for laboratory analyses.
4. Furnish assistance of manufacturer's representative(s) for Owner-furnished products, as specified in Section 01 64 00, Owner-Furnished Products.
5. Make available spare parts, special tools, and operation and maintenance information for Owner-furnished products.

3.02 EQUIPMENT TESTING

A. Preparation:

1. Complete installation before testing.
2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.
3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Proper Installation Form, in accordance with Section 01 43 33, Manufacturers' Field Services, when required by individual Specification sections.
4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
   a. Owner/Project Name.
   b. Equipment or item tested.
   c. Date and time of test.
   d. Type of test performed (Functional or Performance).
   e. Test method.
   f. Test conditions.
   g. Test results.
   h. Signature spaces for Contractor and Engineer as witness.
5. Cleaning and Checking: Prior to beginning functional testing:
   a. Calibrate testing equipment in accordance with manufacturer's instructions.
   b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
   c. Lubricate equipment in accordance with manufacturer's instructions.
   d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.
   e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
   f. Check power supply to electric-powered equipment for correct voltage.

g. Adjust clearances and torque.
h. Test piping for leaks.

6. Ready-to-test determination will be by Engineer based at least on the following:
   a. Acceptable Operation and Maintenance Data.
   b. Notification by Contractor of equipment readiness for testing.
   c. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
   d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested including items to be furnished by Owner.
   e. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
   f. Satisfactory fulfillment of other specified manufacturer's responsibilities.
   g. Equipment and electrical tagging complete.
   h. Delivery of all spare parts and special tools.

B. Functional Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.
3. Prepare Equipment Test Report summarizing test method and results.
4. When, in Engineer's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner's signature as witness on Equipment Test Report.

C. Performance Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
4. Type of fluid, gas, or solid for testing shall be as specified.
5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
6. Prepare Equipment Test Report summarizing test method and results.
7. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer's signature on Equipment Test Report.

3.03 STARTUP OF UNIT PROCESSES

A. Prior to unit process startup, equipment within unit process shall be accepted by Engineer as having met functional and performance testing requirements specified.

B. Startup sequencing of unit processes shall be in the following order:

1. Sludge Holding Tanks 1 and 3.
2. Sludge Holding Tanks 2 and 4.

C. Make adjustments, repairs, and corrections necessary to complete unit process startup.

D. Startup shall be considered complete when, in opinion of Engineer, unit process has operated in manner intended for 5 continuous days without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.

E. Significant Interruption: May include any of the following events:

1. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
2. Failure to meet specified functional operation for more than 2 consecutive hours.
3. Failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours after failure.
4. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 8 hours after failure.
5. As determined by Engineer.

F. A significant interruption will require startup then in progress to be stopped. After corrections are made, startup test period to start from beginning again.

3.04 FACILITY PERFORMANCE DEMONSTRATION

A. When, in the opinion of Engineer, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.

B. Demonstrate proper operation of required interfaces within and between individual unit processes.

C. After facility is operating, complete performance testing of equipment and systems not previously tested.

D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility, until all unit processes are operable and under control of computer system.

E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic operation.

3.05 SUPPLEMENTS

A. Supplements listed below, following "End of Section," are a part of this Specification:

1. Unit Process Startup Form.
2. Facility Performance Demonstration/Certification Form.

END OF SECTION

UNIT PROCESS STARTUP FORM

OWNER:_____ **PROJECT:**_____

Unit Process Description: (Include description and equipment number of all equipment and devices):

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

Startup Requirements (Water, power, chemicals, etc.):_____

Evaluation Comments:_____

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER:_____ **PROJECT:**_____

Unit Processes Description (List unit processes involved in facility startup):

_____

_____

_____

_____

Unit Processes Startup Sequence (Describe sequence for startup, including computerized operations, if any):

_____

_____

_____

_____

_____

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: _____ **Date:** _____**, 20____**

Engineer: _____ **Date:** _____**, 20____**

(Authorized Signature)

SECTION 02 41 00
DEMOLITION

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): A10.6, Safety Requirements for Demolition Operations.
2. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.
3. American Petroleum Institute (API): RP 1604, Closure of Underground Petroleum Storage Tanks.
4. Environmental Protection Agency (EPA):
   a. SW-846, Test Methods for Evaluating Solid Waste, 3rd Edition, 1986.
   b. Functional Guidelines for Evaluating Data Quality, 1991.
5. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
   a. Part 61—National Emission Standards for Hazardous Air Pollutants.
   b. Part 82—Protection of Stratospheric Ozone.
   c. Part 273—Standards for Universal Waste Management.

1.02 DEFINITIONS

A. ACM: Asbestos containing material.

B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof.

C. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.

D. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on the Drawings.

E. Renovation: Altering a facility or one or more facility components in any way.

F. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.

G. Universal Waste Lamp: In accordance with 40 CFR 273, the bulb or tube portion of an electric lighting device, examples of which include, but are not limited to, fluorescent, high-intensity discharge, neon, mercury vapor, high-pressure sodium, and metal halide lamps.

H. Universal Waste Thermostat: A temperature control device that contains metallic mercury in an ampule attached to a bimetal sensing element, and mercury-containing ampules that have been removed from these temperature control devices in compliance with the requirements of 40 CFR 273.

1.03 SUBMITTALS

A. Informational Submittals:

1. Submit proposed Demolition Plan, in accordance with requirements specified herein, for approval before such Work is started.
2. Submit copies of any notifications, authorizations and permits required to perform the Work.
3. Submit a shipping receipt or bill of lading for all universal waste shipped.

1.04 REGULATORY AND SAFETY REQUIREMENTS

A. When applicable, demolition Work shall be accomplished in strict accordance with 29 CFR 1926-Subpart T.

B. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the General Conditions, Contractor’s safety requirements shall conform to ANSI A10.6.

C. Furnish timely notification of this demolition project to applicable federal, state, regional, and local authorities in accordance with 40 CFR 61-Subpart M.

1.05 DEMOLITION PLAN

A. Demolition Plan shall provide for safe conduct of the Work and shall include:

1. The Contractor’s planned sequence of operations, including coordination with other work in progress.

2. Site layout plan that includes the following:
   a. Exclusion zone.
   b. Work areas.
   c. Support zone.
   d. Material staging area.
   e. Fencing and other security devices.
   f. Location of existing structures, facilities, utilities, and other applicable features.
3. Description of proposed equipment, procedures, and materials for removal, cleaning, purging, cutting, plugging, capping and disposing of tank roofs, piping, and appurtenant features.
4. Proposed sequence and schedule for tank removal, disposal, and restoration operations.
5. Written requirements and controls for protecting personnel and property.
6. Written procedures for controlling, handling, and disposing of fluids, sludge and grits, including containment and spill prevention requirements.
7. Proposed Transportation and Disposal Subcontractors.
8. Name and letter of acceptance from disposal facilities proposed for disposal of liquids, sludge and grits.
9. Name, qualifications, and licensing information for transportation Subcontractor proposed for removing tank roofs, appurtenances, liquid, sludge, and grits.

B. Include statements affirming Contractor inspection of the existing roof deck, floors, walls, and framing members, and their suitability to perform as a safe working platform or, if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the Work.

1.06 SEQUENCING AND SCHEDULING

A. The Work of this Specification shall not commence until Contractor's Demolition/Renovation Plan has been approved by Engineer.

B. Include the Work of this Specification in the progress schedule, as specified in Section 01 32 00, Construction Progress Documentation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING STRUTURES TO BE DEMOLISHED

A. Two Digester Tanks (2 and 4) and associated piping:

1. Demolish digester tank covers, gas collection pipes, mixing gun assemblies, sludge feed and withdraw pipes, and their supports and other associated parts located within the tanks or on the covers.
2. Demolish the gas collection pipes between the digesters and the digester building and associated pipe supports. Cap the pipes 8 inches from the digester building exterior wall.
3. Demolish the gas recirculation manifolds on the exterior wall of the digester tanks and associated pipe supports. Cap the 4-inch pipes that feed the manifolds.

B. Patching:

1. Where removals leave holes and damaged surfaces exposed in the finished Work, patch and repair to match adjacent finished surfaces as to texture and finish.
2. Patching shall be as specified and indicated, and shall include: Fill holes and depressions caused by previous physical damage or left as a result of removals in existing walls with an approved patching material, applied in accordance with the manufacturer's printed instructions.

C. Electrical:

1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
2. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
3. Raceways and cabling not scheduled for reuse.
4. Inaccessibly Concealed: Cut off and abandon in place.
5. Exposed or Concealed Above Accessible Ceilings: Remove.
6. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
7. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
8. Where the concealed raceway is uncovered remove raceway (or extended to new location if appropriate).
9. Provide new typewritten panelboard circuit directory cards.
10. Lockout and tagout all electrical motors and equipment abandoned in place or no longer used as part of normal plant operations.

D. Universal Waste Lamps and Thermostats: Manage, contain, package, and label in strict accordance with 40 CFR 273.

E. If any material is found to be hazardous, including ACM, as defined by pertinent local, state or federal regulations, Contractor shall notice the attention of the Owner in writing. Do not remove any hazards material without Owner's written approval. The disposal of the material shall comply with all pertinent local, state or federal regulation.

3.02 REMOVAL OF TANK CONTENTS AND PURGING

A. The digester tanks will be drained by the Owner with existing piping and equipment prior to demolition. Residual solids will be removed by the Owner.

B. Drain and purge appurtenant piping into tank.

3.03 REMOVAL OF APPURTENANT PIPING

A. Disconnect piping and ancillary equipment from tank. Remove piping as shown on Drawings.

B. Expose and remove piping as shown on Drawings. Permanently cap ends of piping that are to be abandoned in place.

C. Pipes to remain shall be protected from damage.

3.04 TANK CLEANING

A. Interior Cleaning:

1. Tank interior shall be cleaned using high pressure (greater than 100 psi water spray until loose scale and sludge is removed and contamination, in form of sheen, is no longer visible in effluent stream.
2. Clean interior surfaces of piping using same method used for cleaning tank.

3.05 PROTECTION

A. Dust and Debris Control: Prevent the spread of dust and debris and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

B. Traffic Control Signs: Where pedestrian and driver safety is endangered in the area of removal Work, use traffic barricades with flashing lights.

C. Existing Work:

1. Survey the site and examine the Drawings and Specifications to determine the extent of the Work before beginning any demolition or renovation.

2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Owner; any Contractor-damaged items shall be repaired or replaced as directed by Engineer.
3. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Engineer approval.
4. Do not overload pavements to remain.

D. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Owner's personnel and the general public from injury due to demolition Work.
3. Provide protective measures as required to provide free and safe passage of Owner's personnel and the general public to occupied portions of the structure.

3.06 BURNING

A. The use of burning at the Site for the disposal of refuse and debris will not be permitted.

3.07 TITLE TO MATERIALS

A. Title to equipment and materials resulting from demolition is vested in the Contractor upon approval by Engineer of Contractor's Demolition Plan, and the resulting authorization by Engineer to begin demolition.

3.08 DISPOSITION OF MATERIAL

A. Do not remove equipment and materials without approval of Contractor's Demolition Plan by Engineer.

3.09 UNSALVAGEABLE MATERIAL

A. Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of off the Site.

B. Combustible material shall be disposed of off the Site.

C. Universal Waste Lamps and Thermostats: Dispose of in strict accordance with 40 CFR 273.

3.10 CLEANUP

A. Debris and rubbish shall be removed from basement and similar excavations. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION

SECTION 03 31 00
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. 306.1, Specification for Cold Weather Concreting.
   e. 308.1-11, Specification for Curing Concrete.
   f. SP-66, Detailing Manual.
2. ASTM International (ASTM):
   a. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   b. A497/A497M, Standard Specification for Steel Welded Reinforcement, Deformed, for Concrete.
   c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   d. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   e. C33/C33M, Standard Specification for Concrete Aggregates.
   f. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   g. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   h. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   i. C150/C150M, Standard Specification for Portland Cement.
   j. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
   k. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   l. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.

m. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
n. C595/C595M, Standard Specification for Blended Hydraulic Cements.
o. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
p. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
q. C920, Specification for Elastomeric Joint Sealants.
r. C989, Standard Specification for Slag Cement for Use in Concrete and Mortars.
s. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
t. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
u. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
v. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
w. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
x. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
y. C 1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
z. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
aa. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
bb. D226, Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
cc. D227, Specification for Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing.
dd. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
ee. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
ff. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
gg. D2240, Standard Test Method for Rubber Property – Durometer Hardness.

hh. 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. 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. New Concrete: Concrete less than 60 days old.

G. 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.

B. Joints in forms shall not leak concrete mortar.

C. Limit panel deflection to 1/240th of each component span to achieve tolerances specified.

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. 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 43 33, Manufacturers' Field Services, 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. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
c. Methods for temperature protection during placement.
d. Types of covering, insulation, housing, or heating to be provided.
e. Curing methods to be used during and following protection period.
f. Use of strength accelerating admixtures.
g. Methods for verification of in-place strength.
h. Documentation of embeds that must be at a temperature above freezing prior to placement of concrete.
i. Procedures for measuring and recording concrete temperatures.
j. Procedures for preventing drying during dry, windy conditions.
5. 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.
6. 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. Joint filler and primer.
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.
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 and placement time to maintain slump.
   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 and Class C fly ash in accordance with ASTM C618.
      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. Normal-Weight 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-µm (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. Air-Entraining Admixture: ASTM C260/C260M.
   c. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
   d. Retarding Admixture: ASTM C 494/C 494M, Type B.
   e. Accelerating Admixture: ASTM C 494/C 494M, Type C.
   f. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
   g. Plasticizing Admixture: ASTM C1017/C1017M, Type I or Type II.
   h. Do not use calcium chloride as an admixture.
   i. 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 SO_4: 3,000 ppm.
      3) Alkalis as (Na_2O + 0.658 K_2O): 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 water-reducing admixture and 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 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 C260/C260M 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 C227 or 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.

3) Use low-alkali cement or incorporate pozzolans into concrete mixture as necessary to satisfy testing for potential alkali reactivity. Alternately, a chemical inhibitor such as a lithium based admixture may be proposed.

c. Use low alkali cement or incorporate pozzolans into the concrete mixture as necessary to satisfy testing for potential alkali reactivity. Alternately, a chemical inhibitor such as a lithium based admixture may be proposed. Submit documentation of control of alkali-aggregate reactivity for proposed admixtures.

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 Range at Site:
   a. Prior to submitting mix design, consult with concrete producer and select a target slump value at point of delivery, for each application of each design mix. Unless otherwise permitted, target slump value will then be enforced for duration of Project.
   b. Design mixes that include a high-range, water-reducing or a plasticizing admixture shall have a minimum slump of 2 inches prior to addition of admixture. Unless otherwise permitted, slump shall be 10 inches maximum at point of delivery, for concrete with a high-range, water-reducing admixture.
   c. Slump Tolerance: Meet requirements of ACI 117.
5. Combined Aggregate Gradation:
   a. Combined Gradation Limits: Fine aggregate shall be in range of 36 percent to 40 percent of total aggregate weight.

C. Concrete Mixing:

1. General: In accordance with ACI 301, except as modified herein.
2. Truck Mixers:
   a. For every truck, test slump 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; Concresive Standard LVI.
   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. Premolded Joint Filler:

1. Bituminous Type: ASTM D994 or ASTM D1751.
2. 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.

F. 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. BASF Construction Chemicals, Shakopee, MN; Kure 1315.
   b. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
   c. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
   d. Vexcon Chemical, Inc.; Philadelphia, PA; Starseal 1315.
   e. Dayton Superior; Safe Cure and Seal 1315 EF.

G. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
   a. Master Builders Co., Cleveland, OH; Confilm.
   b. Euclid Chemical Co., Cleveland, OH; Eucobar.

H. 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; Master Flow 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., Kansas City, KS; Sure Grip High Performance Grout.
    e. L & M Construction Chemicals, Inc., Omaha, NE; Crystex.

I. 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; EMACO S-Series products.
    b. Sika Chemical Corp., Lyndhurst, NJ; SikaTop-Series.

J. 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 Building Systems, Inc., Shakopee, MN.
        2) Euclid Chemical Co., Cleveland, OH.
        3) Prime Resins, Conyer, GA.
        4) Sika Chemical Corp., Lyndhurst, NJ.
4. Unless otherwise specified, use hydrophilic polyurethane resin.
    a. Manufacturers:
        1) Prime Resins, Conyer, GA.
        2) Sika Chemical Corp., Lyndhurst, NJ.

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. Prior to form removal, provide thermal protection for concrete being placed under the requirements of cold weather concreting.

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 CONCRETE PLACEMENT INTO FORMWORK

A. Inspection: Notify Engineer and 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 and architectural 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:
   a. Forms 8 Inches or Less Wide: 5 feet.
   b. Forms Wider than 8 Inches: 8 feet, except as specified.
6. 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.
7. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
8. 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 expansion, 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 expansion, 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 expansion, 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 or Control Joints: 7 days.
2. Construction joint between top of footing or slab, and column or wall: As soon as can safely be done without damaging previously cast concrete or interrupting curing thereof, but not less than 24 hours.
3. Expansion or Contraction Joints: 1 day.
4. For columns and walls with a height in excess of 10 feet, wait at least 2 hours before depositing concrete in beams, girders, or slabs supported thereon.
5. For columns and walls 10 feet in height or less, wait at least 1 hour prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon.

3.04 CONSOLIDATION AND VISUAL OBSERVATION

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

B. Provide sufficient windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.

C. Vibrate concrete in vicinity of joints to obtain impervious concrete.

3.05 COLD WEATHER PLACEMENT

A. Unless otherwise permitted, shall be in accordance with requirements of ACI 306.1 and as follows:

1. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
2. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Engineer.
3. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
4. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
5. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
6. Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3,500 psi.

B. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.

C. Cure as specified.

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 mechanically 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. Interior Slab Finish: Provide trowel finish unless specified otherwise on drawings.

D. 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 and then cutting or removing metal object. Refer to Drawings for additional information.

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.

B. Grouting Machinery Foundations:

1. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material.
2. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts.
3. Form with watertight forms at least 2 inches higher than bottom of plate.
4. Fill space between bottom of machinery base and original concrete in accordance with 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 CONTROL

A. General:

1. 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.
2. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
3. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
4. Evaluation will be in accordance with ACI 301 and Specifications.
5. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
6. Frequency of testing may be changed at discretion of Engineer.
7. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M.
8. 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. High Range Water Reducer (Superplasticizer) Admixture Segregation Test: Test each truck prior to use on job.

1. Segregation Test Objective: Concrete with 4-inch to 8-inch slump shall stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump test.
2. Test Procedure: Make slump test and check for excessive slump and observe to see if mortar or moisture flows from slumped concrete.
3. Reject concrete if mortar or moisture separates and flows out of mix.

D. Cold Weather Placement Tests:

1. During cold weather concreting, cast cylinders for field curing as follows. Use method that will produce greater number of specimens:
   a. Six extra test cylinders from last 100 cubic yards of concrete.
   b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
2. These specimens shall be in addition to those cast for lab testing.
3. Protect test cylinders from weather until they can be placed under same protection provided for concrete of structure that they represent.
4. Keep field test cylinders in same protective environment as parts of structure they represent to determine if specified strength has been obtained.
5. Test cylinders in accordance with applicable sections of ASTM C31/C31M and ASTM C39/C39M.
6. Use test results to determine specified strength gain prior to falsework removal.

E. 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 in accordance with Section 01 43 33, Manufacturers' Field Services, 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. If redosing of admixtures is acceptable to Concrete Producer, provide equipment for control of redosing, at Site to maintain proper slump and air content if needed.
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 4500F0S1P0C1.
2. Concrete Mix Design, Class 3500F0S0P0C1.

END OF SECTION

Concrete Mix Design, Class 4500F0S1P0C1

A. Mix Locations: All structural concrete unless otherwise called for in drawings.

B. Exposure Categories and Classifications: F0S1P0C1.

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 4,500 psi at 28 days.
      a. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
         1) Slabs to receive a hard-troweled finish.
         2) Slabs to receive a dry shake floor hardener.
         3) Slabs to receive a topping placed monolithically as a two-course floor on top of plastic concrete.
   3. 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.
         3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
   4. 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.

Concrete Mix Design, Class 3500F0S0P0C1

A. Mix Locations: Secondary concrete elements such as electrical duct banks, and pipe encasements.

B. Exposure Categories and Classifications: F0S1P0C1.

C. Mix Properties:
   1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.50.
   2. Minimum concrete compressive strength (f'c) shall be 3,500 psi at 28 days.
      a. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
         1) Slabs to receive a hard-troweled finish.
         2) Slabs to receive a dry shake floor hardener.
         3) Slabs to receive a topping placed monolithically as a two-course floor on top of plastic concrete.
   3. 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.
         3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
   4. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 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 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 National Standards Institute (ANSI).
5. 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.
6. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   e. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   f. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   g. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   h. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   i. A276, Standard Specification for Stainless Steel Bars and Shapes.
   j. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
   k. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.

l. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
m. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
n. A489, Standard Specification for Carbon Steel Lifting Eyes.
o. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
p. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
q. A563, Standard Specification for Carbon and Alloy Steel Nuts.
r. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
s. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
t. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
u. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
v. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
w. A992/A992M, Standard Specification for Structural Steel Shapes.
x. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
y. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
z. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
aa. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
bb. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
cc. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
dd. F436, Standard Specification for Hardened Steel Washers.
ee. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
ff. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
gg. F594, Standard Specification for Stainless Steel Nuts.
hh. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

ii. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

7. International Code Council Evaluation Service (ICC-ES):
   a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
   c. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
8. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
9. 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.

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. 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.

B. Informational Submittals:

1. Concrete 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. 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. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit the combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon (such as plates over 1.5 inches thick for ASTM A36/A36M steel), limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.

B. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/992M
Other Steel Shapes and Plates	A36/A36M
Steel Pipe	A501 or A53/A53M, Type E or S, Grade B
Hollow Structural Sections (HSS)	A500/A500M, Grade B
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 316 (316L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Condition CW
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 36, with weldability supplement S1.
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436

Item	ASTM Reference
Aluminum Plates and Structural Shapes	B209 and B308/B308M, Alloy 6061-T6
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48/A48M, Class 35

C. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types 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, hot-dip galvanized, or zinc-plated steel, as shown in Fastener Schedule at end of this section.
2. Current ICC-ES Report indicating acceptance per FBC 2010 for anchors at structural applications in cracked concrete.
3. Anchors shall be suitable for long-term loads, as well as for wind and seismic loads.
4. Torque-Controlled Expansion Anchors (Wedge Anchors):
   a. Wedge anchors used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report that demonstrates compliance with ICC-ES AC193 for cracked concrete.

b. Manufacturers and Products:
   1) ITW Ramset/Red Head, Addison, IL; Trubolt+ Wedge Anchor (ESR-2427).
   2) Hilti, Inc., Tulsa, OK; Kwik-Bolt–TZ (KB-TZ) Anchors (ESR-1917).
   3) Powers Fasteners, Brewster , NY; Power-Stud +SD2 or +SD1 Anchors (ESR-2502 and ESR-2818).
   4) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt Anchors (ESR-1771).
   5) Wej-It Corp., Tulsa, OK; ANKRtite CCAT Wedge Anchor (ESR-2777).

5. Displacement-Controlled Expansion Anchors (Drop-in Anchors):
   a. Self-drilling anchors, snap-off or flush type, zinc-plated.
   b. Nondrilling Anchors: Flush type for use with zinc-plated or stainless steel bolt, or stud type with projecting threaded stud.
   c. Manufacturers and Products:
      1) ITW Ramset/Red Head, Addison, IL; Multi-Set II Drop-In and Self Drill Anchor.
      2) Hilti, Inc., Tulsa, OK; Hilti HDI Drop-In Anchor.
      3) Powers Fasteners, Brewster, NY; Steel Drop-In Anchor.
      4) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Drop-In Anchor.
6. Undercut Anchors:
   a. When used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report that demonstrates compliance with ICC-ES AC193 for cracked concrete.
   b. Manufacturers and Products:
      1) USP Structural Connectors, Burnsville, MN; DUC Undercut Anchor (ESR-1970).
      2) Hilti, Inc., Tulsa, OK; HDA Undercut Anchor (ESR-1546).
      3) Powers Fasteners, Brewster, NY; Atomic+ Undercut (ESR-3067).
      4) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Torq-Cut (ESR pending).
7. Light-Duty Torque Controlled Expansion Anchors (Sleeve Anchors):
   a. Manufacturers and Products:
      1) ITW Ramset/Red Head, Addison, IL; Dynabolt Hex Nut Sleeve Anchor.
      2) Powers Fasteners, Brewster, NY; Lok-Bolt AS.
      3) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Sleeve-All Hex Head Anchor.
      4) Wej-It Corp., Tulsa, OK; Wej-It Sleeve Anchor.

8. Heavy-Duty Torque Controlled Expansion Anchors (Sleeve Anchors):
    a. Manufacturers and Products:
        1) Powers Fasteners, Brewster, NY; Power-Bolt+ Anchor.
        2) Hilti, Inc., Tulsa, OK; HSL-3 Heavy Duty Sleeve Anchor.

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.
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 on pallets or shelving in covered storage area.
    c. Container Markings: Include manufacturer’s name, product name, batch number, 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 (ESR-2322).
    b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors(ESR-2508).
    c. Powers Fasteners, Brewster NY, PE1000+ Adhesive anchoring system (ESR-2583).

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 PIPE SLEEVES

A. As specified in Section 40 27 01, Process Piping Specialties.

2.05 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.

2.06 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. Materials:

1. Use steel shapes, unless otherwise noted.
2. Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 and 0.25 percent.
3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.

C. 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. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
4. Aluminum: Meet requirements of AWS D1.2/D1.2M.
5. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
6. Complete welding before applying finish.

D. 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.

E. 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.

F. 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.

G. Watertight Seal: Where required or shown, furnish neoprene gasket of a type that is satisfactory for use in contact with sewage. Cover full bearing surfaces.

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

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

2.07 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Aluminum: AWS D1.2/D1.2M.
3. Stainless Steel: AWS D1.6/D1.6M.

B. Hot-Dip Galvanizing:

1. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123/A123M and ASTM A153/A153M.
2. Reject and retest nonconforming articles in accordance with ASTM A123/A123M and ASTM A153/A153M.

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.

C. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide center flange for water stoppage on sleeves in exterior or water-bearing walls.
4. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.

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 POST-INSTALLED ANCHORS

A. Begin installation only after concrete 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)
Expansion	9	6	12
Undercut	9	12	16
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. For undercut anchors, use special undercutting drill bit and rotary hammer drill and apply final torque as recommended by anchor manufacturer.

F. 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.

G. 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. Do not disturb anchor during recommended curing time.
4. Do not exceed maximum torque as specified in manufacturer's printed installation instructions.

H. Prestressed Concrete: Do not use post-installed anchors in prestressed or post-tensioned concrete members without Engineer's prior approval, unless specifically shown on Drawings. If Engineer approves anchor installation all prestressed tendons in vicinity of anchors must be located prior to drilling.

3.04 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:

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.

3.05 PAINTING

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

B. Repair of Damaged Hot-Dip Galvanized Coating:

1. Conform to ASTM A780/A780M.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.
4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

3.06 FIELD QUALITY CONTROL

A. Contractor-Furnished Quality Control:

1. Certificate of Compliance per Section 01 43 33, Manufacturer's Field Services, for test results, or calculations, or drawings that ensure material and equipment design and design criteria meet requirements of Section 01 61 00, Common Product Requirements.

3.07 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		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts or stainless steel adhesive anchors where indicated on Drawings.	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts, or stainless adhesive anchors where shown on Drawings.	
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	

Service Use and Location	Product	Remarks
3. Drilled Anchors for Metal Components to Cast-in-Place Concrete (e.g., Ladders, Handrail Posts, Electrical Panels, and Equipment)		
Interior Dry Areas	Zinc-plated or stainless steel wedge or expansion anchors	Use zinc-plated wedge anchors approved for use in cracked concrete for overhead and ceiling installations.
Submerged, Exterior, Interior Wet, and Corrosive Areas	Adhesive stainless steel anchors	Use stainless steel wedge anchors approved for use in cracked concrete for overhead and ceiling installations.
4. Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members.
5. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
6. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on stainless steel threads.

C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

SECTION 05 52 16
ALUMINUM RAILINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. Aluminum Association, Incorporated (AA): DAF45, Designation System for Aluminum Finishes.
2. American Concrete Institute (ACI) 318, Building Code Requirements for Structural Concrete.
3. American Iron and Steel Institute (AISI).
4. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. E894, Standard Test Method for Anchorage of Permanent Metal Railing Systems and Rails for Buildings.
   d. E935, Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
   e. E985, Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
5. International Code Council (ICC): International Building Code (IBC).
6. Florida Building Code (FBC) 2010.
7. Occupational Safety and Health Act (OSHA): 29 CFR 1910, Code of Federal Regulations.

1.02 DEFINITIONS

A. ICC Evaluation Services Report: ICC report on evaluation of manufactured concrete anchor systems.

B. Railings: This term includes guardrail systems, handrail systems, platform railing systems, ramp-rail systems, and stair-rail systems. Railings may be comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.

C. Toeboards: Vertical barrier at floor level usually erected on railings along exposed edges of floor or wall openings, platforms, or ramps to prevent miscellaneous items from falling through.

1.03 DESIGN REQUIREMENTS

A. Structural Performance of Railing Systems: Design, test, fabricate, and install railings to withstand the following structural loads without exceeding allowable design working stress or allowable deflection. Apply each load to produce maximum stress and deflection in railing system components.

1. Railing System: Capable of withstanding the following load cases applied:
   a. Concentrated load of 200 pounds applied at any point and in any direction in accordance with FBC and OSHA.
   b. Uniform load of 50 pounds per linear foot applied in any direction in accordance with FBC.
   c. Concentrated load need not be assumed to act concurrently with uniform loads in accordance with FBC.
2. Calculated lateral deflection at top of posts shall not exceed 1 inch.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Project-specific scaled plans and elevations of railings and detail drawings. Include railing profiles, sizes, connections, anchorage, size and type of fasteners, and accessories.
   b. Manufacturer’s literature and catalog data of railing and components.
   c. Design Data: Calculations or test data using specified design performance loads and including the following:
      1) Bending stress in, and deflection of, posts in accordance with ASTM E985 as modified herein.
      2) Design of post base connection.
      3) Documentation that concrete anchors have been designed in accordance with one of the following:
         a) ACI 318, Appendix D.
         b) ICC Evaluation Services Report for selected anchor.
2. Samples:
   a. Rail sections, 6 inches long showing each type of proposed connection, proposed finish, and workmanship.
   b. Each fitting including wall brackets, castings, toeboard, and rail expansion joints.

B. Informational Submittals:

1. Manufacturer’s assembly and installation instructions.
2. Special Inspection: Manufacturer’s instructions for Special Inspection of post-installed anchors.

3. Test Reports: Test data may supplement load calculations providing data covers complete railing system, including anchorage:
   a. Test data for railing and components showing load and deflection as a result of load, in enough detail to prove railing is strong enough and satisfies national, state, local standards, regulations, code requirements, and OSHA 29 CFR 1910, using design loads specified. Include test data for the following:
      1) Railing and post connections.
      2) Railing wall connections.
      3) Railing expansion joint connections.
      4) Railing system gate assembly, including latch, gate stop, and hinges. Both gate latch and stop to support required loads applied independent of each other.
   b. Testing of anchorages shall be in accordance with ASTM E894 and ASTM E935 using applied loads in accordance with FBC.
   c. Deflection Criteria: In accordance with ASTM E985 and design loads specified, except as follows: maximum calculated lateral deflection at top of posts shall not exceed 1 inch.
   d. Aluminum Rail Piping: Test data showing yield strength of pipe as delivered equals or exceeds specified values.
4. Manufacturer's written recommendations describing procedures for maintaining railings including cleaning materials, application methods, and precautions to be taken in use of cleaning materials.

1.05 QUALITY ASSURANCE

A. Qualifications: Calculations required for design data shall be stamped by a registered civil or structural engineer licensed in state where Project will be constructed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package and wrap railings to prevent scratching and denting during shipment, storage, and installation. Maintain protective wrapping to the extent possible until railing is completely installed.

B. Delivery:

1. Shop assemble into practical modules of lengths not exceeding 24 feet for shipment.
2. Deliver toeboards loose for field assembly.
3. Deliver clear anodized railing pipe and posts with protective plastic wrap.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Thermal Movements: Allow for thermal movement resulting from the following maximum range in ambient temperature in design, fabrication, and installation of railings to prevent buckling, opening up of joints, over stressing of components, connections and other detrimental effects. Base design calculation on actual surface temperature of material as a result of both solar heat gain and night time sky heat loss. Temperature change is difference between high or low temperature and installation temperature.

1. Temperature Change Range: 70 degrees F, ambient; 100 degrees F, material surfaces.

PART 2 PRODUCTS

2.01 ALUMINUM RAILINGS

A. General:

1. Furnish pre-engineered and prefabricated railing systems as shown on Drawings.
2. Railing systems using pop rivets or glued railing construction are not permitted.
3. Sand cast accessories and components are not permitted.
4. Fasteners shall be AISI Type 316 stainless steel, unless otherwise noted.

B. Rails, Posts, and Formed Elbows:

1. Extruded Alloy 6105-T5, 6061-T6, or equivalent.
2. Tensile Strength: 38,000 psi, minimum.
3. Yield Strength: 35,000 psi, minimum.
4. Wall Thickness: 0.145 inch, minimum.
5. Posts and railings shall be nominal 1-1/2-inch diameter (1.90-inch outside diameter).

C. Accessories:

1. Fittings and Accessories:
   a. Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet load requirements.
   b. Gauge metal components are not acceptable for load-resisting components.
   c. Fittings shall match color of pipe in railings.
2. Miscellaneous Extruded Aluminum Parts: Alloys 6063-T6, 6061-T6, or 6105 T5 aluminum, or equivalent, and of adequate strength for all loads.

3. Castings for Railings:
   a. Cast Al-mag with sufficient strength to meet load and test requirements.
   b. Anodizable grade finish with excellent resistance to corrosion when subjected to exposure of sodium chloride solution intermittent spray and immersion.
4. Post Anchorages:
   a. Refer to standard details for types of post anchorages and minimum requirements.
   b. Bolts at anchorages shall be minimum 1/2-inch diameter.
5. Wall Brackets: Adjustable wall fitting, with provision for minimum three 3/8-inch diameter AISI Type 316 stainless steel bolts or concrete anchors.
6. Rail Terminals (including Wall Returns): Aluminum wall fitting with provision for three 3/8-inch Type 304 fasteners.
7. Railing System Gate:
   a. Extruded aluminum rail components.
   b. Hardware Manufacturers and Products:
      1) Julius Blum & Co., Inc., Carlstadt, NJ; No. 782/3 gate hinges with springs, and No. 784 gate latch and stop.
      2) CraneVeyor Corp., South El Monte, CA; No. C4370b gate hinges with spring, No. C4369 gate latch, and No. C4368 gate stop.
      3) Moultrie Manufacturing Co., Moultrie, GA; Part No. W60006.
8. Toeboards:
   a. Molded or extruded Alloy 6063-T6 or 6061-T6 aluminum.
   b. Provide slotted holes for expansion and contraction where required.
9. Fasteners: Stainless steel.

D. Metal Supports Embedded in Concrete: In accordance with Section 05 50 00, Metal Fabrications.

E. Finishes:

1. Pipe and Post: In accordance with AA DAF45, designation AA-M32-C22-A41.
2. Cast Fittings and Toeboards: In accordance with AA DAF45, designation AA-M10-C22-A41.

2.02 ANCHOR BOLTS, FASTENERS, AND CONCRETE ANCHORS

A. Locknuts, Washers, and Screws:

1. Elastic Locknuts, Steel Flat Washers, Round Head Machine Screws (RHMS): AISI Type 316 stainless steel.
2. Flat Washers: Molded nylon.

B. Bolts and Nuts for Bolting Railing to Metal Beams: ASTM A193/A193M and ASTM A194/A194M, Type 316 stainless steel.

C. Concrete Anchors:

1. Stainless steel, AISI Type 316.
2. Post-installed anchors in accordance with Section 05 50 00, Metal Fabrications, unless otherwise specified herein.
3. Bolt Diameter: 1/2-inch, minimum.

2.03 FABRICATION

A. Shop Assembly:

1. Post Spacing: Maximum 6-foot horizontal spacing.
2. Railing Posts Bolted to Metal or Concrete:
   a. In lieu of field cutting, provide approved fitting with sufficient post overlap, containing provisions for vertical adjustment.
   b. Field fit-up is required.
3. Free of burrs, nicks, and sharp edges when fabrication is complete.
4. Welding is not permitted.

B. Shop/Factory Finishing:

1. Use same alloy for uniform appearance throughout fabrication for railings.
2. Railing and Post Fittings: Match fittings with color of pipe in railing.

C. Shop Assembly:

1. Shop assemble rails, posts, and formed elbows with a close tolerance for tight fit.
2. Fit dowels tightly inside posts.

D. Repair of Defective Work: Remove stains and replace defective Work.

PART 3 EXECUTION

3.01 GENERAL

A. Field fabrication of aluminum railing systems is not permitted.

B. Where required, provide railing posts longer than needed and field cut to exact dimensions required in order to satisfy vertical variations on actual structure.

C. Install railing with base that provides plus or minus 1/4-inch vertical adjustment inside base fitting. If adjustment is required in field and exceeds plus or minus 1/4-inch, reduce post length not to exceed beyond bottom of lowest set-screw or bolt in base fitting.

D. Modification to supporting structure is not permitted where railing is to be attached.

E. Protection from Entrapped Water:

1. Make provisions in exterior and interior installations subject to high humidity to drain water from railing system.
2. For posts mounted in concrete, bends, and elbows occurring at low points, drill weep holes of 1/4-inch diameter at lowest possible elevations, one hole per post or rail. Drill hole in plane of rail.

3.02 RAILING INSTALLATION

A. Assembly and Installation: Perform in accordance with manufacturer’s written recommendations for installation.

B. Expansion Joints:

1. Maximum intervals of 54 feet on center and at structural joints.
2. Slip joint with internal sleeve extending 2 inches beyond each side of joint. Provide 1/2-inch slip joint gap to allow for expansion.
3. Fasten to one side using 3/8-inch diameter set-screw. Place set-screw at bottom of pipe.
4. Locate joints within 12 inches of posts. Locate expansion joints in rails that span expansion joints in structural walls and floors supporting the posts.

C. Posts and Rails:

1. Surface Mounted Posts:
   a. Bolt post baseplate connectors firmly in place.
   b. Shims, wedges, grout, and similar devices for railing post alignment not permitted.

2. Set posts plumb and aligned to within 1/8 inch in 12 feet.
3. Set rails horizontal or parallel to slope of steps to within 1/8 inch in 12 feet.
4. Install posts and rails in same plane.
5. Remove projections or irregularities and provide a smooth surface for sliding hands continuously along top rail.
6. Use offset rail for use on stairs and platforms if post is attached to web of stringers or structural platform supports.
7. Support 1-1/2-inch rails directly above stairway stringers with offset fittings.

D. Wall Brackets: Support wall rails on brackets spaced maximum 5 feet on centers as measured on the horizontal projection.

E. Toeboard:

1. Provide at railings, except where 4-inch or higher concrete curbs are installed, at gates, or at stairways unless shown otherwise.
2. Accurately measure in field for correct length; after railing post installation cut and secure to posts.
3. Dimension between bottom of toeboard and walking surface not to exceed 1/4 inch.
4. Install plumb and aligned to within 1/8 inch in 12 feet.

F. Railing System Gate: Install in accordance with manufacturer's installation instructions.

3.03 FIELD FINISHING

A. Corrosion Protection: Prevent galvanic action and other forms of corrosion caused from direct contact with concrete and dissimilar metals by coating metal surfaces as specified in Section 09 90 00, Painting and Coating.

3.04 CLEANING

A. Wash railing system thoroughly using clean water and soap. Rinse with clean water.

B. Do not use acid solution, steel wool, or other harsh abrasive.

C. If stain remains after washing, restore in accordance with railing manufacturer's recommendations or replace stained railings.

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.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
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 5, White Metal Blast Cleaning.
   d. SP 10, Near-White Blast Cleaning.
   e. 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. HCl: Hydrochloric Acid.
3. MDFT: Minimum Dry Film Thickness, mils.
4. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
5. Mil: Thousandth of an inch.
6. PDS: Product Data Sheet.
7. PSDS: Paint System Data Sheet.
8. PVC: Polyvinyl Chloride.
9. SFPG: Square Feet per Gallon.
10. SFPGPC: Square Feet per Gallon per Coat.
11. 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.
   c. Submittal shall cover shop coating of items, components, and equipment. Submittal shall indicate compatible paint products proposed, required surface preparation, and post-application protection.
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, in accordance with Section 01 43 33, Manufacturers' Field Services.
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:

1. Minimum 5 years' experience in application of specified products. Trained and certificated by the manufacturer.
2. Applicator shall be SSPC-QP-1 certified.

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. Shop coated items:

1. For each shop-coated item, Contractor shall provide written certificate of compliance for approved preparation, application, quality controls, and application dates.
2. Contractor shall test all shop-coated items for holidays and thickness.

D. 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 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. Ameron Protective Coatings.
2. Sherwin Williams.
3. Tnemec Coatings.

2.02 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.

2.03 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
Bituminous Paint	Single-component, coal-tar pitch based.
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service
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

2.04 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.

2.05 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. Provide adhesion tests and moisture test to confirm and establish that all requirements of this specification and of the paint manufacturer are met. 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. Surface Contamination Testing:

1. A surface contamination analysis test shall be performed every 50 square feet by means of a Chlor Test CSN Salts or approved equivalent.
2. Surface with chloride levels exceeding 3 µg/square centimeter for submerged surfaces and 5 µg/square centimeter for exposed surfaces shall be treated with a liquid soluble salt remover equivalent to CHLOR*RID (CHLOR*RID International, Chandler, AZ).
3. Follow manufacturer's recommendations and procedures for the use of this product to remove the surface contamination.

C. Metal Surface Preparation:

1. Before all abrasive blasting and where indicated, meet requirements of SSPC Specifications summarized below:
   a. 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.
   b. 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.
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.
        4) Requirements for submerged metal surfaces are to comply with SPO 178.
    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.

D. Plastic Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

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. 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, metal and submerged metal 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 and all required testing and repairs are completed.
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. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
6. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
7. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
8. Keep paint materials sealed when not in use.
9. 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. Each undercoat shall be tined differently so that each can be identified visually.

B. Shop Primed and Factory Finished Surfaces:

1. Schedule inspection with Engineer before shop priming or topcating factory finished items delivered to Site.
2. Prepare surfaces and spot prime suing specified primer.
3. Apply mist coat of primer, 1-mil dry film thickness and holiday test.
4. After welding prepare and prime holdback areas as required for paint system. Apply primer in accordance with manufacturer's instructions.
5. Thickness test all shop-applied coating for compliance with required thickness per specified coating system. If no system is specified, test for coating manufacturer's recommended thickness.
6. All shop-painted items shall be holiday tested before shipment.

C. 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. System No. 2 Submerged Metal—Domestic Sewage:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	Prime in accordance with manufacturer's recommendations	
	Coal-Tar Epoxy -OR- High Build Epoxy	2 coats, 16 MDFT 2 coats, 16 MDFT

1. Use on the following items or areas:
    a. Metal surfaces below a plane 1 foot above maximum liquid surface, metal surfaces above maximum liquid surface that are a part of immersed equipment, concrete embedded surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, and structural steel, and the following specific 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, located inside or outside of structures and exposed to weather, and the following specific surfaces:
        1) Ductile Iron pipes, valves, and other appurtenances.

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.

F. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

3.08 COLORS

A. Provide as 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 equipment and piping one color as selected. 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.
4. All PVC and CPVC pipe located outside shall be painted.

3.09 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide new, electronic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
2. Provide new, 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, drips, 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. In accordance with Section 01 43 33, Manufacturers' Field Services, 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 one additional Site inspection visit, 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.: _____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

SECTION 23 05 48
VIBRATION ISOLATION
FOR HVAC PIPING AND EQUIPMENT

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. ASTM International (ASTM):
   a. A36/A36M, Specification for Carbon Structural Steel.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. American Welding Society (AWS): D1.1/D1.1M, Structural Welding Code—Steel.

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. EPDM: Ethylene-Propylene-Diene Monomer.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings, Vibration Isolators:
   a. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.
   b. Product Data:
      1) Manufacturer’s product data including details of materials, construction, dimensions of individual components, installation details, and finishes.
      2) Schedule of vibration isolator type with location and static and dynamic load on each.
      3) Vibration Isolation Base Details:
         a) Detail fabrication, including anchorages and attachments to structure and to supported equipment.

B. Informational Submittals:

1. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
2. Certifications:
   a. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
   b. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
   c. Welding Certificates: Welding procedures and personnel.

1.04 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Isolation materials and flexible connectors shall be same manufacturer. Select and certify using published or factory certified data.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION

A. General:

1. Provide for mechanical piping, and equipment as identified by this Specification.
2. Select in accordance with equipment, or pipe weight distribution to produce reasonably uniform deflections.

B. Elastomeric Pad:

1. Oil-resistant and water-resistant elastomer or natural rubber waffle pads, arranged in single or multiple layers, molded with a nonslip pattern.
2. Waffle pads bonded each side of minimum 1/4-inch thick galvanized steel separator plate.
3. Height of waffle ribs shall not exceed 0.7 times width.
4. Maximum Loading: 60 psi.
5. Minimum Single Layer Thickness: 1/4 inch.
6. Separator plate of sufficient stiffness for uniform loading over pad area.
7. Factory cut to size that matches requirements of supported equipment.
8. Waffle Pad Material: Standard neoprene.
9. Number of Layers: As required to support equipment load; refer to manufacturer's data for load capacities.

C. Elastomeric Mount:

1. Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements.
2. Factory-drilled, encapsulated top plate for bolting to equipment.
3. Baseplate for bolting to structure.

D. Open Spring Isolator:

1. Freestanding, laterally stable, open-spring isolators.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplate:
   a. Factory drilled for bolting to structure and bonded to 1/4-inch thick rubber isolator pad attached to baseplate underside.
   b. Limit floor load to 100 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolator:

1. Freestanding, steel, open-spring isolators with seismic restraint.
2. Housing: Steel with resilient vertical limit stops to prevent spring extension because of wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
3. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
4. Minimum Additional Travel: 50 percent of required deflection at rated load.
5. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. Elastomeric Hanger:

1. Double-deflection type.
2. Molded, oil-resistant rubber or neoprene isolator elements bonded to steel housing.
3. Threaded connections for hanger rods.

G. Spring Hanger:

1. Combination coil spring and elastomeric insert hanger with spring and insert in compression.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: 80 percent minimum of compressed height of spring at rated load.
4. Minimum Additional Travel: 50 percent of required deflection at rated load.
5. Lateral Stiffness: 80 percent minimum of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element:
   a. Molded, oil-resistant rubber or neoprene.
   b. Steel washer reinforced cup to support spring and bushing projecting through bottom of frame.

H. Manufacturers:

1. Mason Industries, Inc.
2. Kinetics Noise Control, Inc.
3. California Dynamics Corp.
4. Isolation Technology, Inc.
5. M.W. Sausse & Co., Inc. (VIBREX).
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation Co., Inc.
8. The VMC Group.

2.02 FLEXIBLE CONNECTORS

A. Flexible Pipe Connectors:

1. Braided Nonferrous: For nonferrous piping systems, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, braze-welded to hose.
2. Rubber:
   a. Neoprene or EDPM construction consisting of multiple piles of nylon tire cord fabric and elastomer, molded and cured in hydraulic rubber presses.
   b. Straight or elbow connector as indicated on Drawings, rated at 125 psi at 220 degrees F.

3. Manufacturers:
    1. Mason Industries, Inc.
    2. General Rubber.
    3. Kinetics Noise Control, Inc.

2.03 SHOP/FACTORY FINISHING

A. Manufacturer's standard paint applied to factory-assembled and factory-tested equipment, before shipping.

1. Powder coating on springs and housings.
2. Electro-galvanized hardware.
3. Hot-dip galvanized metal components for exterior use.
4. Baked enamel coat metal components for interior use.

B. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:

1. Install products in accordance with manufacturers' written instructions.
2. Connect wiring to isolated equipment with flexible hanging loop.
3. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

B. Vibration Isolators: On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

C. Flexible Connectors: Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

3.03 FIELD QUALITY CONTROL

A. Testing: Conduct the following field quality-control testing: Isolator deflection.

3.04 ADJUSTING

A. Vibration Isolation Devices:

1. Adjust isolators after piping systems have been filled and equipment is at operating weight.
2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height.
3. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
4. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.
5. Adjust isolators to ensure units do not exceed rated operating deflections or bottom out under loading, and are not short circuited by other contacts or bearing points.
6. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

3.05 CLEANING

A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION

SECTION 23 09 00
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

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): INCITS 4, Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII).
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):
   a. Handbook Fundamentals.
   b. Guideline 3, Reducing Emission of Fully Halogenated Refrigerants in Refrigeration and Air-Conditioning Equipment and Systems.
   c. 135, Data Communication Protocol for Building Automation and Control Networks.
3. American Society of Mechanical Engineers (ASME): B19.3, Safety Standard for Compressors for Process Industries.
4. American Water Works Association (AWWA): C704, Propeller-Type Meters for Waterworks Applications.
5. Electronic Industries Alliance (EIA):
   a. TIA-232-F, Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
   b. 485, Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multi-point Systems.
6. Federal Communications Commission (FCC).
7. International Organization for Standardization (ISO): 8802-3, Information Technology - Telecommunication and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Carrier Sense Multiple Access with Detection (CSMA/CD) Access Method and Physical Layer Specifications.
8. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
9. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code.
   b. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
10. Underwriters Laboratories, Inc. (UL): 916, Standard for Safety Energy Management Equipment.

1.02 DEFINITIONS

A. The terms “HVAC Control System,” “Automatic Temperature Control System,” “Building Automation System,” and “Environmental Management and Control System” shall be considered equivalent and used interchangeably for the purposes of this Contract.

B. Algorithm: A software procedure for solving a recurrent mathematical or logical problem.

C. Analog: A continuously varying signal or value (temperature, current, velocity, etc.).

D. Binary: A two-state system where an “ON” condition is represented by a high signal level and an “OFF” condition is represented by a low signal level.

E. Control Wiring:

1. Wiring, high or low voltage other than power wiring required for proper operation of mechanical systems.
2. Includes conduit, wire and wiring devices to install complete control system including motor control circuits, interlocks, thermostats, PE and EP switches and like devices.
3. Includes wiring from DDC cabinet to all sensors and points defined in the Points List summary or specified herein and required to execute sequence of operation.
4. Includes necessary power wiring to HVAC control devices, digital controllers including terminal units and actuators.

F. Control Process: Software required to complete control loop from input signal to interlock logic and process calculation to final output signal control.

G. Deadband: Temperature range over which no heating or cooling energy is supplied, such as 72 degrees F to 78 degrees F; as opposed to single point changeover or overlap, or a range from set point over which no control action is taken.

H. Direct Digital Control (DDC): Consists of microprocessor-based controllers with control logic performed by software. Analog-to-digital (A/D) converters transform analog values into digital signals that microprocessor can use.

I. Power Wiring: Line voltage wiring to mechanical equipment. Line voltage wiring that also serves as control circuit, such as line voltage thermostat or involves interlocking with damper shall be considered control wiring.

J. Abbreviations that may be used in this section:

1. AC: Air Conditioning.
2. ATC: Automatic Temperature Control.
3. BAS: Building Automation System.
4. CHWS/R: Chilled/Hot Water Supply/Return.
5. CMOS: Complementary Metal Oxide Semiconductor.
6. DDC: Direct Digital Control.
7. DX: Direct Expansion.
8. EP: Electro-Pneumatic.
9. EEPROM: Electronic Erasable Programmable Read Only Memory.
10. EMCS: Environmental Management and Control System.
11. HCP: HVAC Control Panel.
12. HGS/R: Hot Glycol Supply/Return.
13. HMI: Human-Machine Interface.
14. HOA: Hand-Off-Auto (Switch).
15. HVAC: Heating, Ventilation, and Air Conditioning.
16. IP: Current (I) - Pressure (P), as in IP transducer.
17. LCD: Liquid Crystal Display.
18. LED: Light Emitting Diode.
19. PE: Pneumatic-Electric.
20. PLC: Programmable Logic Controller.
21. RAM: Random Access Memory.
22. RTD: Resistance Temperature Detectors.
23. VAV: Variable Air Volume.
24. W3: Nonpotable Water.
25. DB: Dry bulb temperature.
26. WB: Wet bulb temperature.

1.03 SYSTEM DESCRIPTION

A. General Requirements:

1. Provide control wiring, power wiring, conduit, hardware, and electrical work associated with the HVAC control system.
2. Provide control wiring between HVAC control panel contacts and field control devices.
3. Provide controls necessary for entire system to have fail-safe operation.
4. Control sequences and functions including alarms, monitoring and resetting functions, and operational sequences shall not be limited to point schedules and sequences of operation.
5. Provide sequences and functions as required to deliver a fully functioning HVAC system.

B. Control System Types:

1. The following control system types may be used in this Project:
   a. Electric/Electronic Control System (ELECTRIC):
      1) System using simple electric or electronic control devices.
      2) User interface at control device.
   b. Standalone DDC Control System (STANDALONE DDC):
      1) Microprocessor-based DDC Control System utilizing standalone DDC controllers.
      2) No information sharing between controllers.
      3) User interface at DDC controller.
2. Provide control system(s) of architecture as required to meet the intent of the sequences of operations as shown on the Drawings.

C. Performance Requirements: Design control system and equipment to perform under the following conditions:

1. Temperature, Ambient:
   a. Summer maximum 92 DB/80 WB degrees F.
   b. Winter minimum 39 DB degrees F.
   c. Based on ASHRAE Handbook Fundamentals weather data for the City of Bradenton, FL.
2. Temperature, Indoor:
   a. Air-conditioned Electrical Room: Summer maximum 80 degrees F; winter minimum 60 degrees F.

1.04 SUBMITTALS

A. Action Submittals:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that includes make, model, dimensions, weight of equipment, and electrical schematics, for all control system components.
2. Complete system power, interlock, control, and data transmission wiring diagrams no smaller than 11 inches by 17 inches.
3. Complete drawings and schematics of proposed control system, including panel power requirements.
4. System operating sequences to be programmed, in exact English language.
5. Complete points list.
6. Interfaces with HVAC equipment.
   a. Schematic diagram of each equipment item.
   b. Indicate location of each control item in equipment.
   c. Show equipment manufacturer controls where installed.
7. Panel face layout drawings.

B. Informational Submittals:

1. Table identifying which member of Contractor's team is responsible for furnishing and setting in-place power wiring and control wiring of each item or component of HVAC equipment.
2. Recommended procedures for protection and handling of equipment and materials prior to installation.
3. Certificates, in accordance with Division 01, General Requirements:
   a. Manufacturer's Certificate of Compliance.
   b. Manufacturer's Certificate of Proper Installation.
4. Confirmation that control system Supplier has received, and coordinated with all approved HVAC equipment submittals.
5. Experience and qualifications of control system Supplier's proposed representative who will supervise installation, adjustment, and calibration of control systems.
6. Performance test plan and schedule.
7. Test Results:
   a. Functional and performance test documentation.
   b. Component calibration sheets for each instrument and panel component as described in Section 40 90 00, Instrumentation and Control for Process systems.
8. Operation and maintenance data:
   a. Operation and maintenance instructions for control system as furnished and installed, including control of associated mechanical and electrical equipment.
   b. Record of system adjustments and calibration methods.
   c. Performance test results.

1.05 QUALITY ASSURANCE

A. Materials, devices, appliances, and equipment used shall be indicated as acceptable by established standards of Underwriters Laboratories, Inc. (UL).

B. Codes and Standards: Meet requirements of applicable standards and codes, except when more detailed or stringent requirements are indicated by Contract Documents, including requirements of this section.

1. Underwriters Laboratories: Products shall be UL 916-PAZX listed.
2. National Electrical Code NFPA 70.
3. Federal Communications Commission Part J.

C. Qualifications of HVAC Controls System Supplier:

1. Minimum of 5 years' experience as manufacturer's authorized representative in design, installation, and maintenance of manufacturer's system and products.

2. Capable of furnishing factory-trained technicians, competent to provide instruction, routine maintenance, and emergency service onsite within 4 hours after receipt of request.
3. Factory trained certified engineering and commissioning staff, and complete offsite training facilities.

D. FCC Regulation: Electronic equipment shall conform to requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.

E. Compatibility:

1. System shall have documented history of compatibility by design for minimum of 15 years. Future compatibility shall be supported for no less than 10 years.
2. Compatibility shall be defined as:
   a. Ability to upgrade existing field panels to current level of technology, and extend new field panels on previously installed network.
   b. Ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers, or protocol converters.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handle and store products in accordance with manufacturer's written instructions and in a manner to prevent damage. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.

B. Manufacturer's instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.

D. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust damage.

E. After installation, provide coverings to protect products from damage because of traffic and construction operations. Remove coverings when no longer needed.

F. Corrosion Protection:

1. Control panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, shall be protected from corrosion through use of corrosion-inhibiting vapor capsules.
2. Prior to shipment, capsules shall be provided within shipping containers and equipment as recommended by capsule manufacturer.
3. During construction period, capsules shall be replaced in accordance with capsule manufacturer's recommendations.

1.07 EXTRA MATERIALS

A. Tools:

1. For each building, furnish one complete set of special tools recommended by manufacturer for maintenance, dismantling, or repair of each separate type of equipment item.
2. Furnish toolbox for storage of special tools. Identify purpose by means of stainless steel or solid plastic nametag attached to box.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified shall be products of the following manufacturers, unless indicated otherwise:

1. Allen-Bradley.
2. Siemens Building Technologies.
3. Johnson Controls.
4. Honeywell.
5. Invensys.
6. Alerton Technologies.
7. Automated Logic Corporation.

2.02 MATERIALS

A. General:

1. Products used in this installation shall be new, currently under manufacture, and shall have been applied in similar installations for minimum of 5 years.

2. System shall not be used as test Site for new products, unless explicitly approved by Owner's representative, in writing.

B. Control Components:

1. Control range to obtain specified capacities.
2. Sensitivity to maintain control points close enough to set point for acceptable offset, without cycling equipment more frequently than recommended by manufacturer.
3. Field or computer adjustable to actual set point, ranges. Adjustable to other settings that will provide proper operation of entire control system.

C. Controls Interfacing:

1. Interface controls properly with factory supplied components of mechanical systems. Coordinate special control interfacing requirements.
2. For equipment that requires special interfacing with control system, provide equipment with integral controls or provide accessory devices required for operation of total mechanical system.
3. Coordinate interfaces with electrical work as necessary.
4. Provide electric, electronic, and mechanical devices as required to properly interface with prewired control panels furnished with HVAC equipment and with other mechanical and electrical components.

2.03 LABELING

A. All products, namely electrical materials, devices, appliances, and equipment used, shall be indicated as acceptable by established standards of Underwriters Laboratories, Inc. (UL) and Factory Mutual (FM).

B. Valid label affixed to item shall provide indication of product acceptance by required agencies.

C. HVAC control panels and control components that consist of multiple components shall bear UL listing mark on unit.

2.04 SERVICE CONDITIONS

A. Refer to Division 01, General Requirements, Section 26 05 02, Basic Electrical Requirements, and Electrical Drawings for classification of areas as hazardous, corrosive, wet, indoor dry, and dust-tight.

B. Use materials and methods, and enclose devices in NEMA enclosure types suitable for classification indicated, and as required by NFPA 70.

2.05 ELECTRICAL COMPONENTS AND ACCESSORIES

A. Electrical components shall be provided in accordance with requirements of Division 26, Electrical.

B. Wiring:

1. In accordance with Section 26 05 05, Conductors, and NFPA 70.
2. Insulation shall be rated 600 volts, minimum.

C. Electrical Raceways: In accordance with Section 26 05 33, Raceway and Boxes, and NFPA 70.

D. Provide surge suppressors on each power connection, meeting applicable requirements of Section 40 90 00, Instrumentation and Control for Process Systems.

2.06 FIELD COMPONENTS AND INSTRUMENTS

A. Refer to HVAC controls detailed specification, Section 23 09 13, HVAC Controls, Field Components, and Instruments.

2.07 ACCESSORIES

A. Corrosion-inhibiting vapor capsules as manufactured by:

1. Northern Instruments; Model Zerust VC.
2. Hoffman; Model A-HCI.

B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

C. Equipment Identification Plates:

1. Provide 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification tag number indicated in this Specification and as shown.
2. Provide adjacent to the following control devices, and for equipment whose function is not readily apparent.
   a. Night low limit thermostats.
   b. Manual override timers.
   c. START/STOP switches.

d. Humidistats.
e. Emergency STOP switches.
f. Special purpose devices.
g. HVAC control panels.

D. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer.

2.08 EQUIPMENT FINISH

A. Provide materials and equipment with manufacturer's standard finish system. Provide manufacturer's standard finish color, except where specific color is indicated.

B. If manufacturer has no standard color, provide gray finish as approved by Owner.

PART 3 EXECUTION

3.01 SEQUENCES OF OPERATION

A. Reference Contract Drawings.

3.02 INSTALLATION

A. General:

1. Install systems and materials in accordance with manufacturer's instructions, rough-in Drawings, and equipment details.
2. Changes in location or installation of control devices or equipment shall be approved by Engineer before proceeding with the Work.
3. Mount devices requiring manual reset and all other user serviceable control devices in readily accessible locations.

B. Hazardous and Corrosive Areas:

1. Control equipment and wiring shall be suitable for corrosive environments.
2. Protect control equipment located in areas identified as being corrosive as follows:
   a. Use corrosion-inhibiting vapor capsules inside control equipment enclosures and HCP.
   b. Replace capsules prior to Owner's acceptance of equipment.

C. Wiring:

1. General:
   a. Install electric wire, cable, fittings, and conduit associated with systems specified in this section, in accordance with requirements of NFPA 70.
   b. Install control and interlock wiring separate from power wiring.
   c. Number code or color code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.
   d. Provide wire markers on each conductor in panel and at load connections. Identify circuit with control wire number.
   e. Restrain wiring in control panels by plastic ties or ducts.
   f. Hinge wiring shall be secured at each end so that any bending or twisting will be around longitudinal axis of wire and bend area shall be protected with sleeve.
   g. Arrange wiring neatly, cut to length, and remove surplus wiring. Provide abrasion protection for any wire bundles that pass through holes or across edges of sheet metal.
   h. Use manufacturer's recommended tool with proper sized anvil for crimp terminations. No more than two wires may be terminated in single crimp lug and no more than two lugs may be installed on single screw terminal.
   i. Wiring shall not be spliced or tapped except at device terminals or terminal blocks.
   j. Properly support and run wiring in a neat manner.
   k. Run wiring parallel or at right angles to building structure.
2. Concealment:
   a. Generally conceal wiring from view, except in mechanical rooms and areas where other conduit and piping are exposed; install exposed wiring and conduit to be as unobtrusive as possible.
   b. Install line voltage control wiring, wiring exposed to view, surface-mounted wiring, and wiring concealed within walls in conduit, in accordance with Division 26, Electrical.
   c. Wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.
   d. Conduit shall be sized to suit the number, type, and size of conductors as specified in Section 26 05 05, Conductors.

D. End-User Accessible Control Components:

1. Do not mark room thermostats.
2. Mount user adjustable control components (room thermostats) level and in accordance with applicable accessibility requirements of local Building Code.

E. DDC Controllers:

1. Verify control wiring for correctness.
2. Verify power wiring.
3. Calibrate and adjust manual and auto control actions of controllers.
4. Tune control loop.
5. Stroke associated final element through controller output.
6. Verify set points and alarm functions.

F. HVAC Control Panel (HCP) Equipment:

1. Mount HCPs level, plumb, and securely to wall or column. Verify that adequate clearance is provided to allow for full front panel swing.
2. Provide field terminations and conduit knockouts for control/instrumentation wiring.
3. Field termination wiring shall have designated instrument tag.
4. Panel cutouts shall be cut, punched, or drilled and smoothly finished with round edges.
5. Provide separate conduit entry for each power feeder circuit.
6. Signals requiring grounding shall be grounded within panel.
7. Field end of conductor shield/drain wires shall be folded back and placed under heat-shrink tubing without being grounded.
8. Panel end of conductor shield/drain wires shall be covered with clear tubing at panel and grounded.
9. Calibrate instrumentation provided on control panels.
10. Provide labels for internal panel material (e.g., terminal blocks, power supplies, relays, PLC racks).

3.03 FIELD QUALITY CONTROL

A. Performance and Functional Testing:

1. Tests and certification shall be as specified in Division 01, General Requirements.
2. HVAC controls interface with process control system shall be coordinated with the Work of Section 40 90 00, Instrumentation and Control for Process Systems.

3.04 MANUFACTURER'S SERVICES

1. Provide manufacturer's services in conformance with requirements of Division 01, General Requirements.

2. Manufacturer's Representative: Present at Site or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:
   a. 1 person-day for installation, assistance, and inspection.
   b. 1/2 person-day for functional and performance testing and Manufacturer's Certificate of Proper Installation.
   c. 1 person-day for facility startup and training.

3.05 TRAINING

A. Provide training of Owner's personnel to enable them to operate HVAC equipment in available modes, to adjust set points, and to interpret alarm signals.

B. Training sessions shall be prepared in advance, and arranged for clear, effective transfer of information in minimum time.

3.06 ADJUSTING AND CALIBRATING

A. Control system shall be adjusted and calibrated by qualified manufacturer's representative.

B. Calibrate control devices at time of installation to ensure measuring and reading accuracy.

C. Adjustment Record:

1. Prepare complete record of system adjustments for each control system.
2. Indicate deviations from specified temperatures.
3. Include copy of completed record in each copy of Operation and Maintenance Manual.

3.07 CLEANING AND TOUCHUP PAINTING

A. Touchup scratches, scrapes, or chips in exterior surfaces with finish matching type, color, consistency, and type of surface of original finish.

END OF SECTION

SECTION 23 09 13
HVAC CONTROLS, FIELD COMPONENTS, AND INSTRUMENTS

PART 1 GENERAL

1.01 GENERAL

A. This section is a supplement to Section 23 09 00, Instrumentation and Control Devices for HVAC.

B. The requirements of this section shall be provided in addition to those listed in Section 23 09 00, Instrumentation and Control Devices for HVAC.

1.02 EXTRA MATERIALS

A. HVAC Control Panel (HCP) Spare Lamps: Furnish spare lamps for each type and color of pilot light used, a minimum of one per HCP, stored inside HCP in dummy light sockets secured to back panel surface.

PART 2 PRODUCTS

2.01 HVAC CONTROL PANELS (HCP)

A. Provide at locations shown on Drawings for convenient operator interface with control system.

B. A single 120-volt, 20-amp feeder shall serve each HCP, unless otherwise indicated.

C. HCP Contents: Set point adjustment dials, gauges, receiver controllers, manual timers, time clocks, microprocessor control modules, electronic indication relays, control switches, transformers, pilot lights, alarm lights, display screens, keypads, and other devices necessary for particular system.

D. HCP Construction:

1. Construct each HCP to NEMA 250 rating as indicated in Schedule below, except where indicated otherwise:

HVAC Control Panel (HCP) NEMA 250 Construction Schedule

Location	NEMA 250 Type
All Areas, Indoor	12
All Areas, Outdoor	3R

2. Metal enclosure to accommodate secure conduit fittings and protect against electrical transients.
3. Hinged front door with locking handle.
4. Flush-mount manual switches, pilot lights, and direct-reading gauges on front panel face.
5. Identify front panel mounted devices and HCP with labeling in accordance with Section 23 09 00, Instrumentation and Control Devices for HVAC.

E. Panel Listing: Panels shall bear UL or ETL listing mark stating “LISTED ENCLOSED INDUSTRIAL CONTROL PANEL.”

F. Control Devices:

1. Mount inside HCP.
2. Prewired internally.
3. Terminate wires leaving HCP at separately numbered terminal strips (one terminal pair per circuit).
4. Furnish individual connectors for every item of mechanical equipment, integral and remote pilot lights, and other devices described for each panel.
5. Refer to Drawings for power and control circuit requirements.
6. Identify wires by color coding or numerical tags at both ends.
7. Wire control devices without splices to the terminal strip.
8. Furnish integral circuit protection for panel mounted control devices.

G. Terminal Blocks:

1. One-piece molded plastic blocks with screw type terminals and barriers rated for 600 volts.
2. Double sided and supplied with removable covers to prevent accidental contact with live circuits.
3. Furnish permanent, legible identification, clearly visible with protective cover removed.
4. Terminate wires at terminal blocks with crimp type, pre-insulated, ring-tongue lugs.
5. Size lugs for terminal block screws and for the number and size of wires terminated.
6. Provide screwdriver access for blade width of a minimum of 3/16 inch or Klein 601 Series screwdrivers. Terminals requiring use of special screwdrivers are not acceptable.

H. Miscellaneous Accessories:

1. Furnish panel as-built electrical wiring diagrams and schematics, secured to inside of panel door, or enclosed in plastic jackets placed inside each panel.
2. Install plastic or stick-on labels on interior control devices to identify them in conjunction with control schematics.

2.02 ELECTRIC THERMOSTATS (ET)

A. Thermostat:

1. Modulating electric type, except where two-position action is required.
2. Temperature Scale: Furnish 50 to 100 degrees F dial.
3. External adjustments.
4. Adjustable sensitivity.
5. Insulating back where exterior wall mounting is indicated.
6. Nonlocking wire protective guard.

2.03 MISCELLANEOUS DEVICES

A. General:

1. RTD to voltage (0- to 5-volt) converters with zero span adjustments for use with analog inputs.
2. Limited range thermistors are acceptable provided they sense expected range for point at specified accuracy with 0- to 5-volt output.
3. Auxiliary contacts in each motor starter, Work of Division 26, Electrical.
4. START/STOP relay module for either momentary or maintained switch action as indicated.

B. Pilot Relays:

1. Plug-in type.
2. Interchangeable.
3. Mounted on a circuit board.
4. Wired to numbered terminal strips.

C. Motorized Step Controllers: Furnish with adjustable (from 1 to 10 degrees F) deadband between heating and cooling functions.

D. Electronic Indication:

1. Furnish temperature-indicating dials or digital read-outs on HCP.
2. 2-1/2-inch minimum rectangular.
3. Temperature sensing dc bridge circuit.

E. HVAC System Emergency Shutdown Switch (ESS):

1. Wall-mounted, break-glass type manual pull switches for HVAC system emergency shutdown.
2. Noncoded, single action, single pole.
3. Surface mounting type.
4. Provided with red laminated plastic nameplate with engraved white letters 1/2-inch high reading, “VENTILATION SYSTEM EMERGENCY SHUTOFF SWITCH,” wall mounted directly above each switch.
5. Manufacturers and Products:
   a. Simplex; 2099 Series.
   b. Edwards; 270 Series.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 760, Solenoid Valves for Use with Volatile Refrigerants.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): 15, Safety Standard for Refrigeration Systems.
3. American Society of Mechanical Engineers (ASME):
   a. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   b. B31.5, Refrigeration Piping and Heat Transfer Components.
4. American Welding Society (AWS): A5.8/A5.8M, Specification for Filler Metals for Brazing and Braze Welding.
5. ASTM International (ASTM):
   a. B32, Standard Specification for Solder Metal.
   b. B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
6. National Electrical Manufacturers Association (NEMA).
7. Underwriters Laboratories Inc. (UL).

1.02 DEFINITIONS

A. ACR: Air conditioning and refrigeration.

B. NRTL: National Recognized Testing Laboratory.

1.03 SUBMITTALS

A. Action Submittals: Manufacturer’s data on refrigerant piping, piping products, thermostatic expansion valves, solenoid valves, hot-gas bypass valves, filter dryers, strainers, pressure regulating valves and accessories.

B. Informational Submittals:

1. Welding certificates.
2. Field quality control; test report.

1.04 QUALITY ASSURANCE

A. Safety Code Compliance: Comply with applicable portions of ASHRAE 15.

B. Brazing: Comply with applicable requirements of ASME B31.5 pertaining to brazing of refrigerant piping for shop and Project Site locations.

C. Installer: A firm with at least 5 years of successful installation experience on projects with refrigerant piping similar to that required for this Project.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Refrigerant piping shall be cleaned, dehydrated, and sealed when delivered.

B. Store piping in a clean and protected area with end caps in-place.

PART 2 PRODUCTS

2.01 MATERIALS

A. Material and dimensional requirements for field assembled refrigerant piping, valves, fittings and accessories shall conform to ASHRAE 15 and ASME B31.5, except as hereinafter specified.

B. Piping, 3 Inches and Smaller: Copper, Type ACR (air-conditioning and refrigeration) tube, ASTM B280, copper No. 122, hard-drawn temper. Brazed joints required.

C. Fittings for Copper Tube: Wrought-copper/bronze solder-joint fittings in accordance with ASME B16.22.

D. Pipe Insulation: Type P3—Elastomeric (ASTM C534, Minus 40 Degrees F to 220 Degrees F):

1. Flexible, closed cell elastomeric.
2. Nominal 6 pcf density, K factor 0.27 maximum at 75 degrees F mean.
3. Water vapor transmission 0.1 perm-inch, or less.
4. Manufacturers and Products:
   a. Armacell; AP Armaflex.
   b. Nomaco; K-Flex LS.
   c. Rubatex; R-180-FS.

E. Insulation finish system: Type F3—Aluminum.

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100 or 3105 to ASTM B209 with H-14 temper, minimum 0.016-inch thickness, with smooth mill finish.

2. Moisture Barrier: Provide factory applied moisture barrier, consisting of 40-pound kraft paper with 1-mil-thick low-density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, etc.
4. Manufacturer and Product: RPR Products; INSUL-MATE.

2.02 MISCELLANEOUS PIPING PRODUCTS

A. Soldering Materials: Silver-Lead Solder: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

B. Brazing Materials:

1. Except as otherwise indicated, provide a 15 percent silver alloy brazing material for copper to copper and copper to brass fittings.
2. Comply with AWS A5.8/A5.8M for brazing filler materials.

C. Refrigerant Specialties:

1. Refrigerant Suction Line Filter-Dryer:
   a. Provide steel shell, corrosion-resistant finish filter-dryer, with molded felt core with 10-micron particle retention, in size and working pressure indicated, with copper connectors, and access valve (not applicable for heat pump system).
   b. Provide size recommended by refrigeration equipment manufacturer.
2. Refrigerant Liquid Line Dryer:
   a. Provide refrigerant liquid line filter-dryer for all units.
   b. For heat pumps, provide biflow directional types (not required if included with air-conditioning equipment).
   c. Provide size recommended by refrigeration equipment manufacturer.

D. Refrigerant Valves:

1. Globe and Check Valves: Listed and labeled by an NRTL.
   a. Shutoff Valves:
      1) Forged brass, packed, back seating winged seal cap, 300 degrees F (140 degrees C) temperature rating 500 psi working pressure.
      2) Maximum Opening Pressure: 0.5 psig.
      3) Valve required only if shutoff service valves are not included with package air-conditioning equipment.

b. Manufacturers:
   1) Henry Technologies.
   2) Parker Hannifin Corp.; Refrigeration and Air-Cond. Div.
   3) Sporlan Valve Co.

2. Solenoid Valve:
   a. Two-Way Solenoid Valves: Forged brass, designed to conform to AHRI 760, normally closed, Teflon valve seat, NEMA 1 solenoid enclosure, 24 volts, 60-Hz, UL Listed, 1/2-inch conduit adapter, 250 degrees F (121 degrees C) temperature rating 400 psi working pressure.
   b. Listed and labeled by an NRTL.
   c. Provide valve only if recommended by air-conditioning equipment manufacturer.
   d. Manual Operator: Provide optional manual operator to open valve.
   e. Manufacturers:
      1) Alco Controls Div.; Emerson Electric Co.
      2) Automatic Switch Co.
      3) Sporland Valve Co.
3. Hot Gas Bypass Valve: Listed and labeled by an NRTL.
   a. Body Bonnet and Seal Cap: Ductile iron or steel.
   b. Solenoid Tube, Plunger, Diaphragm, Piston, Closing Spring, Seat Orifices, and Seat Insert: Stainless steel.
   c. Seat: Polytetrafluoroethylene.
   d. Manufacturers:
      1) Parker Hannifin Corp., Refrigeration Division.
      2) Sporland Valve Company.
      3) PE Valve Company.
4. Thermostatic Expansion Valve:
   a. Body Bonnet and Seal Cap: Forged brass or steel.
   b. Diaphragm, Piston, Closing Spring and Seat Insert: Stainless steel.
   c. Capillary and Bulb: Copper tubing filled with refrigerant.
   d. Suction Temperature: 40 degrees F.
   e. End Connections: Socket or flare.
   f. Working Pressure: 700 psig.
   g. Manufacturers:
      1) Henry Technologies.
      2) Sporland Valve Company.
      3) Danfoss Group Global.
5. Safety Relief Valve:
   a. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
   b. Seat Disk: Polytetrafluoroethylene.
   c. Working Pressure: 400 psig.
   d. Operating Temperature: 240 degrees F, maximum.

e. Manufacturers:
   1) Henry Technologies.
   2) Parker Hannifin Corp., Refrigeration Division.
   3) Danfoss Group Global.

E. The support material shall be Galvanized steel or precoated steel, plastic coat hangers for uninsulated copper or stainless steel piping.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING SYSTEM

A. Install piping products in accordance with manufacturer's written instructions, applicable requirements of ASME B31.5, ASHRAE 15, and in accordance with recognized industry practices to ensure products serve intended function.

B. Install dryers on liquid and suction lines.

C. Refrigerant Piping:

1. Cut pipe accurately to measurements established at Site and work into place without springing or forcing.
2. Install piping with sufficient flexibility to adequately provide for expansion and contraction as a result of temperature fluctuation inherent in its operation.
3. Where pipe passes through building structure, pipe joints shall not be concealed, but located where they may be readily inspected.
4. Run pipe to be insulated as shown and as required with sufficient clearance to permit application of insulation.
5. Run piping as shown on Drawings, taking care to avoid interference with other piping, conduit or equipment. Except where specifically indicated otherwise, run piping plumb, and straight and parallel to walls and ceilings.
6. Trapping of lines shall not be permitted, except where indicated.
7. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
8. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.
11. Install refrigerant piping in protective conduit where installed belowground.
12. Install an accumulator in the suction line near the condensing unit.
13. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

14. Slope refrigerant piping as follows:
    a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
    b. Install horizontal suction lines with a uniform slope downward to compressor.
    c. Install traps and double risers to entrain oil in vertical runs.
    d. Liquid lines may be installed level.

D. Pipe Sleeves:

1. Provide pipe sleeves of suitable size for pipe and tubing that penetrate building structure.
2. Sleeves shall be secured in position and location before and during construction. Space between pipe and sleeves, or between insulation and pipe sleeves, shall be not less than 1/4 inch between outside of pipe or insulation, and inside wall of sleeves.
3. Sleeves for uninsulated pipes shall have ends flush with finished wall surfaces and the pipe or tubing shall be provided as above, with outside perimeter of pipe caulked to sleeve.
4. Extend sleeves for insulated pipes 1/2 inch from the wall faces and caulk to the sleeve on both sides.
5. Seal terminal ends of pipe insulation with mastic.
6. Extend sleeves for lines passing through floors 3 inches above finished floor slab and caulk to the slab.

E. Solder cap (seal) ends of piping when not connected to mechanical equipment.

3.02 SOLDER JOINTS

A. Solder joints shall not be used for joining refrigerant piping systems; refer to Paragraph Brazed Joints.

3.03 BRAZED JOINTS

A. Braze copper piping with silver solder complying with AWS A5.8/A5.8M.

B. Brazed Joints:

1. Construct joints according to AWS “Brazing Handbook” Chapter “Pipe and Tube.”
2. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
3. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

C. Inside of tubing and fittings shall be free of flux.

D. Clean parts to be joined with emery cloth and keep hot until solder has penetrated the full depth of the fitting and extra flux has been expelled.

E. Cool joints in air and remove flame marks and traces of flux.

F. During brazing operation, prevent an oxide film from forming on inside of tubing by slowly flowing dry nitrogen to expel the air.

G. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

3.04 PIPE HANGERS

A. The support material shall be galvanized steel or precoated steel, plastic coat hangers for uninsulated copper or stainless steel piping.

3.05 EQUIPMENT CONNECTIONS

A. Connect refrigerant piping to mechanical equipment in the manner shown, and comply with equipment manufacturer’s instructions where not otherwise indicated.

3.06 FIELD QUALITY CONTROL

A. General:

1. Notify Engineer at least 48 hours before any testing is performed.
2. Furnish equipment required for the tests.
3. Group as many systems together as possible when testing in order to consolidate the number of test inspections.

B. Leak Test:

1. Prior to initial operation, clean and test refrigerant piping in accordance with ASME B31.5.
2. Perform initial test with dry nitrogen to 200 psi minimum using soap solution to test joints.
3. Evacuate system after initial test and charge system with refrigerant or dry nitrogen, 20 percent refrigeration mixture to 200 psi minimum.

4. Upon completion of the initial system test, test factory, as well as field, refrigerant piping joints with electronic-type leak detector to acquire a leak-tight refrigerant system.
    a. If leaks are detected, remove entire refrigerant charge for the system, replace defective pipe or fitting, and retest entire system as specified above.

C. Evacuation, Dehydration, and Charging:

1. After system is found to be without leaks, evacuate the system using a reliable gauge and a vacuum pump capable of pulling a vacuum of at least 1-mm Hg absolute (29.88-inch Hg gage).
2. Evacuate system with vacuum pump until temperature of 35 degrees F (2 degrees C) is indicated on vacuum dehydration indicator.
3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
4. Maintain vacuum on system for minimum of 12 hours after closing valve between vacuum pump and system. If system holds vacuum for 12 hours it is ready for charging.
5. Break vacuum with refrigerant gas or dry nitrogen gas, allowing pressure to build up to 2 psi (15 kPa).
6. Install new filter-dryer core in charging line.
7. Repeat evacuation procedure and complete charging of system; provide full operating charge.

3.07 ADJUSTING

A. General:

1. Adjust high-pressure and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
2. Adjust set-point temperature of air-conditioning controllers to the system design temperature.

B. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 81 00
UNITARY AIR-CONDITIONING EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning and Refrigeration Institute (ARI): 210/240, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. Air Moving and Conditioning Association (AMCA): Bulletin 300, Setup No. 1.
3. American Gas Association (AGA).
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
   a. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   b. 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
5. American Society of Mechanical Engineers (ASME): Section IX, Welding and Brazing Qualifications.
6. ASTM International (ASTM):
   a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
   b. D2370, Standard Test Method for Tensile Properties of Organic Coatings.
   c. D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
   d. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   e. G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
7. Canadian Standards Association (CSA).
8. ETL Testing Laboratories (ETL).
9. International Organization for Standardization (ISO):
   a. 9001, Quality Management Systems - Requirements.
   b. 13256-1, Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps.
10. National Electrical Manufacturers Association (NEMA).
11. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
12. Underwriters Laboratories Inc. (UL): 94-5V, Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Air Conditioning.
2. COP: Coefficient of Performance.
3. EER: Energy Efficiency Ratio.
4. DX: Direct Expansion.
5. HP: Heat Pump.
6. IR: Infra Red.
7. LED: Light Emitting Diode.
8. PSC: Permanent Split Capacitor.
9. PTAC: Packaged Terminal Air Conditioner.
10. SPST: Single Pole, Single Throw.
11. TXV: Thermostatic Expansion Valve.
12. UV: Ultraviolet.

1.03 SUBMITTALS

A. Action Submittals:

1. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for all products specified.
2. Manufacturer's standard finish color selection for enclosure finishes.
3. Complete performance data that will indicate full compliance with the specifications:
    a. Include fan sound power level data (ref. 10 to 12 watts) at design operating point, based on AMCA Bulletin 300, Setup No. 1.
    b. Include heating and cooling performance data at design operating conditions.
4. Factory applied protective coating product data.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance in accordance with Section 01 43 33, Manufacturers' Field Services, for air-conditioning units, and motors.
2. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement or details shown to equipment furnished.
3. Sample copy of guarantee.
4. Test reports.

5. Operation and Maintenance Data in conformance with Section 01 78 23, Operation and Maintenance Data.
    a. Include wiring and control diagrams for equipment.
    b. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Heating and Cooling Equipment: Minimum operating efficiencies, defined as COP and EER, as specified in FLORIDA ENERGY CONSERVATION CODE 2010.

B. Unit shall be rated (when matched with appropriate outdoor unit) per ARI 210/240.

C. Units shall be certified by UL and CSA, and shall be UL or ETL listed and labeled.

D. Cooling performance rated in accordance with ARI testing procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

B. Protection of Equipment:

1. Box, crate, or otherwise protect from damage and moisture during shipment, handling, and storage.
2. Protect from exposure to corrosive fumes and keep thoroughly dry at all times.
3. Store motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings in weathertight and heated storage facilities prior to installation.
4. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

1.06 SPECIAL GUARANTEE

A. Refrigerant Compressors: Furnish 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 compressors specified in this Specification section 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 as specified in the General Conditions.

1.07 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following materials:

Item	Quantity
Fan Belts	One complete set for each belt-driven fan.
Filters	One complete set per unit.

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Specified components of this Section, including insulation, facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

2.02 EQUIPMENT SCHEDULES

A. Refer to Drawings.

2.03 SPLIT SYSTEM AC INDOOR UNIT (UP TO 5 NOMINAL TONS)

A. General:

1. Indoor mounted, draw-through, packaged air-handling unit consisting of forward-curved centrifugal fan(s), motor and drive assembly, prewired fan motor contactor, factory-installed refrigerant metering devices, cooling coil, disposable air filters, and condensate drain pan.
2. Suitable for use with air conditioner or heat pump outdoor unit.
3. Indoor unit shall be of the same manufacturer as the associated outdoor unit.
4. Modular design vertical upflow, field convertible for vertical downflow, or horizontal flow.

B. Unit Cabinet:

1. Heavy gauge galvanized steel sheets.
2. Phosphatized and factory finished in manufacturer’s standard enamel paint.
3. Sufficient removable panels for access to all internal components.

4. Interior of casing insulated with 1-inch, 1-pound density coated glass fiber insulation attached with adhesive material.
5. Duct flanges for connection of supply and return ductwork, and filter racks.
6. Knockouts for unit electrical power and condensate piping connections.

C. Evaporator Fan:

1. Double-inlet, double-width, forward-curved fans mounted on rubber isolators.
2. Direct-drive or belt-drive as standard with the unit furnished.
3. Fan Motor:
   a. Totally enclosed and permanently lubricated with inherent protection.
   b. ECM Motor.

D. DX Evaporator Coil:

1. Copper tube with aluminum fins and galvanized steel tube sheets.
2. Fins bonded to tubes by mechanical expansion.
3. Condensate Drain Pan: High-impact thermoplastic, insulated, sloped in two planes, with primary and secondary brass drain fittings.
4. Refrigerant piping sweat connections.

E. Controls:

1. Refrigerant Metering: Factory installed refrigerant metering device.
2. Magnetic contactor for fan.
3. Overload protection in each leg.
4. Control voltage transformer.
5. Terminal strip for connection of remote controls.
6. Control board fusing.

F. Air Filters: Disposable 1-inch thick strainer type with pleated nonwoven fabric media.

G. Accessories: Provide as scheduled in Equipment Schedule.

H. Manufacturers:

1. Trane.
2. Carrier.
3. Rheem.
4. Lennox International.
5. York Air Conditioning.

2.04 SPLIT SYSTEM AC OUTDOOR UNITS

A. General:

1. Factory assembled, single piece, air-cooled air conditioner outdoor unit.
2. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, and holding charge of R-410A refrigerant.
3. Outdoor unit shall be of the same manufacturer as the associated indoor unit.

B. Unit Cabinet:

1. Constructed of galvanized steel, phosphatized and coated with a baked enamel finish. Finish shall pass the 500-hour salt spray test.
2. Removable access panels for access to all internal components.
3. Outdoor Compartment: Isolated, with acoustic lining to assure quiet operation.
4. Knockouts for unit electrical power.

C. Condenser Fans:

1. Direct-drive propeller type shall discharge air vertically and shall blow air through outdoor coil.
2. Motors:
   a. Totally enclosed, with Class B insulation and permanently lubricated bearings.
   b. Thermal overload protection.
3. Shaft of galvanized or stainless steel construction.
4. Fan blades shall be corrosion-resistant and shall be statically and dynamically balanced.
5. Equip openings with PVC-coated protection grille over fan and coil.

D. Compressor:

1. Fully hermetic reciprocating or scroll type.
2. Equipped with oil system, operating oil charge, and motor.
3. Internal overloads shall protect compressor from overtemperature and overcurrent.
4. Motor: NEMA rated, Class F, suitable for operation in a refrigerant atmosphere.
5. Scroll compressors shall have high discharge gas temperature protection.
6. Reciprocating compressors shall be equipped with crankcase heaters to minimize liquid refrigerant accumulation in compressor during shutdown and to prevent refrigerant dilution of oil.
7. Installed on rubber vibration isolators and shall have internal spring isolation.

E. Condenser Coil: Constructed of aluminum fins mechanically bonded to internally enhanced seamless copper tubes that are cleaned, dehydrated, and sealed. Anticorrosion factory applied protecting coating.

F. Refrigeration Components:

1. Brass external liquid line service valve with service gauge port connections.
2. Suction line service valve with service gauge connection port.
3. Service gauge port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps.
4. Suction Line: Accumulator.
5. Pressure relief.

G. Controls:

1. Factory selected, assembled, and tested.
2. Refrigerant Metering:
   a. Reversing valve for heat pump units.
   b. Heating mode metering device for heat pump units.
3. Automatic restart on power failure.
4. Three-pole contactors.
5. Time delay control sequence shall be provided standard through control board on indoor units.
6. High pressure and liquid line low pressure switches.
7. Automatic outdoor fan motor protection.
8. Start capacitor and relay (single-phase units without scroll compressors).
9. Defrost board to provide defrost control.
10. Safeties:
    a. Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
    b. Safety lockout if any outdoor unit safety is open.
    c. High condensing temperature protection.
    d. System diagnostics.
    e. Compressor motor current and temperature overload protection.
    f. High pressure relief.
    g. Outdoor fan failure protection.
11. Accessories: Provide as scheduled in Equipment Schedule.

H. Manufacturers:

1. Trane.
2. Carrier.
3. Dakin.
4. Mitsubishi.

5. Rheem.
6. Lennox International.
7. York Air Conditioning.

2.05 WALL MOUNT AC UNITS

A. General:

1. Self-contained wall-mounted air conditioner suitable for outdoor use, specifically designed for telecommunications/electrical enclosure climate control.
2. Completely factory assembled and tested; includes compressor, indoor and outdoor coils, fans, motors, prewired controls, interconnecting refrigerant tubing, wiring, circuit breaker, and other necessary components mounted in corrosion resistant cabinet.
3. Unit shall be shipped from factory with full operating refrigerant and oil charge.

B. Unit Cabinet:

1. Constructed of galvanized steel sheet metal with factory applied paint finish.
2. Sloped top with built-in mounting flanges.
3. Unit Mounting Brackets: Full-length bracket shall be factory provided.
4. Conditioned air section shall be insulated with 1/2-inch, 2-pound dual density fiberglass.
5. Supply Grille: Adjustable aluminum double deflection type, factory installed.
6. Return Grille: Aluminum, fixed blade type, factory installed.

C. Compressor:

1. Hermetic type, equipped with immersion type self regulating crankcase heater.
2. Motor shall be protected by internal line-break thermostat.
3. Electrical wiring connections at compressor shall be protected by receptacle housing.

D. Refrigeration Components:

1. Refrigeration Circuit:
   a. Liquid filter dryer.
   b. Suction and liquid access valves.

E. Condenser Section:

1. Condenser Coil: Constructed of aluminum plate fins mechanically bonded to seamless copper tubes.
   a. Entire condenser coil coated with anticorrosion protective coating in accordance with Article Factory Dip-Applied Protective Coating.
2. Fan:
   a. Direct driven, slow speed propeller type for quiet operation.
   b. Motor: Equipped with thermal protector.

F. Evaporator Section:

1. Evaporator Coil: Constructed of aluminum plate fins mechanically bonded to seamless copper tubes.
2. Two direct driven evaporator blowers shall be of centrifugal type, forward curved.
3. Indoor Motor: Equipped with thermal protector.

G. Electric Heat Coil:

1. UL listed.
2. Heavy-duty nickel-chromium elements.
3. Individual line-break HIGH limit control for each stage.
4. HIGH limit control operating through heating element contactors, equipped with automatic reset.
5. Internally factory-wired to provide single-point power connection with unit.

H. Controls:

1. Refrigerant Metering: Factory installed refrigerant metering device.
2. Internal control circuit of a current limiting type transformer to generate 24V ac, switching devices to operate compressor and indoor fan motor.
3. Provide automatic resetting adjustable time delay circuit to prevent rapid compressor cycling and to delay startup of compressor on call for cooling.
4. Low pressure bypass shall be factory installed for startup of unit down to 0 degree F.
5. Safeties:
   a. Control circuit shall incorporate manual reset safety circuit to render refrigerant system (compressor and outdoor fan motor) inoperative should there be a loss of airflow or refrigerant.
   b. System lockout condition shall be indicated by contact closure available at low voltage terminal block.
   c. Safety circuit shall be resettable at wall thermostat.

d. Refrigeration circuit shall include high and low pressure switches with lockout relay.

I. Filters: 2-inch pleated throwaway type filter, mounted internally, factory supplied, and accessible through access panel.

J. Accessories: Provide as scheduled in Equipment Schedule.

1. Cold Weather Kit: Factory installed controls and components permit unit cooling operation down to outdoor temperatures of minus 20 degrees F.
2. Electronic controller with two units alternating mode capabilities.

K. Manufacturers and Products:

1. Marvair; Compac.
2. Bard; WA Series.

2.06 FACTORY DIP-APPLIED PROTECTIVE COATING

A. Provide Factory dip-applied protective coating to every coil in the design as equipment schedule.

B. General:

1. Factory dip-applied protective coating for application to plate fin and tube coils.
2. Coil factory assembled and tested before coating application.
3. Coating suitable for coils with maximum 30 fins per inch fin density. Bridging of product across coil fins is unacceptable.
4. After application and proper curing, product shall endure bending of coil assembly in standard manufacturing process without cracking.

C. Coating Material: Use one of the following materials:

1. Epoxy Modified Phenolic. Straight phenolic materials are not acceptable.
2. Epoxy or epoxy urethane.
3. Polyelastomer: Complex chain linked polyelastomer material.

D. Coating Process:

1. Coil Inspection and Sealing:
   a. Inspect coil for open tubes, headers, capillary tubes; repair as necessary.
   b. Fill with dry nitrogen, cap and seal, to prevent contamination of internal coil surfaces with cleaning or coating solutions.

2. Coil Cleaning:
   a. Immerse coil in heated alkaline cleaning solution to remove lubricants, machining oils, and residual factory contamination.
   b. Followed with immersion in potable water bath to neutralize and remove cleaning solution.
3. Coating Application:
   a. Immerse coil assembly in coating bath, including headers, casing, and heat exchange surfaces.
   b. Completed remove coil from equipment during coating application.
   c. Spray-on coatings are not acceptable.
4. Curing: Oven baked at metal temperature not to exceed 400 degrees F.
5. Quality Control: Free from voids, checks, cracks and blisters.

E. Performance: Coil finish shall meet or exceed the following criteria:

1. Salt Spray Test: In accordance with ASTM B117, minimum 3,000-hour duration, with no fin corrosion or degradation.
2. Thermal Efficiency: Loss no greater than 1 percent after coating application.
3. Exposure to UV Light: UV inhibited life of minimum 10 years when exposed to sun in the State of Florida.

F. Manufacturers and Products:

1. Aero-Marine Engineering Inc.; Technicoat 10-1.
2. AST ElectroFin Inc; ElectroFin.

2.07 ELECTRICAL

A. General:

1. Units shall include high and low voltage terminal block connections.
2. Control voltage to indoor unit fan shall be 24 volts.
3. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.
4. Disconnects: Factory installed nonfused disconnects or circuit breakers on each unit, unless otherwise noted.

B. Motors:

1. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for general requirements.
2. Unless otherwise stated, electric motors shall comply with the following:
   a. Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.

b. Enclosure: ODP, unless specified otherwise.
c. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
d. Winding Thermal Protection: Manufacturer's standard.
e. Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer's standard.
f. Efficiency: Primium efficiency motors.

2.08 ACCESSORIES

A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Equipment Identification Plates: Furnish 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8 inch-high die-stamped block type black enamel filled equipment identification number and letter indicated in this Specification and as shown.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter. Quantity as recommended by manufacturer.

2.09 SOURCE QUALITY CONTROL

A. Factory Tests: Direct expansion coils leak tested underwater with 200-psig air. Pressure tested to 450 psig.

PART 3 EXECUTION

3.01 INSTALLATION

A. Set and install equipment so that equipment is level and properly supported.

B. Make certain that piping connections to equipment do not cause any strain on equipment.

C. Make certain that vibration isolation has been installed per manufacturer's instructions and isolation devices are performing satisfactorily.

D. Install equipment in accordance with manufacturer's recommendations, and these Specifications.

E. Install all safety devices as recommended by manufacturer and/or required by code in these Specifications.

F. Initial equipment startup shall be made by an authorized representative of the unit manufacturer.

G. Air-cooled outdoor unit shall not be started without complete prestart checkout of entire refrigerant piping system and charging of system with refrigerant as recommended by equipment manufacturer.

H. Startup: Manufacturer shall provide a factory-trained representative employed by the equipment manufacturer to perform the following services. Supervision only, of Contractor personnel, will not be acceptable.

1. Leak test.
2. Refrigerant pressure test.
3. Evacuate (if required).
4. Dehydrate (if required).
5. Charge condensing unit with refrigerant and oil (if required).

I. Factory Checkout:

1. Contractor shall secure the services of a factory trained and qualified service engineer employed by the equipment manufacturer who shall inspect the installation including external interlock, power connections; supervise initial operation, calibration of operating and safety controls and supervise electrical testing including insulation resistance of motors and voltage balance between phases during starting and running.
2. This service engineer shall forward a report in three copies to Engineer when the unit is in safe and proper operating condition. This report shall contain all pressure and control settings, meg readings, voltage readings per phase during START and RUN, suction temperature and pressure, liquid temperature and pressure, and shall list minor discrepancies to be corrected which do not affect safe and reliable operation.
3. One additional copy of report shall be left in unit control panel. One copy of bound installation operation and maintenance service, and parts brochures, including applicable serial numbers, full unit description, parts ordering sources, shall be placed in the unit control panel at the time of starting.

J. Locate units to provide access for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.

K. Isolate sheet metal duct connections from all portions of the unit not internally spring-isolated from fans, or other vibrating or rotating equipment.

L. Inspect internal casing insulation, seal all exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

3.02 ADJUSTING AND CLEANING

A. Lubricate unsealed bearings prior to startup.

B. Do not operate units until filters are installed. If operated without filters, completely clean ductwork, coils, and interior of units.

3.03 FILTERS

A. Install a complete set of filters in each unit before operating, and leave in place during startup and testing to keep the equipment and ductwork clean.

B. Install a complete set of filters at the time of final cleaning as defined in Section 01 77 00, Closeout Procedures.

3.04 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified equipment.

END OF SECTION

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 DESIGN REQUIREMENTS

A. All equipment anchoring and mounting shall be in accordance with manufacturer's requirements for the seismic zone criteria given in Section 01 61 00, Common Product Requirements.

1.05 SCOPE OF WORK (Includes But Is Not Limited To:)

A. Furnish, install, and test pad-mounted switchgear.

B. Furnish, install, and test pad-mounted.

C. Furnish, install, and test low voltage motor control centers and interconnecting power and control cables as shown on the Drawings.

D. Furnish, install, and test medium voltage and low voltage site power distribution system as shown. Furnish and install the medium voltage, low voltage and control duct bank systems as shown.

E. Furnish, install, terminate, and test all interconnecting power, control, and instrumentation wiring as shown on the One-Line Diagrams, Riser Diagrams, and P&I Drawings.

F. Furnish and install all conduit, wiring, and field connections for all motors, motor controllers, control devices, control panels, and electrical equipment furnished under other divisions of the Contract.

G. Furnish and install an equipment ground conductor sized per Table 250-122 of the NEC in all new and existing conduits throughout the entire plant.

H. Furnish and install raceways for the fiber optic cable system as required to implement fiber optic data links shown on the instrumentation Drawings. Install an inner duct/outer duct system as shown and specified. Install fiber optic cable furnished by PICS subcontractor. Termination and testing by PICS subcontractor. Provide accurate estimate of fiber optic cable lengths to the PICS subcontractor.

I. Furnish and install a complete raceway system for data highway cables and specialty cables systems. Install the data highway cables and other specialty cable systems in accordance with the system manufactures' installation instructions. Review the raceway layout, prior to installation, with the PICS subcontractor and cable manufacture to ensure raceway compatibility with the systems and materials being furnished. Where redundant cables are furnished, install cables in separate raceways.

J. Provide support to the PICS subcontractor for installation, wiring, and termination of all control panels, field instruments, lightning, and surge protection equipment at process instrumentation transmitters, and computer equipment. Install vendor furnished cables specified under other Divisions of the Specification.

K. Furnish and install power wiring for all heating, ventilation, and air conditioning (HVAC) equipment furnished under other divisions of these specifications, including power wiring for 120-volt unit heaters, thermostats, fan motors, dampers and other HVAC inline unit wiring shown on the Drawings.

L. Furnish, install, and wire all site and facility lighting as shown.

M. Conduct and participate in all electrical and PICS subcontractor's testing. Specifically all operational readiness tests and functional acceptance tests shall be jointly conducted by the PICS subcontractor and the Electrical subcontractor.

N. Furnish and install all telephone/data outlet raceway systems as shown and required for satisfactory operation.

O. Sequence work to meet the Contractor's overall schedule and construction sequence.

P. Prepare and furnish electrical and instrumentation conduit layout Shop Drawings for yard electrical, within and under all roads, buildings and structures to the Engineer for approval prior to commencing work. Layouts shall include but not be limited to equipment, pull boxes, manholes, handholes, conduit routing, dimensioning, methods and location of supports, reinforcing, encasement, materials, conduit sizing, equipment access, potential conflicts, building and yard lighting, and all other pertinent technical specifications for all electrical and instrumentation conduits and equipment to be furnished.

Q. Provide complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

R. Provide temporary power for miscellaneous loads (drills, pumps, etc., independent of electrical systems either existing as provided under this Contract). Any temporary added shall be removed at job completion.

S. Complete coordination with other Contractors. Contractor shall coordinate with all other Contractor's equipment submittals and obtain all relevant submittals.

T. Provide modifications to existing control systems including installation of auxiliary motor starter contacts, relays, switched, etc, as required to provide the control functions or inputs as shown on the Drawings. Obtain the existing equipment Shop Drawings from the Owner before attempting to make any modifications to the existing equipment wiring. Verify all existing wiring and connections for correctness. If Record Drawings are not available, trace all circuits in the field and develop the wiring diagrams necessary for completion of the word. Document all changes made to the wiring diagrams and return a marked-up set of Record Drawings to the Owner after the work is complete.

U. Coordinate the sequence of demolition with the sequence of construction to maintain plant operation in each area. Remove and demolish equipment and materials in such a sequence that the existing and proposed plant will function properly with no disruption of treatment.

V. Provide modifications to existing motor control centers, switchboards, panelboards, and motor controllers, including installation of circuit breakers, etc, or disconnection of circuits as required, to provide the power supplies to new and existing equipment to maintain the plant in operation.

W. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing site, buildings and structures in which work under this Division is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the Site, buildings and structures, and noted the locations and conditions under which the work will be performed and that he/she takes full responsibility for a complete knowledge of all factors governing his/her work.

X. Provide all electrical demolition work associated with the removal of equipment from the existing facilities, including disconnecting and removing all electrical wiring and conduit to equipment being removed under other sections. Survey the existing electrical systems with representatives from other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.

Y. Provide all electrical relocation work associated with the relocation of equipment for the existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment.

Z. All power interruptions to electrical equipment shall be at the Owner’s convenience with 72 hour’s (minimum) notice. Each interruption shall have prior approval.

AA. The Contractor shall maintain the existing plant in operation at all times. Temporary power connections as required shall be provided by the Contractor at no additional expense to the Owner. All temporary wiring shall be in accordance with the NEC.

BB. Field verify all existing underground electrical and mechanical piping.

CC. The Contractor shall provide their own temporary power for miscellaneous power (drills, pumps, etc.). No facility circuit shall be used unless approved in writing by the Owner. Any temporary added shall be removed at job completion.

1.06 TELECOMMUNICATIONS SERVICE DIVISION OF RESPONSIBILITY

A. Interior telecommunications central and station equipment (telephone instruments, telephone switches, data switches, and hubs, servers, software, etc.) is work provided outside this Contract. Under this Contract provide raceways, outlet and junction boxes, cover plates, as indicated.

1.07 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.

1.08 HAZARDOUS AND CORROSIVE AREA CLASSIFICATIONS

A. Several areas in the plant are classified as hazardous and/or corrosive. Equipment, materials, and installation in these areas shall comply with NEC Articles 500, 501, 502, and 503. All equipment and materials installed in hazardous areas shall be UL listed for the appropriate hazardous area classifications, for the following locations:

1. Sludge Holding Tanks.
2. Digester Building.

1.09 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 EQIPMENT

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.

B. Attachment Screws: Stainless steel.

C. Color: Black, engraved to a white 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 code 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 light fixtures, switches, electrical outlets, equipment, and other 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 additional cost to the Owner.

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 additional cost to the Owner.

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 additional compensation 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 additional expense to the Owner. 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 ANCHORING AND MOUNTING

A. Equipment anchoring and mounting shall be in accordance with manufacturer's requirements for seismic zone criteria given in Section 01 61 00, Common Product Requirements.

3.03 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.

3.04 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.

3.05 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.

3.06 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.

3.07 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 of suitable patching material.

3.08 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.

3.09 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.

3.10 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 as shown.
   b. 250-600V ac: 42,000 amps or as 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. Cable Limiters:

1. 600V or less; crimp to copper cable, bolt to bus or terminal pad.
2. Manufacturer and Product: Bussmann; K Series.

E. 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. Time Delay Relay Attachment:

1. Pneumatic type, timer adjustable from 0.2 second to 60 seconds (minimum) unless otherwise shown.
2. Field convertible from ON delay to OFF delay and vice versa.

D. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.

E. 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. PVC Coated Framing Channel: Carbon steel framing channel with 40-mil polyvinyl chloride coating.

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

C. Extruded Aluminum Framing Channel:

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

D. Nonmetallic Framing Channel:

1. Material: Fire retardant, fiber reinforced vinyl ester resin.
2. Channel fitting of same material as channel.
3. Nuts and bolts of long glass fiber reinforced polyurethane.

E. 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"	3R
Indoor and Outdoor	Any	Wet and/or Corrosive	4X 316 Stainless Steel
Indoor and Outdoor	Any	Hazardous Gas	7
Indoor and Outdoor	Any	Hazardous Dust	9

PART 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: PVC coated.
2. Interior, Corrosive (Wet or Dry) Locations:
   a. Aluminum Raceway: Extruded aluminum.
   b. PVC Conduit: Type 316 stainless steel or nonmetallic.
   c. PVC-Coated Conduit and Other Systems Not Covered: Type 316 stainless steel, or PVC-coated 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. PVC-Coated Conduit and Other Systems Not Covered: Type 316 stainless steel, or PVC coated steel.

C. Paint cut ends prior to installation with the following:

1. Nonmetallic Channel: Epoxy resin sealer.
2. PVC-Coated Channel: PVC patch.

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 CONDUCTORS ABOVE 600 VOLTS

A. EPR Insulated Cable:

1. Extrusion: Single-pass, triple-tandem, of conductor screen, insulation, and insulation screen.
2. Type: 5 kV, shielded, UL 1072, Type MV-105.
3. Conductors: Copper concentric lay Class B round stranded in accordance with ASTM B3, ASTM B8, and ASTM B496.
4. Conductor Screen: Extruded, semiconducting ethylene-propylene rubber in accordance with NEMA WC 71 and AEIC CS 8.
5. Insulation: 133 percent insulation level, ethylene-propylene rubber (EPR) containing no polyethylene, in accordance with NEMA WC 71, and AEIC CS 8.
6. Insulation Thickness: 115-mil, 5 kV nominal.
7. Insulation Screen: Thermosetting, semiconducting ethylene-propylene rubber (EPR), extruded directly over insulation in accordance with NEMA WC 74 and AEIC CS 8.
8. Metallic Shield: Uncoated, 5-mil, copper shielding tape, helically applied with 12-1/2 percent minimum overlap.
9. Jacket: Extruded polyvinyl chloride (PVC) compound applied in accordance with NEMA WC 71 or NEMA WC 74.
10. Operating Temperature: 105 degrees C continuous normal operations, 130 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.
11. Manufacturers:
    a. Okonite Co.
    b. Pirelli Wire and Cable.
    c. General Cable.
    d. Southwire Co.

2.03 600-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 3 4	0.42 0.45 0.49	45
10	10	2 3 4	0.54 0.58 0.63	60
8	10	3 4	0.66 0.75	60
6	8	3 4	0.74 0.88	60
4	6	3 4	0.88 1.04	60 80
2	6	3 4	1.01 1.16	80
1	6	3 4	1.10 1.25	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.53	80
3/0	4	3 4	1.40 1.60	80

Conductor Size	Minimum Ground Wire Size	No. of Current Carrying Conductors	Max. Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4/0	4	3 4	1.56 1.78	80 110

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.

H. Type 7, Multiconductor Metal-Clad (UL Type MC) Power Cable:

1. Meeting requirements of UL 44 and UL 1569.
2. Conductors:
   a. Class B stranded, coated copper.
   b. Insulation: 600-volt cross-linked polyethylene, UL Type XHHW or EPR.
   c. Grounding Conductors: Bare, stranded copper.
3. Sheath:
   a. UL listed Type MC.
   b. Continuous welded, corrugated aluminum sheath.
   c. Suitable for use as grounding conductor.

4. Outer Jacket: PVC per UL 1569.
5. Cable shall pass ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
6. Cable Sizes:

Conductor Size	Minimum Ground Wire Size (AWG)	No. of Insulated Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
12 AWG	12 or 3x16	3 4	0.79 0.85	50
10 AWG	10 or 3x14	3 4	0.82 0.90	50
8 AWG	10 or 3x14	3 4	0.85 1.00	50
6 AWG	8 or 3x12	3 4	0.99 1.10	50
4 AWG	8 or 3x12	3 4	1.08 1.20	50
2 AWG	6 or 3x10	3 4	1.24 1.45	50
1 AWG	6 or 3x10	3 4	1.40 1.55	50
1/0 KCM	6 or 3x10	3 4	1.52 1.60	50
2/0 AWG	4 or 3x8	3 4	1.67 1.75	50
4/0 AWG	4 or 3x8	3 4	1.93 2.10	60
250 KCM	4 or 3x8	3 4	2.11 2.20	60
350 KCM	3 or 3x8	3 4	2.39 2.50	60
500 KCM	2 or 3x8	3 4	2.80 2.90	75

7. Manufacturers and Products:
   a. Okonite Co.; Type CLX.
   b. Southwire Type MC.
   c. General Cable, CCW Armored Power.

I. Type 8, Multiconductor Adjustable Frequency Drive Power Cable:

1. Conductors:
   a. Class B, stranded coated copper.
   b. Insulation: 600-volt cross-linked polyethylene, UL Type XHHW-2.
   c. Grounding Conductors: Insulated stranded copper.
2. Sheath:
   a. UL 1277 Type TC, 90 degrees C.
   b. Continuous shield, A1/polyester foil, drain wires, overall copper braid.
3. Outer Jacket: Polyvinyl chloride (PVC) per UL 1569.
4. Cable Sizes:

Conductor Size	Minimum Ground Wire Size (AWG)	No. of Insulated Conductors	Max. Outside Diameter (Inches)	Minimum Jacket Thickness (Mils)
12 AWG	12	4	0.655	50
10 AWG	10	4	0.769	50
8 AWG	8	4	0.940	50
6 AWG	6	4	1.038	50
4 AWG	4	4	1.180	50
2 AWG	2	4	1.351	50

5. Manufacturers and Products:
   a. Alpha Wire; Series V.
   b. Belden; Series 29500.
   c. LAPP USA; OLFLEX VFD Slim.

J. Type 9, Multiconductor Metal-Clad (UL Type MC) Power Cable for Adjustable Frequency Drive Applications:

1. Meeting requirements of UL 44 and UL 1569.
2. Conductors:
   a. Class B, stranded coated copper.
   b. Insulation: 600-volt cross-linked polyethylene, UL Type XHHW or EPR.
   c. Grounding Conductors: Bare, stranded copper. Provide three symmetrical grounding conductors.
3. Sheath:
   a. UL listed Type MC.
   b. Continuous welded, corrugated aluminum sheath.
   c. Suitable for use as grounding conductor.

4. Outer Jacket: PVC per UL 1569.
5. Cable shall pass ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
6. Cable Sizes:

Conductor Size	Minimum Ground Wire Size (AWG)	No. of Insulated Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
12 AWG	3x16	3 4	0.79 0.85	50
10 AWG	3x14	3 4	0.82 0.90	50
8 AWG	3x14	3 4	0.85 1.00	50
6 AWG	3x12	3 4	0.99 1.10	50
4 AWG	3x12	3 4	1.08 1.20	50
2 AWG	3x10	3 4	1.24 1.45	50
1 AWG	3x10	3 4	1.40 1.55	50
1/0 KCM	3x10	3 4	1.52 1.60	50
2/0 AWG	3x8	3 4	1.67 1.75	50
4/0 AWG	3x8	3 4	1.93 2.10	60
250 KCM	3x8	3 4	2.11 2.20	60
350 KCM	3x8	3 4	2.39 2.50	60
500 KCM	3x8	3 4	2.80 2.90	75

7. Manufacturer and Product: Okonite Co.; Type CLX MC-HL.

2.04 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.

B. Type 31, Modbus RTU/RS 485 Twin Axial Cable, 600V, Class 1, Twisted, Shielded Pairs with Overall Shield:

1. Outer Jacket: PVC.
2. Overall Shield: Aluminum foil-polyester tape, plus tinned copper braid, 20 AWG tinned copper drain wire.
3. Dimension: 0.460-inch nominal OD.
4. Conductors:
   a. 18 AWG stranded tinned copper.
   b. Insulation: Flame retardant polydefin (FRPO).
5. Manufacturer and Product: Belden; 3074 Twinax-Datatray.

2.05 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded tinned copper.

2.06 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.

2.07 ACCESSORIES FOR CONDUCTORS ABOVE 600 VOLTS

A. Molded Splice Kits:

1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
2. Capable of making splices with a current rating equal to, or greater than cable ampacity, conforming to IEEE 404.
3. Class 5 kV, with compression connector, EPDM molded semiconductive insert, peroxide-cured EPDM insulation, and EPDM molded semiconductive outer shield.
4. Premolded splice shall be rejacketed with a heat shrinkable adhesive-lined sleeve to provide a waterproof seal.
5. Manufacturers:
   a. Elastimold.
   b. Cooper Industries.

B. Heat Shrinkable Splice Kits:

1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
2. Capable of making splices with a current rating equal to, or greater than, cable ampacity, conforming to IEEE 404.
3. Class 5 kV, with compression connector, splice insulating and conducting sleeves, stress-relief materials, shielding braid and mesh, and abrasion-resistant heat shrinkable adhesive-lined rejacketing sleeve to provide a waterproof seal.
4. Manufacturers:
   a. Raychem.
   b. 3M Co.

C. Termination Kits:

1. Capable of terminating 5 kV, single-conductor, polymeric-insulated shielded cables plus a shield ground clamp.
2. Capable of producing a termination with a current rating equal to, or greater than, cable ampacity meeting Class 1 requirements of IEEE 48.
3. Capable of accommodating cable shielding or construction without need for special adapters or accessories.
4. Manufacturers:
   a. Raychem.
   b. 3M Co.

D. Bus Connection Insulation:

1. Heat shrinkable tubing, tape, and sheets of flexible cross-linked polymeric material formulated for high dielectric strength.
2. Tape and sheet products to have coating to prevent adhesion to metal surfaces.
3. Insulating materials to be removable and reusable.
4. Manufacturer: Raychem.

E. Elbow Connector Systems:

1. Molded, peroxide-cured, EPDM-insulated, Class 15 kV, 95 kV BIL, 200A, 15,000A rms nonload-break and 600A, 40,000 rms nonload-break elbows as shown, having copper current-carrying parts in accordance with IEEE 386.
2. Protective Caps: Class 15 kV, 95 kV BIL, 200 and 600 amperes, with molded EPDM insulated body.
3. Insulated Standoff Bushings: Class 15 kV, 95 kV BIL, 200 and 600 amperes, complete with EPDM rubber body, stainless steel eyebolt with brass pressure foot, and stainless steel base bracket.
4. Bushing Inserts: Class 15 kV, 95 kV BIL, 200A, nonload-break 600A, nonload-break with EPDM rubber body and all-copper, current-carrying parts.
5. Junctions: Class 15 kV, 95 kV two-way, three-way, or four-way, 600A, nonload-break, having EPDM rubber body mounted on adjustable bracket.
6. Mounting Plates: Two, Three, or Four-way, ASTM A167 stainless steel, complete with universal mounting brackets, grounding lugs and two parking stands.
7. Manufacturers:
   a. Cooper Industries.
   b. Elastimold.

F. Cable Lugs:

1. In accordance with NEMA CC1.
2. Rated 5 kV of same material as conductor metal.
3. Manufacturers and Products, Uninsulated Compression Connectors and Terminators:
   a. Burndy; Hydent.
   b. Thomas & Betts; Color-Keyed.
   c. ILSCO.
4. Manufacturers and Products, Uninsulated, Bolted, Two-Way Connectors and Terminators:
   a. Thomas & Betts; Locktite.
   b. ILSCO.

2.08 CABLE FAULT DETECTION SYSTEM

A. One fault sensor for each phase conductor prewired with lead cable extending to remote indicator target.

B. Magnetically operated, automatic indicator target.

C. Nonresettable, unless all three phases are fault free.

D. Sensor/indicator target sealed for submersible operation.

E. Trip Rating 300 and 600 amperes.

F. Fault powered with a normal current flow rating in excess of 5 amperes.

G. Equip each sensor with auxiliary relay contacts for future use.

H. Manufacturers and Products:

1. Cooper Industries; Type CR3.
2. AB Chance.

2.09 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.

2.10 WARNING TAPE

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

2.11 SOURCE QUALITY CONTROL

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

B. Conductors Above 600 Volts: Test in accordance with NEMA WC 71 and AEIC CS 8 partial discharge level test for EPR insulated cable.

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.

J. Cable Tray Installation:

1. Install wire and cable parallel and straight in tray.
2. Bundle, in groups, wire and cable of same voltage having a common routing and destination; use cable ties, at maximum intervals of 8 feet.
3. Clamp cable bundles prior to making end termination connections.

4. Separate cables of different voltage rating in same cable tray with barriers.
5. Fasten wires, cables, and bundles to tray with nylon cable straps at the following maximum intervals:
   a. Horizontal Runs: 20 feet.
   b. Vertical Runs: 5 feet.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. 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.

B. Conductors Above 600 Volts:

1. 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. Colors:
   a. Grounded Neutral: White.
   b. Phase A: Brown.
   c. Phase B: Orange.
   d. Phase C: Yellow.

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 CONDUCTORS ABOVE 600 VOLTS

A. Do not splice unless specifically indicated or approved by Engineer.

B. Make joints and terminations with splice and termination kits, in accordance with kit manufacturer's instructions.

C. Install splices or terminations as continuous operation in accessible locations under clean, dry conditions.

D. Single Conductor Cable Terminations: Provide heat shrinkable stress control and outer nontracking insulation tubings, high relative permittivity stress relief mastic for insulation shield cutback treatment, and a heat-activated sealant for environmental sealing plus a ground braid and clamp.

E. Install terminals or connectors acceptable for type of conductor material used.

F. Provide outdoor rain skirts for outdoor switchgear terminations.

G. Provide shield termination and grounding for terminations.

H. Provide necessary mounting hardware, covers, and connectors.

I. Where elbow connectors are specified, install in accordance with manufacturer's instructions.

J. Connections and Terminations:

1. Install uninsulated crimp connectors and terminators for power circuit conductors 4 AWG and larger.
2. Install uninsulated, bolted, two-way connectors for motor circuit conductors No. 12 and larger.
3. Insulate bus connections with heat shrinking tubing, tape, and sheets.
4. Make bus connections removable and reusable in accordance with manufacturer's instructions.

K. Give 2 working days notice to Engineer prior to making splices or terminations.

3.06 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. Install arc and fireproofing tape on 5 kV cables throughout entire exposed length in manholes, handholes, vaults, cable trays, and other indicated locations.

C. Wrap conductors of same circuit entering from separate conduit together as single cable.

D. Follow tape manufacturer's installation instructions.

E. 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.

3.07 CABLE FAULT DETECTION SYSTEM

A. Install remote indicator target, externally exposed, on side of equipment enclosure in which cable terminates.

B. Mounting Height: Minimum 36 inches, maximum 60 inches from floor.

3.08 UNDERGROUND DIRECT BURIAL CABLE

A. Install in trench as specified in Section 31 23 23.15, Trench.

B. Warning Tape: Install approximately 6 inches above cable, aligned parallel to, and within 12 inches of centerline of the run.

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. Ground rod box complete with cast iron riser ring and 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. Provide dual ground of the low voltage switchgear and motor control centers as shown on the Drawings.

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 RGS conduit above grade. Bond ground conductors to RGS at both ends using grounding bushings.

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 (1000 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 Galvanized Steel 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.

D. 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.

E. Flexible Metal, Liquid-Tight Conduit:

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

F. Flexible Metal, Nonliquid-Tight Conduit:

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

G. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Material: PVC core with fused flexible PVC jacket.
2. UL 1660 listed for:
    a. Dry Conditions: 80 degrees C insulated conductors.
    b. Wet Conditions: 60 degrees C insulated conductors.
3. Manufacturers and Products:
    a. Carlon; Carflex or X-Flex.
    b. T & B; Xtraflex LTC or EFC.

H. 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. 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.

D. 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.

E. 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.

F. 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.

G. 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.

H. Watertight Entrance Seal Device:

1. New Construction:
   a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Manufacturer 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. Sheet Steel: One-piece drawn type, zinc-plated or cadmium-plated.

B. 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.

C. 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 Metal Box, Hazardous Locations:

1. NEMA 250 Type 7 or Type 9 as required for Class, Division, and Group involved.
2. Box: Copper-free aluminum with drilled and tapped conduit entrances.
3. Cover: Nonhinged with screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers and Products:
   a. Crouse-Hinds; Type EJB.
   b. Appleton; Type AJBEW.

D. 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.

E. 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.

F. 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, hot-dip galvanized.

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. Reference Section 26 05 05, Conductors, concerning conduit sizing for aluminum 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 40.

I. Transition from Underground or Concrete Embedded to Exposed: PVC-coated rigid s 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.

M. Hazardous Gas Areas: 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.

5. Hazardous Areas: Flexible coupling suitable for Class I, Division 1 and 2 areas.

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 condulet 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.

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 31 00, Structural 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 approximately12 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 stamped and signed by a professional Engineer registered in the State of Florida.

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 any major electrical equipment. 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. Electric utility’s supply termination point.
2. Pad-mounted switchgear.

3. Unit substation primary.
4. Motor control centers.
5. All branch circuit panelboards.
6. Other significant locations throughout the system.
7. 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. Electric utility’s relays.
2. Electric utility’s fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands, medium-voltage equipment relays.
3. Medium-voltage and low voltage equipment circuit breaker trip devices, including manufacturers tolerance bands.
4. Medium-voltage and low-voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands.
5. Pertinent transformer full-load currents at 100 and 600 percent.
6. Transformer magnetizing inrush currents.
7. Transformer damage curves.

8. ANSI transformer withstand parameters.
9. Significant symmetrical and asymmetrical fault currents.
10. Ground fault protective device settings.
11. Motor overload relay settings.
12. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center.
13. Generator short circuit document curves and thermal limit curves.

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. Separate protective medium and low-voltage relay and circuit breaker characteristic curves from curves for other devices by at least 0.4-second time margin.

K. 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. Zone interlocking.
   g. Electronic settings data file.

L. 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. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5kV through 500kV.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.
   e. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.

f. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.
g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
h. C2, National Electrical Safety Code.
i. C37.20.1, Standard for Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
j. C37.20.2, Standard for Metal-Clad Switchgear.
k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
l. C37.23, Standard for Metal-Enclosed Bus.
m. C62.33, Standard Test Specifications for Varistor Surge-Protective Devices.

3. Insulated Cable Engineers Association (ICEA):
   a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
   b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
   c. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
4. 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.
   b. PB 2, Deadfront Distribution Switchboards.
   c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
5. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. 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.
7. National Institute for Certification in Engineering Technologies (NICET).
8. 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, tranducers 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 SWITCHGEAR ASSEMBLIES

A. Visual and Mechanical Inspection:

1. Insulator damage and contaminated surfaces.
2. Proper barrier and shutter installation and operation.
3. Proper operation of indicating devices.
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 ON or CLOSED 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. Pushbutton.
    c. Control switch.
    d. Pilot light.
    e. Control relay.
    f. Circuit breaker.
    g. Indicating meter.
10. Verify fuse and circuit breaker ratings, sizes, and types conform to those specified.
11. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.
    a. Ohmic value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
12. 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.
13. Verify performance of each control device and feature.
14. Control Wiring:
    a. Compare wiring to local and remote control and protective devices with elementary diagrams.

b. Proper conductor lacing and bundling.
c. Proper conductor identification.
d. Proper conductor lugs and connections.

15. Exercise active components.
16. Perform phasing check on double-ended equipment 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. Each phase of each bus section.
   c. Phase-to-phase and phase-to-ground for 1 minute.
   d. With switches and breakers open.
   e. With switches and 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. Overpotential Tests:
   a. Applied ac or dc voltage and test procedure in accordance with IEEE C37.20.1, C37.20.2, C37.20.3 and NEMA PB 2. Alternatively use NETA ATS, Table 100.2.
   b. Each phase of each bus section.
   c. Phase-to-phase and phase-to-ground for 1 minute.
   d. Test results evaluated on a pass/fail basis.
3. Current Injection Tests:
   a. For entire current circuit in each section.
   b. Secondary injection for current flow of 1 ampere.
   c. Test current at each device.
4. Control Wiring:
   a. Apply secondary voltage to control power and potential circuits.
   b. Check voltage levels at each point on terminal boards and each device terminal.
5. Operational Test:
   a. Initiate control devices.
   b. Check proper operation of control system in each section.

3.04 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.

3.05 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.

3.06 LIQUID FILLED 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. Effective core and equipment grounding.
7. Removal of shipping brackets, fixtures, or bracing.
8. Tank leaks and proper liquid level.
9. Integrity and contamination of bus insulation system.
10. Verify tap-changer is set at correct ratio for rated voltage under normal operating conditions.
11. 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. Sample insulating oil in accordance with ASTM D923 and have laboratory test for:
   a. Dielectric breakdown voltage in accordance with ASTM D877 or ASTM D1816.
   b. Acid neutralization number in accordance with ASTM D974.
   c. Interfacial tension in accordance with ASTM D971.
   d. Color in accordance with ASTM D1500.
   e. Visual condition in accordance with ASTM D1524.
   f. Specific gravity in accordance with ASTM D1298.
   g. Water content, in parts per million, in accordance with ASTM D1533.
   h. Dielectric fluid test results in accordance with NETA ATS, Table 100.4.
   i. Power factor at 25 degrees C and at 100 degrees, in accordance with ASTM D924.
   j. Maximum power factor, corrected to 20 degrees C, in accordance with manufacturer's specifications.

3.07 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.

3.08 MEDIUM-VOLTAGE CABLES, 15 KV MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed cable for:
    a. Physical damage plus jacket and insulation condition.
    b. Proper connections in accordance with single-line diagram or approved Submittals.
    c. Proper shield grounding.
    d. Proper cable support.
    e. Proper cable termination.
    f. Cable bends not in conformance with manufacturer’s minimum allowable bending radius.
    g. Proper arc and fireproofing in common cable areas.
    h. Proper circuit and phase identification.
2. Mechanical Connections:
    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 manufacturers.
3. Conductors Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 2,500-volt megohmmeter for 5 kV conductors.
   b. Test each cable individually with remaining cables and shields grounded.
   c. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   d. Evaluate ohmic values by comparison with conductors of same length and type.
   e. Investigate values less than 50 megohms.
2. Shield Continuity Tests:
   a. By ohmmeter method on each section of conductor.
   b. Investigate values in excess of 10 ohms per 1,000 feet of conductors.
3. Acceptance Tests:
   a. In accordance with IEEE 400, ICEA S-93-639, NEMA WC 74, ICEA S-94-649, and ICEA S-97-682 for insulated conductors.
   b. Each conductor section tested with:
      1) Splices and terminations in place but disconnected from equipment.
      2) Remaining conductors and shields grounded in accordance with IEEE 400.
   c. Apply maximum test voltage per NETA ATS, Table 100.6, based on method (DC, AC, PD or VLF) used.
   d. Measure only leakage current associated with conductor.
   e. Utilize guard ring or field reduction sphere to suppress corona at disconnected terminations.
   f. Maximum test voltage shall not exceed limits for terminators specified in IEEE 48, IEEE 386, or manufacturer's specifications.
   g. Apply test voltage in a minimum of five equal increments until maximum acceptable test voltage is reached.
      1) Increments not to exceed ac voltage rating of conductor.
      2) Record dc leakage current at each step after a constant stabilization time consistent with system charging current.
   h. Raise conductor to specified maximum test voltage and hold for 15 minutes or as specified by conductor manufacturer. Record leakage current at 30 seconds and 1 minute, and at 1-minute intervals, thereafter.
   i. Immediately following test, ground conductor for adequate time period to drain insulation stored charge.
   j. Test results evaluated on a pass/fail basis.

3.09 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.

3.10 MEDIUM-VOLTAGE METAL-ENCLOSED AIR SWITCHES

A. Visual and Mechanical Inspection:

1. Proper blade pressure, alignment, and arch interrupter operation.
2. Proper operation of operating mechanism.
3. Proper contact condition.
4. Adequate mechanical support for each fuse.
5. Proper contact-to-contact tightness between fuse clip and fuse.
6. Bus and cable connection tightness.
7. Proper phase barrier material and installation.
8. Proper operation of indicating devices.
9. Installation of expulsion limiting devices on expulsion type element holders.
10. Verify fuse links and types correspond to one-line diagram or approved Submittals.

11. Perform mechanical operational test to verify electrical and mechanical interlocking system operation and sequencing.
12. Perform phasing check on double-ended air switch arrangements 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. 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 values exceeding 500 microhms or deviation of 50 percent or more from adjacent poles or similar switches.
3. Overpotential Tests:
   a. Applied ac or dc voltage in accordance with NETA ATS, Table 100.19.
   b. Phase-to-phase and phase-to-ground for 1 minute.
   c. Test results evaluated on pass/fail basis.

3.11 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.

3.12 LOW VOLTAGE POWER CIRCUIT BREAKERS

A. Visual and Mechanical Inspection:

1. Proper mounting, cell fit, and element alignment.
2. Proper operation of racking interlocks.
3. Check for damaged arc chutes.
4. Proper contact condition.
5. Bolt torque level in accordance with NETA ATS, Table 100.12.
6. Perform mechanical operational and contact alignment tests in accordance with manufacturer's instructions.
7. Check operation of closing and tripping functions of trip devices by activating ground fault relays, undervoltage shunt relays, and other auxiliary protective devices.
8. Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operation are correct.

9. Check charging motor, motor brushes, associated mechanism, and limit switches for proper operation and condition.
10. Check operation of electrically operated breakers in accordance with manufacturer's instructions.
11. Check for adequate lubrication on contact, moving, and sliding surfaces.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-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 characteristic when adjusted to setting sheet parameters shall be within manufacturer's published time-current tolerance band.

3.13 MEDIUM-VOLTAGE AIR CIRCUIT BREAKERS

A. Visual and Mechanical Inspection:

1. Proper cell fit and element alignment.
2. Proper operation of cubicle shutters and racking mechanism.
3. Proper contact condition.
4. Bolt torque level in accordance with NETA ATS, Table 100.12.
5. Perform mechanical operator and contact alignment tests on breaker and its operating mechanism in accordance with manufacturer's instructions.
6. Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operations are correct.
7. Ensure maintenance devices are available for servicing and operating breaker.
8. Check for adequate lubrication on contact, moving, and sliding parts.
9. Check condition of brushes and limit switches on charging and lifting motors.

10. With breaker in TEST position:
    a. Trip and close breaker with control switch.
    b. Trip breaker by manually operating each protective relay.
11. Perform breaker travel and velocity analysis in accordance with manufacturer's instructions; values shall be in accordance with manufacturer's acceptable limits.

B. Electrical Tests:

1. Insulation Resistance Tests:
    a. Utilize 2,500-volt dc megohmmeter for 5-kV 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. Overpotential Tests:
    a. Maximum applied ac or dc voltage in accordance with NETA ATS, Table 100.19.
    b. Each pole-to-ground with other poles grounded and contacts closed for 1 minute.
    c. Test results evaluated on pass/fail basis.
4. Minimum pickup voltage tests on trip and close coils.
5. Control Wiring Tests: Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components. Insulation resistance to be 1 megohm minimum.
6. Power factor test on each phase with breaker in both OPEN and CLOSED positions. Compare power factor and arc chute watt loss with adjacent poles or manufacturer's published data.
7. Power factor test on each bushing utilizing conductive straps and hot collar procedures if bushings are not equipped with power factor tap. Power factor and capacitance test results within nameplate rating of bushings.

3.14 MEDIUM-VOLTAGE VACUUM CIRCUIT BREAKERS AND INTERRUPTORS

A. Visual and Mechanical Inspection:

1. Check for proper element alignment.
2. Check for proper operation of cubicle shutters and racking mechanism.
3. Bolt torque level in accordance with NETA ATS, Table 100.12.

4. Perform mechanical operational tests on breaker and its operating mechanism in accordance with manufacturer's instructions, plus check:
   a. Pull rod adjustment.
   b. Trip latch clearance.
   c. Overtravel stops.
   d. Wipe and gap setting.
5. Perform breaker travel and velocity analysis in accordance with manufacturer's instructions; values shall be in accordance with manufacturer's acceptable limits.
6. Check contact erosion indicators in accordance with manufacturer's instructions.
7. With breaker in TEST position:
   a. Trip and close breaker with control switch.
   b. Trip breaker by manually operating each protective relay.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 2,500-volt dc megohmmeter for 5-kV 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. Between the line and load stab of closed contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Overpotential Tests:
   a. Maximum applied ac or dc voltage in accordance with NETA ATS, Table 100.19.
   b. Each pole-to-ground with other poles grounded and contacts closed for 1 minute.
   c. Test results evaluated on pass/fail basis.
4. Minimum pickup voltage tests on trip and close coils.
5. Control Wiring Tests:
   a. Insulation resistance test at 1,000-volt dc on control wiring, except that connected to solid state components.
   b. Insulation resistance to be 1 megohm minimum.
6. Vacuum bottle overpotential integrity test across each vacuum bottle with breaker in OPEN position, in accordance with manufacturer's instructions.

7. Power Factor Test (Each Phase):
    a. With breaker in both OPEN and CLOSED position.
    b. Compare power factor and arc chute watt loss with adjacent poles or manufacturer's published data.
8. Power Factor Test (Each Bushing):
    a. Utilize conductive straps and hot collar procedures if bushings are not equipped with power factor tap.
    b. Power factor and capacitance test results within nameplate rating of bushings.

3.15 PROTECTIVE RELAYS

A. Visual and Mechanical Inspection:

1. Visually check each relay for:
    a. Tight cover gasket and proper seal.
    b. Unbroken cover glass.
    c. Condition of spiral spring and contacts.
    d. Disc clearance.
    e. Condition of case shorting contacts if present.
2. Mechanically check each relay for:
    a. Freedom of movement.
    b. Proper travel and alignment.
3. Verify each relay:
    a. Complies with Contract Documents, approved Submittal, and application.
    b. Is set in accordance with recommended settings from Coordination Study.

B. Electrical Tests:

1. Insulation resistance test on each circuit to frame, except for solid state devices.
2. Test on nominal recommended setting for:
    a. Pickup parameters on each operating element.
    b. Timing at three points on time-current curve.
    c. Pickup target and seal-in units.
    d. Special tests as required to check operation of restraint, directional, and other elements in accordance with manufacturer's instruction manual.
3. Phase angle and magnitude contribution tests on differential and directional relays after energization to vectorially verify proper polarity and connections.

4. Current Injection Tests:
    a. For entire current circuit in each section.
    b. Secondary injection for current flow of 1 ampere.
    c. Test current at each device.

3.16 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.

3.17 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.

3.18 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.

3.19 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.

3.20 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.

3.21 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 OPENposition.
   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.

3.22 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.

3.23 MEDIUM-VOLTAGE SURGE ARRESTORS AND SURGE CAPACITORS

A. Visual Inspection:

1. Ground connections to ground bus.
2. Shortest practical jumper connections to line.

B. Electrical Tests:

1. Grounding electrode resistance test in accordance with IEEE 81, Section 8.2.1.5 using three-point fall-of-potential method.
2. Insulation power factor.
3. Insulation resistance.
4. RF noise test using Stoddart noise test set with applied voltage of 1.18 times maximum continuous operating voltage.
5. Insulation power factor leakage current, watts loss, and insulation resistance test in accordance with manufacturer's test values. RIV value not to exceed 10 microvolts above background noise.
6. Leakage current and watts loss tests.

3.24 THERMOGRAPHIC SURVEY

A. Provide thermographic survey per NETA ATS Table 100.18 of connections associated with incoming service conductors, bus work, and branch feeder conductors No. 4 and larger at each:

1. Medium and low voltage switchgear.
2. Low voltage motor control center.
3. Panelboard.

B. Provide thermographic survey of feeder conductors No. 4 and larger terminating at:

1. Motors rated 50 hp and larger.
2. Low voltage disconnect switches.
3. Transfer switches.

C. Remove necessary enclosure metal panels and covers prior to performing survey.

D. Perform with equipment energized during periods of maximum possible loading per NFPA 70B, Section 20.17.

E. Do not perform survey on equipment operating at less than 40 percent of rated load. If plant load is insufficient, perform test with supplemental load bank producing rated load on item being measured.

F. Utilize thermographic equipment capable of:

1. Detecting emitted radiation.
2. Converting detected radiation to visual signal.
3. Detecting 1 degree C temperature difference between subject area and reference point of 30 degrees C.

G. Temperature Gradients:

1. 3 degrees C to 7 degrees C indicates possible deficiency that warrants investigation.
2. 7 degrees C to 15 degrees C indicates deficiency that is to be corrected as time permits.
3. 16 degrees C and above indicates deficiency that is to be corrected immediately.

H. Provide written report of:

1. Areas surveyed and the resultant temperature gradients.
2. Locations of areas having temperature gradients of 3 degrees C or greater.
3. Cause of heat rise and actions taken to correct cause of heat rise.
4. Detected phase unbalance.

END OF SECTION

SECTION 26 12 02
OIL-FILLED PAD MOUNTED TRANSFORMERS

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): D3487, Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   b. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   c. C57.12.22, Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2,500 kVA and Smaller.
   d. C57.12.26, Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors.
   e. C57.12.28, Switchgear and Transformers—Pad-Mounted Equipment, Enclosure Integrity.
   f. C57.12.90, Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers.
   g. C57.106, Guide for Acceptance and Maintenance of Insulating Oil in Equipment.
   h. C62.11, Metal-Oxide Surge Arrestors for Alternating-Current Power Circuits (>1 kV).
3. National Electrical Manufacturers Association (NEMA):
   a. TR 1, Transformers, Regulators, Reactors.
   b. 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).

1.02 SCOPE OF WORK

A. Furnish, install, and test two new un-used 500 kVA Oil-Filled Pad Mounted Transformers as specified herein.

1.03 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Dimensional drawings.
3. Transformer nameplate data.
4. Schematic and connection diagrams.

B. Informational Submittals:

1. Operation and Maintenance Data: Operation and Maintenance Manual as specified in Section 01 78 23, Operation and Maintenance Data.
2. Factory test reports certified.

1.04 QUALITY ASSURANCE

A. Design, test, and assemble in accordance with applicable standards of NEMA TR 1, IEEE C57.12.00, IEEE C57.12.22, IEEE C57.12.26, and IEEE C57.12.90.

1.05 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage and deliver prior to Project substantial completion the following spare parts, special tools, and materials:

1. One quart of paint to match color and quality of equipment final shop finish.
2. Pentahead socket for 1/2-inch socket drive.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB.

B. Square D Co.

C. General Electric.

D. Cooper Power System.

2.02 GENERAL

A. Provide Pad Mounted Transformers that are the product of a single manufacturer.

B. Integral Unit: Compartmental type unit consisting of transformer, oil-filled tank, and high and low voltage terminating compartments, assembled on a common structural base.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer and as specified in Section 05 55 00, Metal Fabrications.

2.03 TRANSFORMER

A. kVA Rating: 500.

B. Primary Voltage: 4.16 kV line-to-line volts, three-phase, three-wire, 60-Hz.

C. Secondary Voltage: 480/277 volts, three-phase, four-wire, 60-Hz, solidly grounded.

D. BIL Rating:

1. 60 BIL for 5 kV insulation class transformers.
2. 30 BIL for secondary.

E. Temperature Rise: 55/65 degrees C above 30 degrees average ambient with direct sun exposure, maximum ambient not to exceed 40 degrees C.

F. Impedance: 3.0 percent minimum.

G. Efficiency: Meet or exceed values in Table 4-1 of NEMA TP 1.

H. Dielectric Coolant: Fully biodegradable, nontoxic, and nonbio-accumulating fluid, qualifying as “less flammable” per NEC 450.23; Factory Mutual Approved or UL Classified.

I. Primary Taps:

1. Full capacity, two 2-1/2 percent below and two 2-1/2 percent above, rated voltage.
2. Externally operated no-load tap changer.
3. Provisions for locking handle in any position.

J. Coil Conductors: Copper windings.

K. Delta-wye transformers wound on triplex cores.

L. Sound Level: In accordance with manufacturer’s standards.

2.04 ENCLOSURE

A. In accordance with IEEE C57.12.28 requirements.

B. Welded carbon steel transformer tank, with cooling panels when required, and lifting eyes.

C. 12-gauge sheet steel terminal compartment enclosure having no exposed screws, bolts, or other fasteners that are externally removable.

D. Color: Gray.

2.05 TERMINAL COMPARTMENTS

A. General: IEEE C57.12.28, enclosed high and low voltage compartments side by side, separated by steel barrier, bolted to transformer tank.

1. Doors:
   a. Individual, full-height, air-filled.
   b. Low voltage door with three-point latching mechanism, vault type handle, and single padlocking provision.
   c. High voltage door fastenings inaccessible until low voltage door has been opened.
   d. Door Bolts: Penta-head type.
   e. Lift-off, stainless steel hinges and door stops.
   f. Removable front sill to facilitate rolling or skidding over conduit stubs.
   g. Recessed lock pocket, with steel door release bolt adjacent to secondary compartment door handle.

B. High Voltage Compartment:

1. Deadfront in accordance with IEEE C57.12.26 type construction.
2. High voltage bushings.
3. Transformer grounding pad.

C. Low Voltage Compartment:

1. Livefront in accordance with IEEE C57.12.26 type construction.
2. Low voltage bushings.
3. Grounding pad.
4. Stainless steel equipment nameplate.
5. Liquid level gauge.
6. 1-inch upper filter press and filling plug.
7. Drain valve with sampling device.
8. Dial type thermometer.
9. Pressure relief valve.
10. Pressure-vacuum gauge.
11. Nameplate.

2.06 BUSHINGS

A. High Voltage:

1. Deadfront Termination:
   a. Integrated bushing rated at 8.3 kV phase-to-ground/14.4 kV phase-to-phase in accordance with IEEE 386.
   b. Bushings externally clamped and front removable.
   c. Rated for 200 amperes continuous, 95 kV BIL.
   d. Standoff brackets located adjacent to bushings.
   e. Bushings to be constructed of cycloaliphatiy epoxy resin and in compliance with IEEE 386.

B. Low Voltage:

1. Molded epoxy bushing clamped to tank with 4 hole spade type terminals.
2. Rated 150 percent of continuous full-load current, 30 BIL, 600 volts.
3. Internally connected neutral extending to neutral bushing.

2.07 TANK GROUNDING PADS

A. High and Low Voltage Compartments:

1. Connected together with bare No. 2/0 stranded copper conductors.
2. Wye-wye high and low voltage neutrals internally connected with link and brought out to insulated low voltage bushing externally grounded to tank.
3. Low voltage neutral connected to externally mounted insulating bushing in low voltage compartment and grounded to tank with removable strap.

2.08 TAP CHANGER WARNING SIGN

A. Red laminated plastic, engraved to white core.

B. Engrave to read: DO NOT OPERATE WHEN TRANSFORMER ENERGIZED.

C. Mount above tap changer handle.

2.09 FACTORY TESTS

A. Production tests in accordance with IEEE C57.12.90 and IEEE C57.12.00, Section 8 and Table 16.

B. Dielectric test in accordance with IEEE C57.12.26.

PART 3 EXECUTION

3.01 GENERAL

A. Secure to mounting pads with anchor bolts.

B. Install plumb and longitudinally in alignment with pad or adjacent building wall.

C. Ground neutrals and enclosures in accordance with applicable codes.

3.02 ADJUSTMENTS

A. Adjust voltage taps to obtain rated output voltage under normal operating load conditions.

END OF SECTION

SECTION 26 13.16.02
PAD-MOUNTED SWITCHGEAR

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. B117, Standard Practice for Operating for Salt Spray (Fog) Apparatus.
   b. B187, Standard Specification for Copper Bar, Bus Bar, Rod, and Shapes.
   c. B236, Standard Specification for Aluminum Bars for Electrical Purposes (Bus Bars).
   d. D523, Standard Test Method for Specular Gloss.
   e. D543, Standard Practice for Evaluating for Resistance of Plastics to Chemical Reagents.
   f. D570, Standard Test Method for Water Absorption of Plastics.
   g. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   h. D714, Standard Test Method for Evaluating Degree of Blistering of Paints.
   i. D756, Standard Practice for Determination of Weight and Shape Changes of Plastics under Accelerated Service Conditions.
   j. D790, Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastic and Electrical Insulating Materials.
   k. D1654, Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
   l. D2247, Standard Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.
   m. D2794, Standard Test Method for Resistance or Organic Coatings to the Effects of Rapid Deformation.
   n. D3359, Standard Test Methods for Measuring Adhesion by Tape Test.
   o. D4060, Standard Test Method for Abrasion Resistance to Organic Coatings by the Taber Abraser.
   p. D4214, Test Method for Evaluating Degree of Chalking of Exterior Paint Films.
   q. G154, Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600V.
   b. C37.20.3, Metal Enclosed Interrupter Switchgear.
   c. C37.46, Specifications for Power Fuses and Fused Disconnecting Switches.
   d. C37.57, Metal Enclosed Interrupter Switchgear Assemblies—Conformance Testing.
   e. C37.58, Indoor AC Medium-Voltage Switches for Use in Metal-Enclosed Switchgear—Conformance Test Procedures.
   f. C37.91, Guide for Protective Relay Applications to Power Transformers.
   g. C57.12.28, Switchgear and Transformers, Pad-Mounted Equipment, Enclosure Integrity.
   h. C62.11, Metal-Oxide Surge Arrestors for Alternating-Current Power Circuits (>1 KV).
3. National Electrical Manufacturers Association (NEMA):
   a. C2, National Electrical Safety Code.
   b. C29.9, Wet-Process Porcelain Insulators - Apparatus Post-Type.
   c. C29.10, Wet Process Porcelain Insulators - Indoor Apparatus Type.
   d. LA 1, Surge Arrestors.
   e. SG 2, High Voltage Fuses.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.02 SCOPE OF WORK

A. Furnish, install, and test two new un-used pad-mounted switchgear as specified herein.

B. Provide an additive cost on bid form for a stainless steel enclosure.

1.03 SUBMITTALS

A. Action Submittals:

1. Descriptive product information.
2. Dimensional drawings.
3. Itemized bill of material.
4. Operational description.
5. Installation instructions.
6. Switchgear configurations.
7. Load interrupter switch data.
8. Microprocessor controlled vacuum fault interrupter data.
9. Bus data.

10. Time-current characteristics.
11. Conduit entrance locations.
12. Concrete pad details.
13. Base spacer details.
14. Anchoring details**.**

B. Informational Submittals:

1. Certified factory test reports.
2. Manufacturer's installation instructions.
3. Operation and Maintenance Data: Operation and Maintenance Manual as specified in Section 01 78 23, Operation and Maintenance Data.
4. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturer's Field Services.

1.04 EXTRA MATERIALS

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

1. 6 feet 5-1/2 inches long 15 KV shotgun clamp stick for use with separable connectors in accordance with ASTM F711, OSHA 1910.269 (j) and OSHA 1926.95(d) and canvas storage bag.
2. Overcurrent-control, Adapter Cable, provide by switchgear manufacturer. Required for programming overcurrent control.
3. 24-volt portable motor operator for operation of manual load-interrupter switches and manual fault interrupters from a remote location, provided by switchgear manufacturer. Carrying case, 50-foot cable with remote controls. Two 24-volt batteries and battery chargers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. S&C Co.; Vista.

B. G&W Electric Co.

C. ABB.

D. Provide pad-mounted switchgear that is the product of a single manufacturer. Assembled units with component parts of several manufacturers will not be acceptable with the exception that minor items as terminal blacks, test switch, wiring, etc., may be manufactured by others.

2.02 GENERAL

A. Equipment suitable for 4,160 volts, three-phase, three-wire solid grounded-wye electrical system having an available short-circuit current at line terminals of 25,000 amperes rms symmetrical.

B. Pad-mounted switchgear complete with self-supporting enclosure for elbow connected encased components.

C. Switchgear shall be 600A rated with dead break elbow connections.

D. Switchgear load-interrupter switches and disconnect switches shall be manually operated with provisions for operation by portable motor operator with remote controls.

E. Switchgear vacuum fault interrupters shall be microprocessor controlled.

F. Switch Configuration: Two manually operated load-interrupter switches and one microprocessor controlled vacuum fault interrupter with manually operated disconnect switch S&C Vista Model 321 circuit configuration or approved equal.

G. Design, test, and assemble in accordance to IEEE C37.20.3, IEEE C37.57, and IEEE C57.12.28.

H. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.
2. Equipment shall be fully rated with direct sun exposure without derating for these operating conditions.

I. Anchor Bolts: Type 316 stainless steel, sized by manufacturer and as specified in Section 05 50 00, Metal Fabrication.

2.03 EQUIPMENT RATINGS

A. Integrated switchgear assembly ratings at 60-Hz.

1. Voltage: 14.4 kV nominal, 17.0 kV maximum.
2. Insulation Level: 95 kV BIL.
3. Bus Current: 600 amperes continuous.
4. Three-Pole Load-Interrupter Switches:
   a. Current: 600 continuous amperes, 600 load dropping amperes.
5. Vacuum Fault Interrupter:
   a. Current: 600 continuous amperes, 600 load dropping amperes.
6. Short-Circuit Rating: 25,000 amperes rms symmetrical at 15.5 kV.

B. Fault-closing ratings to equal, or exceed, the short-circuit ratings of the pad-mounted switchgear with:

1. Momentary and two-time duty-cycle rating of switches.
2. Momentary rating of bus.
3. Interrupting ratings of vacuum fault interrupters.

2.04 ENCLOSURE

A. Monocoque, freestanding, self-supporting construction with welded structural and butt joints having external seams ground flush and smooth.

B. Enclosure sides, doors, roof, bottom flange, base spacer, and steel barriers constructed with 11-gauge hot-rolled, pickled, and oiled sheet steel (stainless steel as an additive alternate).

C. Tamper resistant with no externally accessible hardware in accordance with security requirements of IEEE C57.12.28.

D. Removable lifting tabs bolted to blind-tapped sockets with resilient anticorrosion material between tabs and enclosure.

E. Enclosure Base:

1. Consisting of continuous 90-degree steel flanges welded to enclosure and turned inward for bolting to base spacer.
2. Resilient closed-cell PVC gasket applied between flange bottom and base spacer.
3. Coat enclosure flange with wax-based anticorrosion moisture barrier.

F. Enclosure Roof:

1. Overlapping edges creating mechanical maze and ventilating openings.
2. Insulating nondrip compound applied to underside.

G. Doors:

1. Constructed with edge flanges overlapping door openings to form mechanical maze.
2. Two extruded-aluminum hinges with Type 316 stainless steel pins, full length of door extruded-aluminum interlocking supports, and stainless steel mounting hardware for each door.
3. Access doors, one to load-interrupter switches and vacuum fault interrupters compartment and one to the conductor termination compartment.
4. Hidden galvanized steel door holders swinging outward when door is in opened position.

H. Door Latch:

1. Automatic positive action, three-point, spring-loaded latching mechanism for each door or set of doors.
2. Pentahead socket wrench to actuate mechanism for unlatching door and recharging spring for next closing operation in same motion.
3. Tamper-proof padlocking shackle coordinated with latches to prevent:
   a. Unlatching mechanism until padlock is removed.
   b. Inserting padlock until mechanism is completely latched closed.

I. Finish:

1. Multistage process applied to interior and exterior surfaces, joints, and blind areas prior to enclosure assembly.
   a. Pretreatment protective film.
   b. Baked epoxy finished coating.
   c. Baked acrylic enamel top coating in accordance with IEEE C57.12.28.
2. Color: Gray.
3. Tests:
   a. Salt-spray test in accordance with ASTM B117.
   b. Humidity test in accordance with ASTM D2247 and ASTM D714.
   c. Accelerated weather tests in accordance with ASTM G154, ASTM D4214, and ASTM D523.
   d. Adhesion tests in accordance with ASTM D3359, Method B and ASTM D2794.
   e. Corrosion tests in accordance with ASTM D1645.
   f. Abrasion tests in accordance with ASTM D4060.
   g. Oil resistance testing with no shift in color, streaking, blistering, or loss of hardness.

2.05 BARRIERS

A. In compliance with NEMA C2.

B. Full-length steel barriers separating side-by-side compartments.

C. BIL Rated Fiberglass-Reinforced Polyester Barriers:

1. Fixed interphase and end barriers for each interrupter switch and each vacuum fault interrupter.
2. Front and rear compartments isolated by fixed barriers.

2.06 COMPONENT ENCASEMENT

A. In compliance with NEMA C2.

B. Switch and interrupter components, and interconnecting bus enclosed in inner air-insulated, grounded, steel compartment bulkheads and 22-gauge galvanized steel floor.

C. Resilient gasketing between compartment bulkheads and enclosure roof and sides.

D. Dense closed-cell gaskets between fuse-handling mechanisms and compartment bulkhead.

E. Full-length steel barriers separating adjoining termination compartments.

F. BIL rated fiberglass-reinforced polyester barriers to isolate interphase bus from components.

G. Wide-angle viewing window in bulkhead for visual verification of each interrupter switch position and vacuum fault interrupter position.

H. Parking stands adjacent to each 600-ampere rated bushing and 600-ampere rated bushing well.

2.07 GROUND-CONNECTION PADS

A. Provided in each compartment on inside at bottom door stile with momentary rating equal to, or exceeding, short-circuit ratings of switchgear.

B. Constructed of 5/8-inch thick nickel-plated steel, with oxide inhibitor and sealant coating, welded to enclosure.

C. Ground studs of each vacuum fault interrupter terminal plus one ground stud at ground connection pad in each compartment and switch terminals.

2.08 GROUND RINGS

A. Provide full width in each switch compartment and vacuum fault interrupter compartment.

B. Constructed of 3/8-inch-thick copper bolted to the metal enclosure inside at bottom door stile.

C. Cable guides at each ground ring.

2.09 INSULATORS

A. Interrupter switch and vacuum fault interrupters, insulated operating shafts, and push rods constructed of cycloaliphatic epoxy resin in accordance with NEMA C29.9 and NEMA C29.10.

2.10 HIGH VOLTAGE BUS

A. Copper bus bar and bus supports.

B. Bus rated 600-ampere with provisions for one-cable terminations per phase.

2.11 INTERRUPTER SWITCHES

A. 600A external handle-operated, three-pole, three-position (closed-open-grounded) nonfused, group-operated with quick-make quick-break mechanism for live, full load, open and close switching in accordance with IEEE C37.58.

B. Enclosed in a SF6-insulated, welded stainless steel tank, completely protected from the environment.

C. Visible gap when open and internal grounding from all three phases.

D. The operating mechanism shall operate independently of the speed of the manual handle and be designed to prevent inadvertent operation from the closed position directly to the ground position and vice versa.

E. Equip each switch assembly with 600-ampere bushing with removable threaded studs, and support insulators.

F. Mount each switch assembly bushing with adjacent elbow parking stand, and operator on a rigid, welded steel frame.

G. Base mounted metal-oxide type distribution class surge arrests rated 5 kV at all source switch terminals.

H. Bushing, with removable threaded studs, to be constructed of cycloaliphatic epoxy resin and in compliance with IEEE 386.

I. Shaft lock for each switch.

2.12 VACUUM FAULT INTERRUPTERS

A. Disconnect style microprocessor controlled vacuum fault interrupter, complete with steel base and loadbreak connector.

B. 600A, resettable, external handle-operated, three-pole, three-position (closed-open-ground) for load switching and fault interruption through 25 KA symmetrical.

C. Fault interruption initiated by a programmable over-current controller.

D. The microprocessor based programmable over-current controller shall be programmed using a personal computer connected to the controller through an adapter cable.

E. Power and input signals to the controller shall be by a current transformer.

F. The control shall be provided with multiple time-current characteristic (TCC) curves: Standard E and K speed curves, innovative coordinating speed tap and main curves, and relay curves per IEEE C37.112. These curves shall be tailorable to the application using a variety of instantaneous and definite-time settings.

G. Total clearing time: 40 milliseconds minimum.

H. Enclosed in a SF6-insulated, welded stainless steel tank, completely protected from the environment.

I. The operating mechanism shall operate independently of the speed of the manual handle and be designed to prevent inadvertent operation from the closed position directly to the ground position and vice versa.

J. Trip indicators for each fault interrupter visible through viewing window.

K. Equip each vacuum fault interrupter with 600-ampere bushing well, having parking stand mounted adjacent to interrupter.

L. Bushing wells to be constructed of cycloaliphatic epoxy resin and in compliance with IEEE 386.

2.13 CONTROL WIRING

A. NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts for control, instrumentation, and power circuits.

B. Individual seven-strand, copper conductors, twisted and covered with a 100 percent aluminum, polyester shield with tinned copper drain wire and overall outer jacket, rated 600 volts, 90 degrees C minimum for transducer output and analog circuits.

C. Conductor Lugs: Preinsulated, self-locking, spade type with reinforced sleeves.

D. Wire Markers: Each wire individually identified with permanent markers at each end.

E. Internal circuit wiring crossing shipping splits to have plug connectors.

F. Splices: Not permitted.

2.14 SURGE PROTECTION

A. Sets of three metal-oxide, in accordance with IEEE C62.11 and NEMA LA 1.

B. Base mounted at switch terminals and bus terminals in Compartments 1 and 2.

C. Connect to line side of switch terminals and ground to switchgear ground bus.

D. Class: Distribution.

E. Rating: 3 kV for 4.16 kV system.

2.15 BASE SPACERS

A. Steel compartmented type bolted to enclosure flange and anchor to on-grade concrete pad.

B. Spacer height of 12 inches.

C. Complete with resilient closed-cell gasket between bottom flange and concrete pad.

D. Finish identical to that specified for enclosure finish.

2.16 LABELING

A. Nonmetallic, self-sticking with integral lettering and symbols.

B. Warning Labels:

1. Attach to exterior surface of each external door labels reading CAUTION—HIGH VOLTAGE-KEEP OUT.
2. Attach to internal surface of each external door and on all barriers used to prevent access to live parts, labels reading DANGER—HIGH VOLTAGE—KEEP OUT—QUALIFIED PERSONS ONLY.

C. Rating Labels: Attach inside each door, or set of double doors, labels indicating:

1. Voltage rating.
2. Main bus continuous rating.

3. Short-circuit ratings in amperes rms symmetrical and mVa three-phase symmetrical at rated nominal voltage.
4. Fuse type.
5. Fuse rating, including duty-cycle fault-closing capability.
6. Interrupter switch ratings, including duty-cycle fault-closing and short time momentary, amperes rms asymmetrical and 1 second, amperes rms symmetrical.

D. Connection Labels: Attach inside each door, or set of double doors, and inside each switch-operating hub access cover, labels showing three-line connection diagram for interrupter switches, fuses with integral load interrupter, and bus along with manufacturer's model number.

E. Phase identification numbers 1, 2, and 3 above each phase connection at each fuse unit and interrupter switch.

2.17 NAMEPLATES

A. Deep etched aluminum on outside of each door, or set of double doors, indicating manufacturer's name, catalog number, model number, date of manufacture, and serial number.

B. Riveted to door surface.

2.18 ACCESSORIES

A. Overcurrent-control, Adapter Cable. Required for programming overcurrent control.

B. 24-volt portable motor operator for operation of load-interrupter switches and fault interrupters from a remote location. Carrying case, 50-foot cable with remote controls. Two 24-volt batteries and battery chargers.

2.19 SOURCE QUALITY CONTROL

A. Switchgear assembly shall be production tested in accordance with IEEE C37.20.3.

B. Fuses shall be production tested in accordance with IEEE C37.46.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions and recommendations.

B. Secure equipment to concrete pad with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Tighten current-carrying bolted bus connections and enclosure framing and panel bolts to manufacturer's recommendations.

D. Coordinate terminal connections with installation of secondary feeders.

3.02 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative for the following services at Site, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance, final adjustment, and initial energization of equipment.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for post-startup training.

B. Furnish training of 1 personnel at such times as requested by Owner.

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. WPII: 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 met 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
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 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
3. Above 400 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 50 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. Provide winding space heaters with leads wired out to motor separate condulet or terminal box.
2. Provide extra hole or hub on motor terminal box as required.
3. 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
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 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):
   a. C2, National Electrical Safety Code (NESC).
   b. C62.41.1, Guide on the Surge Environment in Low-Voltage (1,000 volts and less) AC Power Circuits.
   c. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1,000 volts and less) AC Power Circuits.
2. National Electrical Contractors Association (NECA): 402, Standard for Installing and Maintaining Motor Control Centers.
3. 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. ICS 2.3, Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600V.
   e. ICS 18, Motor Control Centers.
   f. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL):
   a. 98, Enclosed and Dead-Front Switches.
   b. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   c. 845, Motor Control Centers.
   d. 1283, Electromagnetic Interference Filters.
   e. 1449, Surge Protective Devices.

1.02 SCOPE OF WORK

A. Furnish, install, and test two new motor control centers, MCC-D4 and MCC-D5, as specified herein and as shown on the One Line Diagram.

1.03 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.

1.04 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Itemized Bill of Material.
3. Dimensional drawings.
4. Front Panel Elevations.
5. Conduit entrance locations.
6. Bus data.
7. Protective Devices: Copies of time-current characteristics.
8. Operational description.
9. Anchoring instructions and details.
10. 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.
11. Control diagrams.
12. One-line diagrams.
13. Schematic (elementary) diagrams.
14. Outline diagrams.
15. Wireless unit connection diagrams.
16. Interconnection diagrams.

B. Informational Submittals:

1. Manufacturer’s installation instructions.
2. Factory test reports, certified.
3. Operation and Maintenance Data: Operation and Maintenance Manual as specified in Section 01 78 23, Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

A. Provide products manufactured within scope of Underwriters Laboratories that conform to UL Standards and have applied UL Listing Mark.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping Splits: Maximum of 3 sections or 60 inches per shipping split to facilitate ingress of equipment to final installation location within building.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. GE Industrial Systems.
2. Schneider Electric/Square D Services.
3. Allen-Bradley.
4. Siemens.

2.02 GENERAL

A. Like Items of Equipment: End product of one manufacturer and same manufacturer as low-voltage panelboards and dry-type transformers for standardization.

B. Equipment shall be UL listed and in compliance with NFPA 70 (NEC).

C. 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.

D. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.

E. Control Transformer:

1. Two winding, 120-volt secondary, primary voltage to suit.
2. Two current-limiting fuses for primary circuit.
3. One fuse in secondary circuit with blown fuse indicator.

4. Mount within each starter unit for control power and in each section for power to space heaters.

F. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

G. Lifting lugs on equipment and devices weighing over 100 pounds.

H. Anchor Bolts: Type 316 stainless steel, sized seismically by a licensed structural engineer registered in the State where equipment is to reside and as specified in Section 05 50 00, Metal Fabrications.

I. Seismic zone and importance factor shall be as specified in Section 01 61 00, Common Product Requirements.

J. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.
2. Altitude: 100 feet.
3. Equipment to be fully rated without any derating for operating conditions listed above.

K. Enclosures: In accordance with NEMA 250.

L. Equipment Finish:

1. Electrocoating process applied over rust-inhibiting phosphated base coating.
2. Exterior Color: Light gray**.**

2.03 MOTOR CONTROL CENTERS

A. General:

1. In accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 18, and UL 845.
2. Voltage Rating: As shown on Drawings.
3. Short Circuit Rating: Amperes rms symmetrical at 480 volts for entire motor control center as a complete assembly, as shown on Drawings**.**
4. Main and branch circuit breakers, controllers, wire connections, and other devices to be front mounted and accessible, unless otherwise noted.
5. NEMA ICS 18, Part 3.
   a. Class: I.
   b. Type: B.

B. Enclosure:

1. Type: NEMA 250 Type 1, indoor gasketed.
2. Vertical Section Standard Indoor Dimensions for NEMA 1 Type:
   a. Nominal, 90 inches high, 20 inches wide, 21 inches deep.
   b. Alternative width dimensions of 24 inches and 30 inches are acceptable for oversize devices or panels.
   c. Do not exceed dimensions shown on Drawings.
3. Construction:
   a. Sheet steel reinforced with channel or angle irons.
   b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
   c. Removable top cover plates and bottom cover plates.
   d. Removable plates on end panels for future bus extension.
4. Section Mounting: Removable formed-steel channel sills and lifting angles.
5. Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.
6. Vertical Wiring Compartment:
   a. Full height, isolated from unit starters with separate hinged door and tie supports.
   b. No terminal blocks allowed in vertical wireway compartment.
7. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.
8. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.
9. Door Interlocking: Mechanically interlock starter and feeder doors so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access and energizing at any time by qualified individual.
10. External disconnect handles with ON/OFF and trip positions showing, padlockable in OFF position with up to three-lock capability.
11. Cable Entrance: Main leads enter from bottom; control and feeder circuits enter from top and bottom.

C. Bus:

1. Horizontal Power Bus:
   a. Three-phase tin-plated, copper**,** entire width of control center, rated as shown.
   b. Tin-plated at joints**.**
   c. Construct to allow future extension of additional sections.
   d. Pressure type solderless lugs for each incoming line cable.
   e. Isolated from top horizontal wireway.
   f. Provide Belleville washers on bus connection bolts.

2. Vertical Power Bus:
    a. Three-phase tin-plated, copper, full height of section, rated for load. Minimum acceptable rating shall be 300 amperes.
    b. Tin-plated at joints.
    c. Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.
    d. Insulated and isolated barrier, complete with shutters.
    e. Provide Belleville washers on bus connection bolts.
3. Neutral Bus: None.
4. Ground Bus:
    a. Copper, tin-plated, rated 33 percent minimum of phase bus ampacity amperes, entire width of control center.
    b. Provide Belleville washers on bus connection bolts.
5. Bus Bracing: Amperes rms symmetrical as shown on Drawings.

D. Motor Controller Unit:

1. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified herein.
2. Construction:
    a. Drawout combination type with stab connections for starters NEMA ICS, Size 5 and smaller.
    b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 6 and larger.
    c. Readily interchangeable with starters of similar size.
    d. Pull-apart unit control wiring terminal boards capable of accepting up to 2#14 AWG wires minimum on all units.
3. Starters:
    a. NEMA ICS 18, standard rating, except none smaller than NEMA ICS, Size 1.
    b. Rating: Horsepower rated at 600 volt, UL labeled for short circuit rating as shown on Drawings at 480 volts short circuit capacity with overload protection.
    c. Three-phase, nonreversing, unless specified otherwise.
    d. Disconnect Type: Motor circuit protector**.**
    e. Combination Full Voltage, Magnetic Starter:
        1) Control: As shown on Drawings.
        2) Motor overload protection: Solid state.
    f. Combination Reduced Voltage, Solid State Starter:
        1) Control: As shown on Drawings.
        2) Internal bypass contactor.
        3) Isolation contactor.
        4) Class 10/20/30 electronic overload relay, switch, or dip switch selectable.
        5) Kick start, with adjustable torque and time settings.

6) Ramp start, selectable current or torque, and adjustable time.
7) Smooth stop ramp, adjustable time.
8) Phase loss, phase unbalance Phase under-voltage, Phase over-voltage, phase reversal, stall time, starts per hour protection.
9) Motor thermal modeling.
10) LED display or LCD of fault, N.O. contact to communicate fault condition.

g. Communications: Manufacturer's standard or as shown on Drawings.
h. Padlockable operating handle when de-energized with up to three-lock capability.
i. Unit door interlocked to prevent opening when disconnect is in closed position.
j. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.
k. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

4. Disconnecting Device:
   a. In each starter, control circuit disconnect to de-energize circuits in unit which are not de-energized by starter power disconnect device.
   b. Padlockable in OPEN position for up to three locks.
5. Circuit Breaker:
   a. Meet requirements of UL 489.
   b. Molded case with manufacturer's recommended trip setting for maximum motor protection.
   c. Thermal-magnetic trip or magnetic trip only as shown.
   d. Tripping indicated by operating-handle position.
   e. Interrupting capacity required for connection to system with short-circuit capacity indicated.
   f. Shunt trip for ground fault protection.
6. Solid State Motor Overload Protection:
   a. Inverse-time-limit characteristic.
   b. Phase loss, phase unbalance, phase over-voltage, phase under-voltage, and Class II ground fault protection.
   c. Current operated electronic circuitry with adjustable trip.
   d. Class 10/20/30 relay trip, switch selectable.
   e. One N.O. auxiliary contact for remote monitoring.
   f. Manual reset.
   g. Provide in each ungrounded phase.
   h. Mount within starter unit with front panel display.
   i. Communications: Manufacturer's standard or as shown on Drawings.
7. Motor Thermal Protector Interface: Manual-reset interposing relay for connection to motor-mounted thermal protector system.

8. Ground Fault Protection: Where indicated and as specified in Paragraph Main Protective Device and Feeder Units, except provide instantaneous operation device.

E. Control Unit:

1. Disconnecting Device: Pull-apart terminal blocks capable of de-energizing external source control circuits in unit.
2. Control Devices: As indicated.
3. Control Wiring:
   a. Type: SIS.
   b. Copper, 14 AWG, minimum.
   c. Permanent sleeve type markers with wire numbers applied to each end of wires.
   d. Terminate wires using insulated locking fork or ring type crimp terminals.
   e. Terminate current transformer leads on shorting type terminal blocks.

F. Incoming Line Terminal:

1. Construction: As specified in Paragraph, Motor Controller Unit.
2. Incoming Service Feeder: As shown on Drawing.
3. Mechanical type CU-/AL lugs for 75 degrees C cable.

G. Main Protective Device and Feeder Unit:

1. Construction: As specified in Paragraph Motor Controller Unit.
2. Incoming Service Feeder: Cable. As shown on Drawings.
3. Solid State Trip Circuit Breaker:
   a. In accordance with UL 489.
   b. Main and feeder protective device as shown on Drawings.
   c. UL labeled as suitable for service entrance, as shown on Drawings.
   d. Insulated or molded case breakers with ambient insensitive solid-state trips and having current sensors and logic circuits integral in breaker frame.
   e. Solid-state current control with adjustable ampere setting, independent adjustable long-time delay, independent adjustable short-time trip and delay band, fixed or independent adjustable instantaneous trip.
   f. Setting adjustments to be covered by a sealable, tamper-proof, transparent cover (insulated case breakers only) or by compartment door for other breakers).

g. Locate trip button on front cover of breaker to permit mechanical simulation overcurrent tripping for test purposes and to trip breaker quickly in emergency situation.
h. Communications: Manufacturer's standard or as shown on the Drawings.

4. Molded Case Circuit Breaker:
   a. In accordance with UL 489.
   b. Feeder protective device, as shown on Drawings.
   c. Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.
   d. Indicate tripping by operating-handle position.
   e. Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.
5. Key Interlocking:
   a. Mechanical lock cylinders within main and tie breaker compartments as shown.
   b. Key and Lock Cylinder Type: Kirk.
   c. Keys to be captive when breakers are closed.
   d. Two main and one tie breaker arrangements.
6. Phase Monitoring Relay:
   a. Three-phase monitoring relay to protect against low voltage, voltage unbalance, and phase reversal.
   b. Manufacturer and Product: Schneider Electric/Square D; Class 8430 Type MPS or Class 8430 Type MPD.

H. Digital Instruments:

1. Digital Power Meter:
   a. Microprocessor-based electronic monitoring package, complete with keypad where shown on Drawings.
   b. Display Parameters:
      1) Phase current.
      2) Voltage (phase-to-phase and phase-to-ground).
      3) Watts (phase-to-phase and phase-to-ground).
      4) Volt amperes (phase-to-phase and phase-to-ground).
      5) Volt amperes reactive (phase-to-phase and phase-to-ground).
      6) Watt hours.
      7) Volt ampere hours.
      8) Volt ampere reactive hours.
      9) Power factor.
      10) THD.
      11) Frequency.
      12) Present demand current.
      13) Present demand watts.

14) Minimum and maximum current, voltage, watts, volt amperes, power factor, and frequency.

c. Alpha numeric, LED display or LCD.

d. Control power voltage transformed with disconnect and fuses. Voltage sensing directly from bus with disconnect and fuses. Current transformers with ratio as shown, complete with shorting terminal block.

e. Communication Interface: Modbus RTU. Provide all required configuration for communication with the SCADA network. Coordinate signal exchange with the Owner's Consultant. All the display parameters listed above shall be available thru the Modbus RTU interface at the owners PLC-HMI.

f. Ports:
   1) Dual RS-485.
   2) RS-232.

g. Manufacturers and Products:
   1) Square D – Power Logic Series PM850.
   2) Or approved equal.

I. Key Interlocks:

1. Two Main and One Tie Breaker Arrangement:
   a. Two keys available for each group of three locks.
   b. Two out of three breakers closed at any time.

J. Surge Protective Devices (SPD):

1. UL Compliance and Labeling:
   a. For power and signal circuits, SPD 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.
   b. For telephone circuit protection, TVSS devices shall comply with UL 497A.
2. All SPD for power circuits shall be the product of a single manufacturer.
3. SPD 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.
4. SPD 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.
5. Design SPD 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.

6. Power Filter: The SPD shall include a high frequency extended range power filter complimentary listed to UL 1283 as an electromagnetic interference filter.
7. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category C.
8. Surge current capacity shall be not less than the following:
   a. L-N Capacity: 200 kA.
   b. L-G Capacity: 120 kA.
   c. N-G Capacity: 120 kA.
9. Suppressor housing shall be in an enclosure that has the same NEMA rating as the equipment it protects and painted to match.
10. 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

11. Nominal Discharge Current: 20kA.
12. 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.
13. Surge Counter:
    a. Provide each SPD 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.

K. Pushbutton, Indicating Light, and Selector Switch:

1. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.
2. Selector Switch Operating Lever: Standard.
3. Indicating Light: Push-to-test.
4. Pushbutton Color:
   a. ON or START: Black.
   b. OFF or STOP: Red.
5. Pushbutton and selector switch lockable in OFF position where indicated.

6. Legend Plate:
   a. Material: Aluminum.
   b. Engraving: Enamel filled in high contrasting color.
   c. Text Arrangement: 11-character/spaces on one line, 14-character/ spaces on each of two lines, as required, indicating specific function.
   d. Letter Height: 7/64-inch.
7. Heavy-Duty, Oil-Tight Type, 30-mm.

L. Terminal Block, 600 Volts:

1. UL 486E and UL 1059.
2. Size components to allow insertion of necessary wire sizes.
3. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.
4. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.
5. Yoke, current bar, and clamping screw of high strength and high conductivity metal.
6. Yoke shall guide all strands of wire into terminal.
7. Current bar shall ensure vibration-proof connection.
8. Terminals:
   a. Capable of wire connections without special preparation other than stripping.
   b. Capable of jumper installation with no loss of terminal or rail space.
   c. Individual, rail mounted.
9. Marking system, allowing use of preprinted or field-marked tags.

M. Magnetic Control Relay:

1. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.
2. NEMA ICS 2, Designation: A300 (300 volts) or A600 (600 volts as required.
3. Time Delay Relay Attachment:
   a. Pneumatic type, timer adjustable as shown on Drawings.
   b. Field convertible from ON delay to OFF delay and vice versa.
4. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.

N. Time Delay Relay:

1. Industrial relay with contacts rated 5 amps continuous, 3,600VA make, 360VA break.
2. NEMA ICS 2 Designation: B150 (150 volts).

3. Solid-state electronic, field convertible ON/OFF delay.
4. One normally open and one normally closed contact (minimum).
5. Repeat accuracy plus or minus 2 percent.
6. Timer adjustment from 1 second to 60 seconds, unless otherwise indicated on Drawings.

O. Reset Timer:

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

P. Elapsed Time Meter:

1. Drive: Synchronous motor.
2. Range: 0 hour to 99,999.9 hours, nonreset type.
3. Mounting: Semiflush panel.

Q. Nameplates:

1. Laminated plastic; white, engraved to black core.
2. Provide for each motor control center and each unit.
3. Engrave with inscription shown on single-line diagram.
4. Provide blank nameplates on spaces for future units.
5. Attach with stainless steel panhead screws on face of control center.

R. Space Heaters: Thermostatically controlled. Locate in bottom of each vertical section for operation from 120-volt power source derived internal to MCC.

2.04 SOURCE QUALITY CONTROL

A. Factory Testing:

1. Applicable Standards: NEMA ICS 18, UL 845, and NEC Article 430, Part VIII.
2. Perform standard factory inspection and tests in accordance with NEMA requirements to verify components have been designed to Specification, assembled in accordance with applicable standards, and each unit functions in accordance with electrical diagrams.
3. Actual operation shall be performed wherever possible. Otherwise, inspect and perform continuity checks.
4. Verify component devices operated correctly in circuits as shown on diagrams or as called for in Specification.

5. Control Circuits and Devices:
   a. Energize circuit at rated voltage.
   b. Operate control devices.
   c. Perform continuity check.
6. Instruments, Meters, Protective Relays, and Equipment:
   a. Verify devices functioned by energizing potential to rated values with connection to devices made at outgoing terminal blocks.
   b. Verify protective relays operated for functional checks and trips manually initiated to verify functioning of operation for indicator and associated circuits.
7. Perform dielectric tests on primary circuits and equipment, except potential transformers. Tests shall be made phase-to-phase and phase-to-around with 60-cycle test voltages applied for 1 second at 2,640 volts.
8. Verify equipment passed tests and inspection.
9. Provide standard factory inspection and test checklists, and final certified and signed test report.

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. Grout mounting channels into floor or mounting pads.
6. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.
7. 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.

3.02 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative in accordance with Section 01 43 33, Manufacturers' Field Services, for the following services at Job Site or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance, and inspection of installation.
2. 1 person-day for functional and performance testing.
3. 2 person-days for plant startup.
4. 1 person-day for training of Owner's personnel.

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 (1000V 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 (1000 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-Interrupters.
   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 finder 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 HAZARDOUS (CLASSIFIED) LOCATION DEVICES

A. Wiring devices for hazardous (classified) locations shall comply with NEMA FB 11 and UL 1010.

B. Switch:

1. Industrial grade, totally enclosed, ac type, with tumbler switch.
2. Capable of three-way or four-way operation where indicated on Drawings.
3. Rating: 20 amps at 120/277 volts.
4. Material: Cast aluminum backbody and cover.
5. Hazardous Area Ratings: NEMA 7D, suitable for Class I, Group C and Group D; Class 2, Groups E, F and G; and Class 3 locations.
6. Manufacturers and Products:
   a. Killark: XS Series.
   b. Appleton: EDS Series.

C. Switch, Motor Rated:

1. Enclosed manual motor starter-type, three-pole, nonreversing without overloads.
2. Minimum Motor Rating: 10 horsepower, 480V ac, three-phase, three-pole.
3. Enclosure: NEMA 250, Type 7.
4. Operator: External handle with padlocking provisions.
5. Manufacturer and Product: Eaton, Type B101.

D. Receptacles, General:

1. Contain integral switch which must be closed to energize circuit.
2. Design shall permit only an approved plug to be energized.
   a. Actuation of switch shall require plug be inserted and rotated approximately 45 degrees.
   b. Plug shall lock into this position preventing unintended disengagement.
   c. To remove, plug shall be turned opposite direction as engagement and pulled straight out.

E. General Purpose Receptacle, Explosion Proof, 125 Volts, 20 Amps:

1. Dead front, interlocked, circuit breaking.
2. Receptacle Cover: Spring loaded closes when plug is removed.
3. Enclosure: Corrosion-resistant, aluminum alloy with less than 0.4 percent copper.
4. Finish: Electrostatically applied and baked powder epoxy/polyester.
5. External Hardware: Type 316 stainless steel.
6. Switch Chamber: Factory sealed to contain switch's arcing components
7. Hazardous Area Ratings: Suitable for Class I, Division 2 NEMA 7BCD, 9FG.
8. Manufacturers and Products:
   a. Cooper Crouse-Hinds; Ark Guard 2, Series ENR.
   b. EGS/Appleton Electric; U-Line.
   c. Killark, a division of Hubbell Inc.; UGR/UGP.

2.04 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. Sheet Steel:

1. Finish: Zinc electroplate.
2. Screws: Oval-head stainless steel.
3. Manufacturers:
   a. Appleton.
   b. Crouse-Hinds.

F. Engraved:

1. Character Height: 1/8-inch.
2. Filler: Black.

G. 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.

H. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel box.

I. Sheet Steel: Formed sheet steel or Feraloy designed for installation on cast-metal box.

2.05 OCCUPANCY SENSOR, WALL SWITCH

A. Description:

1. Passive-infrared type, 120/277-volt, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 square feet (84 square meters).
2. Provide dual switch unit where indicated.
3. Color: Manufacturer’s standard white.

B. Manufacturers and Products:

1. Hubbell; WS1277.
2. Leviton; ODS 10-ID.

3. Pass & Seymour; WS3000.
4. Watt Stopper (The); WS-200.

2.06 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. Office Areas: White.
2. Other Areas: Ivory.
3. 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. Pigtailing 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, Metal Box:
   a. General Purpose Areas: Sheet Steel.
   b. Other Areas: Cast.
3. Surface Mounted, Aluminum Box:
   a. General Purpose Areas: Stamped.
   b. Other Areas: Cast.
4. Surface Mounted, Sheet Steel Box: Raised sheet steel.
5. Surface Mounted, Nonmetallic Box: Manufacturer's standard.
6. 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 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. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.

E. Stripping: Removal of topsoil remaining after applicable scalping is completed.

F. 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, and strip areas actually needed for waste disposal, borrow, or 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.
   b. Stripping and Scalping feet beyond toe of permanent fill.
3. Structures: 15 feet outside of new structures.
4. Roadways: Clearing, grubbing, scalping, and stripping: 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 SCALPING

A. Do not remove sod until after clearing and grubbing is completed and resulting debris is removed.

B. Scalp areas within limits shown or specified.

3.07 STRIPPING

A. Do not remove topsoil until after scalping is completed.

B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

C. Stockpile strippings, meeting requirements of Section 32 91 13, Soil Preparation, for topsoil, separately from other excavated material.

3.08 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.

B. Scalpings: As specified for clearing and grubbing debris.

C. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil offsite.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

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/ft^3 (600 kN-m/m^3)).
   b. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

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 on every lift of subgrade: or one test per lift, whichever requires more tests.

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, with proper allowance for topsoil or slope protection, where 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. See Section 01 50 00, Temporary Facilities and Controls, Article Temporary Controls.

B. Intercept surface water and divert it away from excavations through the use of diversion ditches, dikes, pipes, or other approved means.

C. 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/ft^3 (600 kN-m/m^3)).
   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/ft^3 (2,700 kN-m/m^3)).
   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, scalping of sod, stripping of topsoil, 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 compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, Cast-in-Place Concrete.

D. 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 95 percent relative compaction as determined in accordance with ASTM D1557.

B. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where 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 minimum90 percent relative compaction as determined in accordance with ASTM D1557.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.04 SITE TESTING

A. Gradation:

1. One sample from each 6,000 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 D2922. During placement of materials, test as follows:

1. Granular Fill and Earthfill: One test for every 7,000 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/ft^3 (600 kN-m/m^3)).
   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/ft^3 (2,700 kN-m/m^3)).
   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. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. 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 TOPSOIL

A. As specified in Section 32 91 13, Soil Preparation.

2.07 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 topsoil, 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 seeded:

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 95 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 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 4 inches of backfilled trench.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.09 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. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

C. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.

D. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.10 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 D2922. 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.

3.11 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 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 91 13
SOIL 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. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C602, Standard Specification for Agricultural Liming Materials.
   c. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
   d. D5268, Standard Specification for Topsoil Used for Landscaping Purposes.

1.02 SEQUENCING AND SCHEDULING

A. Perform Work specified in Section 31 10 00, Site Clearing, prior to performing Work specified under this section.

PART 2 PRODUCTS

2.01 TOPSOIL

A. General: Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

B. Source: Stockpile material onsite, in accordance with Section 31 10 00, Site Clearing.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.

B. Remove stones over 2-1/2 inches in any dimension, sticks, roots, rubbish, and other extraneous material.

C. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.02 TOPSOIL PLACEMENT

A. Do not place topsoil when subsoil or topsoil is excessively wet, or otherwise detrimental to the Work.

B. Place one-half of the total depth of topsoil and work into top 4 inches of subgrade soil to create a transition layer. Place remainder of topsoil to depth of 6 inches where seeding and planting are scheduled.

C. Uniformly distribute to within 1/2 inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

D. Remove stones exceeding 1-1/2-inch diameter, roots, sticks, debris, and foreign matter during and after topsoil placement.

E. Remove surplus subsoil and topsoil from Site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

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. Prepare topsoil as specified in Section 32 91 13, Soil Preparation, before starting Work of this section.

B. Complete Work under this section within **3** days following completion of soil preparation.

C. Notify Engineer at least 3 days in advance of:

1. Each material delivery.
2. Start of planting activity.

D. 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 topsoil, 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 sulpher.

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.

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. International Code Council (ICC).
5. International Building Code (IBC).
6. International Mechanical Code (IMC).
7. 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 of all sizes. 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.

B. Informational Submittals: Maintenance information on piping support system.

1.04 QUALIFICATIONS

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer in the state of Florida.

1.05 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.
3. Not all pipe supports, lateral stiffeners, sway bracings, or similar components are shown or detailed. Contractor shall provide all required supports and stability to all piping, whether shown or not, as part of the Work.
4. Contractor shall select and design all piping support systems within the specified spans and component requirements.
5. All submerged metal piping shall be electrically isolated from the pipe supports with a wrap of 1/8-inch thick by 3-inch wide neoprene rubber between the pipe and the support.
6. Piping connecting to equipment shall be supported by pipe supports and not by the equipment.
7. A pipe support or hanger shall be installed within 3-diameter lengths for pipes smaller than 12 inches, 2-diameter lengths for 12- to 36-inch pipes, and 1-diameter length for 36-inch pipes and greater, adjacent to each pipe fitting, flexible connection, flange coupling adaptor, in-line device such as a valve or a meter, or removable spool piece for all piping lager than 4 inches.

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 General Structural Notes Drawing.

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 unless smaller spacing is specifically shown or specified.

E. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.

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 HANGERS

A. Clevis: MSS SP 58, Type 1:

1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
3. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.

B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:

1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
2. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.

C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:

1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.
2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.

D. Pipe Rollers and Supports: MSS SP 58, Type 44:

1. Anvil; Figure 175, sizes 2 inches through 30 inches.
2. B-Line; Figure B3120, sizes 2 inches through 24 inches.

2.03 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. Channel Type:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).

2.04 PIPE SADDLES

A. Provide 90-degree to120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. In accordance with Standard Detail 4005-515.
2. Sizes 20 inches though 60 inches, Piping Technology and 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.

2.05 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).

2.06 FRP PIPE SUPPORTS SYSTEMS

A. General:

1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.
2. Fire Retardant: ASTM E84.
3. Include hangers, rods, attachments, and fasteners.

B. Clevis Hangers:

1. Factor of Safety: 3 to 1.
2. Minimum Design Load: 200 pounds.

C. Design:

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.
2. Identify and highlight nonFRP fasteners or components in Shop Drawing.

D. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.

2.07 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.

2.08 ELBOW AND FLANGE SUPPORTS

A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.09 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.

1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.

B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.

1. Anvil; Figure 137 and Figure 137S.
2. B-Line; Figure B3188 and Figure B3188NS.

2.10 PIPE ALIGNMENT GUIDES

A. Type: Spider.

B. Manufacturers and Products:

1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.

2.11 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.12 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: Type 316 Stainless Steel, Sized by Contractor for required loads, 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.

C. Insulation Shields:

1. Type: Type 316 stainless steel, MSS SP 58, Type 40.
2. Manufacturers and Products:
   a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
   b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers and Products:
   a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
   b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Welded Beam Attachment: MSS SP 58, Type 22.
   a. Anvil; Figure 66.
   b. B-Line; Figure B3083.
3. Concrete Attachment Plates:
   a. Anvil; Figure 47, Figure 49, or Figure 52.
   b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and elsewhere required.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
11. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls: Support from tank wall is not allowed.
3. 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.
4. Insulated Pipe:
   a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
   b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
   c. Wall-mounted pipe clips not acceptable for insulated piping.
5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
   a. Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
   b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
   a. Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).

b. Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.

3. Steel Beams: I-beam clamp or welded attachments.
4. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
5. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
6. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Saddles for Steel or Concrete Pipe: Provide 90-degree to120-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.

E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. 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 supplement listed below, following “End of Section,” is a part of this specification:

1. Table 1: Nonchemical Areas.

END OF SECTION

Table 1 Nonchemical Areas	
Exposure Conditions	**Support Material**
Sludge Holding Tanks and Surrounding Area	Stainless Steel
Notes: 1. Stainless steel to be Type 316.	

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 VIII, Rules for Construction of Pressure Vessels.
   b. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   c. B1.20.1, Pipe Threads, General Purpose (Inch).
   d. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   e. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
   f. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
   g. B16.9, Factory-Made Wrought Buttwelding Fittings.
   h. B16.11, Forged Fittings, Socket-Welding and Threaded.
   i. B16.15, Cast Bronze Threaded Fittings Classes 125 and 250.
   j. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   k. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   l. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500, and 2500.
   m. B16.25, Butt Welding Ends.
   n. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
   o. B31.1, Power Piping.
   p. B31.3, Process Piping.
   q. B31.9, Building Services Piping.
   r. B36.10M, Welded and Seamless Wrought Steel Pipe.
   s. B36.19M, Stainless Steel Pipe.

5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Personnel 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 for Water.
    b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
    c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings for Water.
    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. C116/A21.16, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
    g. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.
    h. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
    i. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
    j. C606, Grooved and Shouldered Joints.
7. American Welding Society (AWS):
    a. Brazing Handbook.
    b. A5.8/A5.8M, Specification for Filler Metals for Brazing and Braze Welding.
    c. 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-Welded Steel Pipe.
    g. A139/A139M, Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 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 Materials 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 Materials 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, 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 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, N08024, and N08026 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. F436, Standard Specification for Hardened Steel Washers.

nnn. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

ooo. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

ppp. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

qqq. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

rrr. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

sss. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

9. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-43, Wrought Stainless Steel Butt-Welding Fittings.
10. NSF International (NSF): 61 Drinking Water System Components—Health Effects.
11. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
12. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.02 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. Building Service Piping: ASME B31.9, as applicable.
3. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code.
4. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
5. Thrust Restraints: Design for test pressure shown in Piping Schedule.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   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. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
3. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
6. Pipe Corrosion Protection: Product data.

B. Informational Submittals:

1. Manufacturer's Certification of Compliance:
   a. Pipe and fittings.
   b. Welding electrodes and filler materials.
   c. Factory applied resins and coatings.
2. Qualifications:
   a. Weld Inspection and Testing Agency: Certification and qualifications.
   b. Welding Inspector: Certification and qualifications.
   c. Welders:
      1) List of qualified welders and welding operators.
      2) Current test records for qualified welder(s) and weld type(s) for factory and field welding.
3. Weld Procedures: Records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
4. Nondestructive inspection and testing procedures.
5. Test logs.
6. Pipe coating applicator certification.
7. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
8. Certified welding inspection and test results.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
   a. Ten years' experience in field of welding and welded pipe and fittings' testing required for this Project.
   b. Calibrated instruments and equipment, and documented standard procedures for performing specified testing.
   c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
   d. Testing Personnel: Qualified for nondestructive test methods to be performed.
   e. Inspection Services: Qualified welding inspector.
2. Welding Inspector: AWS certified, AWS QC1 qualified, with prior inspection experience of welds specified.
3. Welder and Welding Operator Qualifications:
   a. Qualified by accepted inspection and testing agency before starting Work in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code.
   b. Qualified to perform groove welds in Positions 2G and 5G for each welding process and pipe material specified.

c. Qualification tests may be waived by Engineer based on evidence of prior qualification.
d. Retesting: Upon Engineer's written request, retest qualified welder(s).

B. Quality Control: Provide services of independent inspection and testing agency for welding operations.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, 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 damage and excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.
6. No forks allowed inside pipe or fittings.
7. All factory-installed thread-on flanges on ductile iron pipe shall be sealed with a suitable sealant, to prevent rusting.

PART 2 PRODUCTS

2.01 PIPING

A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.

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.

2.02 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 breakoff tightening bolts.
2. Thrust rated to 250 psi minimum.
3. Rated operating deflection not less than 2-1/2 degrees.
4. UL and FMG approved.

2.03 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

2.04 PIPE CORROSION PROTECTION

A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.

B. 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.

C. 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: Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts. Bolt insulating sleeves shall be provided full length between insulating washers. Contractor shall be responsible for fit-up of all components of insulated flange assembly to provide a complete functioning installation. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of all 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: Hardened steel, ASTM F436, 1/8 inch thick.
        1) Provide two washers per bolt for flange diameters equal to or less than 36-inch.
        2) Provide four washers per bolt for flange diameters larger than 36-inch.
5. Manufacturers and Products:
    a. Dielectric Flanges and Unions:
        1) PSI, Houston, TX.
        2) Advance Products and Systems, Lafayette, LA.
    b. Insulating Couplings:
        1) Dresser; STAB-39.
        2) Baker Coupling Company, Inc.; Series 216.

2.05 THRUST TIES

A. Steel Pipe: Joint harness as specified in Section 40 27 01, Process Piping Specialties.

B. 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.

2.06 VENT AND DRAIN VALVES

A. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.07 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. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer.

2.08 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.

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.

C. Welding Electrodes: Verify proper grade and type, free of moisture and dampness, and coating is undamaged.

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: Mark each weld with symbol identifying welder.

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:

1. Do not perform welding if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32 degrees F.
2. Stainless Steel and Alloy Piping: If the ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.

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 Passes: As required in welding procedure.

J. Weld Quality: Free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of limits shown in applicable piping code.

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. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

E. 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. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

D. 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.

E. 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 1 inch 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. Dissimilar Buried Pipes:
   a. Provide flexible mechanical compression joints for pressure pipe.
   b. Provide concrete closure collar for gravity low pressure (maximum 10 psi) piping or as shown.
2. 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. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
10. 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.
11. After joint has been made, check pipe alignment and grade.
12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
13. Prevent uplift and floating of pipe prior to backfilling.

C. Tolerances:

1. Deflection from Horizontal: 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.

C. All valves and joint saddles shall be wrapped with polyethylene sheets.

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: Standard asphalt coating. Wrap with polyethylene bagging. ANSI/AWWA C105/A21.5 Installation Method A shall be used.
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 61 approved epoxy.

B. 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.

C. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer's instructions.

D. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.

E. Heat Shrink Wrap: Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

F. Insulating Flanges, Couplings, and Unions:

1. Applications:
    a. Dissimilar metal piping connections.
    b. Cathodically protected piping penetration to buildings and watertight structures.
    c. Submerged to unsubmerged metallic piping connections.
    d. Connections to existing metallic pipe.
    e. Where required for electrically insulated connection.
2. Pipe Installation:
    a. Insulating joints connecting immersed piping to nonimmersed piping shall be installed above maximum water surface elevation.
    b. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
    c. 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: Where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist because of hydrostatic testing and normal operating pressure.
2. Exposed Piping: At all joints in piping.

B. Thrust Ties:

1. Ductile Iron Pipe: Attach with socket clamps anchored against a grooved joint coupling or flange.
2. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through the 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. Install the proprietary restrained joins in accordance with the manufacturer's instruction. "Pull" or "extend" the joint per the manufacturer's recommendations.

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 the 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 a 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.

3.13 INSULATION

A. See Section 40 42 13, Process Piping Insulation.

3.14 FIELD FINISHING

A. Notify Engineer at least 3 days prior to start of any surface preparation or coating application work.

B. As specified in Section 09 90 00, Painting and Coating.

3.15 PIPE IDENTIFICATION

A. As specified in Section 31 23 23.15, Trench Backfill.

3.16 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.

B. Minimum Duties of Welding Inspector:

1. Job material verification and storage.
2. Qualification of welders.
3. Certify conformance with approved welding procedures.
4. Maintenance of records and preparation of reports in a timely manner.
5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.

C. Required Weld Examinations:

1. Perform examinations in accordance with Piping Code, ASME B31.3.
2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for all piping covered by this section.
3. Examine at least one of each type and position of weld made by each welder or welding operator.

4. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

3.17 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. Blow clean of loose debris air-lines with compressed air at 4,000 fpm; do not flush with water.

C. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

E. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.18 SUPPLEMENTS

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

1. Piping Schedule.
2. Data Sheets.

Number	Title
40 27 00.01	Cement-Mortar and Ceramic-Lined Ductile Iron Pipe and Fittings
40 27 00.08	Stainless Steel Pipe and Fittings—General Service

END OF SECTION

Piping Schedule

Service	Legend	Size (inches) (Note 1)	Exposure (Note 2)	Material (Note 3)	Specification	Max. Operating Pressure (psig)	Test Pressure (psig) (Note 4)	Color (Note 5)	Remarks
Air, Low Pressure	ALP	ALL	ALL	SST	40 27 00.08	15	25 P	- -	Insulate pipe per Section 40 42 13
Drain, Process	DR	ALL	ALL	CLDI	40 27 00.01	10	Gravity	Light Brown	
Vent	V	ALL	EXP	SST	40 27 00.08	--	--	--	For air release valve piping
Waste Activated Sludge	WAS	ALL	ALL	CLDI	40 27 00.01	30	45 H	Dark Brown	

NOTES:

1) > - Greater than
   < - Less than
   >= - Greater than or equal to
   <= - Less than or equal to
2) BUR - Buried
   ENC - Concrete encased
   EXP - Exposed, either inside or outside
   SUB - Submerged
3) CLDI - Cement mortar-lined ductile iron
   SST - Stainless steel
4) H - Hydrostatic Testing
   P - Pneumatic Testing
5) Color code applies to exposed piping only. Buried or submerged piping need not conform to the color description except where noted.

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance. 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. 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).
Pipe	Buried Liquid Service Using Push-on, Mechanical, or 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. Buried Air Service Using Push-on, Mechanical, or 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. Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.
Lining	Cement-mortar: AWWA C104/A21.4. Ceramic-epoxy: Pipe and fittings to be ceramic epoxy lined shall not have been previously lined. Surface preparation shall be made to surfaces free of grease, oil, or other substance with abrasive blasting using clean sand or grit abrasive. Lining shall be done within 8 hours of surface preparation and surfaces shall be reblasted if rusting appears before lining. Line with a total dry film thickness of 40-mils of ceramic epoxy. Ceramic epoxy shall be amine-cured Novolac epoxy with 20 percent minimum volume ceramic quartz pigment, Protecto 401 by Induron Coating, or equal. Lining shall be applied above 40 degrees F ambient temperature and shall not be applied to flange faces. Lining thickness shall be tested using a magnetic film thickness gauge. Lining integrity shall be tested on surfaces with a nondestructive, 2,500-volt dielectric resistance test.

SECTION 40 27 00.01
CEMENT-MORTAR AND CERAMIC-LINED
DUCTILE IRON PIPE AND FITTINGS

Item	Description
Fittings	Lined and coated same as pipe. Push-on: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. Mechanical: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. Follower glands shall be ductile iron. 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. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.
Joints	Push-on: 250 psi minimum working pressure, AWWA C110/A21.10 and AWWA C111/A21.11. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. Mechanical: 250 psi minimum working pressure. 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. Flange: Class 125 flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed. Branch connections 3 inches and smaller shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Bolting	Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard. 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. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts; 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.
Gaskets	General: Gaskets in contact with potable water shall be NSF 61 certified. Push-on, Mechanical, and Proprietary Restrained Joints; Water and Sewage Service: Rubber conforming to AWWA C111/A21.11. Push-on, Mechanical, and Proprietary Restrained Joints; Hot Air Service: EPDM or Viton and conforming to AWWA C111/A21.11. Grooved End Joints: Halogenated butyl conforming to ASTM D2000 and AWWA C606. 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. 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. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.
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	Schedule 40S: ASTM A312/A312M, Type, 304, seamless, pickled and passivated.
	3" thru 6"	Schedule 10S: ASTM A778, “as-welded” grade, Type, 304L, pickled and passivated.
	8" & larger	Schedule 5S: ASTM A778, “as-welded” grade, Type, 304L, pickled and passivated.
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Fittings	1-1/2" & smaller	Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F304 or cast Class 150, ASTM A351/A351M, Grade CF8/304.
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP304L 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.
	3" & larger	Butt-Welded: ASTM A774/A774M Grade 304L conforming to MSS SP 43, “as-welded” grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
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.
Flanges	All	Forged Stainless Steel: ASTM A182/A182M, Grade F304L ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F304, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.
Bolting	All	Forged Flanges: Type 304 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. 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. Flanged Joints in 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.
Gaskets	All Flanges	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. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE 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): NSF 61, Drinking Water System Components—Health Effects.

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, in accordance with Section 09 90 00, Painting and Coating.

B. Informational Submittals:

1. Coupling Harness:
   a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.
   b. Weld procedure qualifications.
   c. Load proof-testing report of prototype restraint for any size coupling.

C. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data**.**

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.

2.02 CONNECTORS

A. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch.
2. Materials: Nitrile tube and wrap-applied neoprene cover.
3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and steel retaining rings.
4. Working Pressure Rating: 140 psig, minimum, at 180 degrees F for sizes 12 inches and smaller.
5. Thrust Restraint: Control rods to limit travel of elongation and compression.
6. Manufacturers and Products:
   a. Goodall Rubber Co.; Specification E-1462.
   b. Garlock; Style 204.
   c. Unisource Manufacturing, Inc.; Style 1501.
   d. Proco Products, Inc.; Series 220.

B. Metal Bellows Connector:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.

3. End Connections: ANSI 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
6. Manufacturers and Products:
   a. U.S. Bellows, Inc.; Universal Tied Expansion Joint.
   b. Metraflex; Model MN.
   c. Senior Flexonics Pathway, Inc.; Expansion Joints.

2.03 EXPANSION JOINTS

A. Elastomer Bellows:

1. Type: Reinforced molded wide arch.
2. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with split galvanized steel retaining rings.
3. Washers: Over retaining rings to help provide leak-proof joint under test pressure.
4. Thrust Protection: Control rods to protect the bellows from overextension.
5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
6. Rated Temperature: 250 degrees F.
7. Rated Deflection and Pressure:
   a. Lateral Deflection: 3/4 inch, minimum.
   b. Burst Pressure: Four times the working pressure.
   c. Compression deflection and minimum working pressure as follows:

Size (inch)	**Deflection (inch)**	**Pressure (psig)**
2-1/2 to 12	1.06	150
14	1.65	130
16 to 20	1.65	110

8. Manufacturers and Products:
   a. General Rubber Corp.; Style 1015 Maxijoint.
   b. Mercer; Flexmore Style 450.
   c. Goodall Rubber Co.; Specification E-711.
   d. Unisource Manufacturing, Inc.; Series 1500.
   e. Proco Products, Inc.; Series 251.

B. Metal Bellows:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ASME 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
5. Length: Minimum of eight convolutions and minimum axial compression of 3/4 inches.
6. Manufacturers and Products:
   a. U.S. Bellows, Inc.; Universal Tied expansion joint.
   b. Metraflex, Model MN.
   c. Senior Flexonics Pathway, Inc.; Expansion Joints.

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.

B. Stainless steel (for Stainless Steel Pipes):

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. Materials:
   a. Body: Stainless steel.
   b. Seal: Buna-N.
   c. Clamps and Nuts: Stainless steel.
4. Manufacturer: JCM Industries, Style 438; or equal.

2.05 OUTLET/TAPPING SADDLES

A. Materials:

1. Straps: Alloy steel with 3/4-inch threaded ends.
2. Seal: O-Ring SBR rubber gasket.
3. Compatible with ductile iron pipe.

B. Connection: AWWA C110/A21.10 flange for exposed services. Mechanical joint outlet for buried services.

C. Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.

D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.

2.06 PIPE SLEEVES

A. Steel Pipe Sleeve:

1. Minimum Thickness: 3/16 inch.
2. Seep Ring:
   a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
   b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
   c. Continuously fillet weld on each side all around.
3. Factory Finish:
   a. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. 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.

C. Insulated and Encased Pipe Sleeve:

1. Manufacturer and Product: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

D. 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.

2.07 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:

1. Diameter and Ends: Same as connecting ductile iron pipe.
2. Thickness: Equal to or greater than remainder of pipe in line.
3. Fittings: In accordance with applicable Pipe Data Sheet.
4. Thrust Collars:
   a. Rated for thrust load developed at 250 psi.
   b. Safety Factor: 2, minimum.
   c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
5. Manufacturers:
   a. American Cast Iron Pipe Co.
   b. U.S. Pipe and Foundry Co.

B. Steel or Stainless Steel Wall Pipe:

1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
2. Lining: Same as connecting pipe.
3. Thrust Collar:
   a. Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
   b. Continuously fillet welded on each side all around.

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: Install 18 inches or less from face of structures; joint may be flush with face.

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. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
4. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
5. 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 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
2. Nonmetallic Pipe: Teflon bellows expansion joint.
3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.
4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.
5. Pipe Run Offset: Flexible metal hose.

C. Anchors: Install as specified in Section 40 05 15, Piping Support Systems, to withstand expansion joint thrust loads and to direct and control thermal expansion.

3.05 SERVICE SADDLES

A. Ferrous Metal Piping (except stainless steel): Double-strap iron.

B. Stainless Steel Piping: stainless steel.

3.06 OUTLET/TAPPING SADDLE

A. Install in accordance with manufacturer’s written instructions.

3.07 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.

3.08 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. Compressor and Blower Discharge: Metal bellows connector.
2. All Other Piping: Elastomer bellows connector.

C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.09 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.

3.10 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.

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. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
   c. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   d. C550, Protective Interior Coatings for Valves and Hydrants.
   e. C606, Grooved and Shouldered Joints.
   f. 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-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
13. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1.000 Volts Maximum).
14. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
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.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services, 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, in accordance with Section 01 43 33, Manufacturers' Field Services.

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. Size operators and actuators to operate valve for full range of pressures and velocities.

F. Valve to open by turning counterclockwise, unless otherwise specified.

G. Factory mount operator, actuator, and accessories.

2.02 SCHEDULE

A. Additional requirements relative to this section are shown the Self-Regulated Valve Schedule located at the end of this section.

2.03 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. 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.

2.04 VALVES

A. Ball Valves:

1. Type V307 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Three-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball, NPT threaded ends, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 800 psig to 1,000 psig CWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 86R-100/86-500 Series.
      2) Nibco; T-595-S6-R-66-LL.

B. Plug Valves:

1. Type V405 Eccentric Plug Valve 3 Inches to 12 Inches:
   a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, unless otherwise shown.
   b. Plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearings lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.
   c. For buried service, provide external epoxy coating.
   d. Operators:
      1) 3-Inch to 4-Inch Valves: Wrench lever manual.

2) 6-Inch to 12-Inch Valves: Totally enclosed, geared, manual operator with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.

e. Manufacturers and Products:
1) Pratt; Ballcentric.
2) DeZurik; Style PEC.
3) Milliken; Millcentric Series 600.

2. Type V406 Eccentric Plug Valve 14 Inches to 20 Inches:
a. Nonlubricated type rated 150 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joints ends, unless otherwise shown, plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearings lubricated stainless steel or bronze, stem seal multiple V-rings or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.
b. Totally enclosed, geared, manual operator with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.
c. For buried service, provide external epoxy coating.
d. Manufacturers and Products:
1) Pratt; Ballcentric.
2) DeZurik; Style PEC.
3) Milliken; Millcentric Series 600.

C. 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 bronze seat**,** 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, and limit switch. 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.

D. Self-Regulated Automatic Valves:

1. Type V752 Sewage Air Release Valve 2 Inches to 4 Inches:
   a. Suitable for sewage service; automatically exhausts entrained air that accumulates in a system.
   b. Rated working pressure of 150 psi, built and tested to AWWA C512.
   c. Materials: Cast-iron or ductile iron body and cover with NPT threaded inlet and 1-inch NPT threaded outlet, concave or skirted stainless steel float and trim; Buna-N resilient seat.
   d. Sewage air release valve fitted with blowoff valve, flushing valve with quick disconnect couplings, and a minimum 5 feet of hose with quick disconnect couplings to permit backflushing after installation without dismantling valve.
   e. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 400 SARV or 450 SARV.
      2) Val-Matic Valve; Series 48 or 49.

E. Miscellaneous Valves:

1. Type V910 Telescoping Decant Valve:
   a. The slip tube material shall be stainless steel. The slip tube shall have a V-notch on top. Slip tubes shall be equipped with a grease fitting to allow the operator to apply grease to the slip tube from the operator level. The slip tube gasket shall be BUNA-N and replaceable without removal of the slip tube assembly from the riser pipe, lift rod or actuator. The gasket retainer and the flange shall be stainless steel.
   b. The operator shall be rising stem, rack and pinion type, with a worm gear operator and bronze bearings. The operator shall be self-locking, eliminating the need for additional locking devices. A clear acrylic rack cover with a calibrated Mylar strip position indictor shall be provided. A stainless steel traveling torque tube and stainless steel anti-rotation plate shall be incorporated to prevent the slip tube from rotating. All fasteners are to be Type 316 stainless steel. The operator shall be screw type with a stainless steel acme thread screw. A Type 316 stainless steel base plate with minimum 1/4-inch thickness shall be provided.
   c. A stainless steel base plate with minimum of 1/2-inch thickness shall be provided to support the floor stand.
   d. Size: 6 inches. Travel length: 6 feet.

e. Anchor Bolts: Type 316 stainless steel.
f. Manufacturers and Products:
   1) Halliday.
   2) Troy Valve.

2.05 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.

2.06 ACCESSORIES

A. Limit Switch:

1. Factory installed NEMA 4X limit switch by actuator manufacturer.
2. SPST, rated at 5 amps, 120 volts ac.

B. Floor Stand:

1. Nonrising, heavy pattern, indicating type.
2. Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment. Stem length as required to connect valve operating nut and floor stand.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 stainless steel.

5. Manufacturers and Products:
    a. Clow; Figure F-5515.
    b. Mueller, Figure A-26426.

C. Chain Wheel and Guide:

1. Handwheel direct-mount type.
2. Complete with chain.
3. Galvanized or cadmium-plated.
4. Manufacturers and Products:
    a. Clow Corp.; Figure F-5680.
    b. Walworth Co.; Figure 804.
    c. DeZurik Corp.; Series W or LWG.

D. Indicator Post Assembly:

1. Cast or ductile iron post head, bell, and wrench with cast or ductile iron or steel barrel.
2. Plexiglas or equal protected window to indicate OPEN and CLOSED position.
3. Padlockable eye bolt for wrench.
4. Adjustable bury depth. Bury depth as required for valve installation.
5. UL Listed and FM Approved.
6. Manufacturers and Products:
    a. Clow; Style 2945.
    b. Mueller; A-20806.

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. 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. Eccentric Plug Valves:
   a. Unless otherwise restricted or shown on Drawings, install valve as follows:
      1) Liquids with suspended solids service with horizontal flow: Install valve with stem in horizontal position with plug up when valve is open. Install valve with seat end upstream (flow to produce unseating pressure).
      2) Liquids with suspended solids service with vertical flow: Install valve with seat in highest portion of valve (seat up).
      3) Clean Liquids and Gas Service: Install valve with seat end downstream of higher pressure when valve is closed (higher pressure forces plug into seat).
4. 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.
5. Check Valves:
   a. Install valve in horizontal or vertical flow (up) flow piping only for liquid services.
   b. Install valve in vertical flow (up) piping only for gas services.
   c. Install swing check valve with shaft in horizontal position.

D. Install safety isolation valves on compressed air.

E. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

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.

G. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.

H. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate “L” type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

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 MANUFACTURER’S SERVICES

A. Valve(s) as listed below require manufacturer’s field services: V406, V608, V752, V910.

B. For V910: Manufacturer's Representative: Present at Site for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.

C. For V406, V608 and V752 each: Manufacturer's Representative: Present at Site for minimum person-days listed below, travel time excluded:

1. 1/2 person-day for installation assistance and inspection.
2. 1/2 person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.

3.04 SUPPLEMENTS

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

1. Self-Regulated Valve Schedule.

END OF SECTION

Self-Regulated Valve Schedule							
Tag No.	**Valve Type No.**	**Size (inches)**	**Inlet* Pressure (psi)**	**Outlet* Pressure (psi)**	**Maximum psig**	**Flow (gpm)**	**Fluid**
830-ARV-002-01	V752	2	10	0	30	6,600	WAS
830-ARV-005-01	V752	2	10	0	30	6,600	WAS
830-ARV-008-01	V752	2	10	0	30	6,600	WAS
830-ARV-011-01	V752	2	10	0	30	6,600	WAS
*Inlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.							

SECTION 40 42 13
PROCESS PIPING INSULATION

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 Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
    a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    b. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
    c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
    d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
    e. C534/C534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
    f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
    g. C552, Standard Specification for Cellular Glass Thermal Insulation.
    h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
    i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
    j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
    k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
    l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
3. International Code Council (ICC): International Energy Conservation Code (IECC).
4. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s descriptive literature.

B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

A. Type 2—Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Insulation Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
6. Flame Spread Rating: Less than 25 per ASTM E84.
7. Smoke Developed Index: Less than 50 per ASTM E84.
8. Manufacturers and Products:
   a. Owens Corning Fiberglass; ASJ/SSL-11.
   b. John Manville; Micro-Lok with Jacket.

2.02 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Refer to Section 40 05 15, Piping Support Systems.

B. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.

2.03 INSULATION FINISH SYSTEMS

A. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, in accordance with ASTM C1729, minimum 0.016-inch thickness, with smooth mill finish.

2. Vapor Barrier: Provide factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
4. Manufacturers:
   a. RPR Products; Insul-Mate.
   b. ITW, Pabco-Childers.

PART 3 EXECUTION

3.01 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following “End of Section” and to Piping Schedule in Section 40 27 00, Process Piping—General.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer’s instructions and as specified herein.
2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

D. Placement:

1. Insulate valves and fittings with sleeved or cut pieces of same material.
2. Seal and tape joints.

E. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

F. Aluminum Jacket:

1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
4. Do not use screws or rivets to fasten fitting covers.
5. Install removable prefabricated aluminum covers on exterior flanges and unions.
6. Caulk and seal exterior joints to make watertight.

3.03 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.

C. Painting Piping Insulation (Exposed to View):

1. Aluminum jacketing does not require painting.

3.04 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Service and Insulation Thickness Table.

END OF SECTION

Service and Insulation Thickness								
					Finish Systems			
Service Type	Pipe Legend	Thickness	Fluid Temperature (degrees F)*	Insulation	Concealed from View	Indoors Exposed	Outdoors	Buried
PE–Personnel Exposure	ALP	ASHRAE 90.1 or IECC whichever results in the thickest insulation	>140	Type 2 Minimum 1.5" thick	No insulation or finish inside of tanks	NA	F3 below 8’ from grade	NA
*Use these fluid temperatures unless otherwise noted in the Piping Schedule.								

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan: Submit prior to testing and include at least the information that follows.
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Test type.
   d. Method of isolation.
   e. 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 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
3. New Piping Connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
4. 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 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. Empty pipe of water prior to final cleaning or disinfection.

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:

$$L = \frac{SD(P)^{1/2}}{133{,}200}$$

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 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2 gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 40 feet of water column.

D. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

E. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

F. Defective Piping Sections: Replace and retest as specified.

3.05 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 80, Fiber Optic Communication System.

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. Provide an Allen-Bradley SLC 5/05 PLC with RSLogix500 software and network the PLC to the Owner's current SCADA system as shown in the Drawings.
3. Interface I/O points defined in the supplementary I/O list and Drawings to the Allen-Bradley SLC 5/05 PLC.
4. Provide communication link between power monitoring equipment and the Owner's SCADA system using a DigiIAP serial-to-Ethernet protocol converter.
5. Wire and network all control devices, including equipment within control panels, as shown on the Drawings.
6. Provide a panel-mounted PC with Citect software to function as a client HMI to the Owner's exisiting SCADA system as shown in the Drawings.
7. Applications Software for PLC and HMI:
   A. PLC and HMI software in accordance with Owner's standards.
   B. PLC: Provided by PICS Contractor for all PLCs
   C. HMI: Provided by the PICS Contractor for all HMIs.
   d. All Other Standard and Applications Software Including Network Communications 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: Instrinsic 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. PLC: Programmable Logic Controller.
12. RTU: Remote Terminal Unit.
13. SCADA: Supervisory Control and Data Acquisition.
14. SLDC: Single Loop Digital Controller.
15. SSDT: Staging Site Demonstration Test.

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. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
   b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.
   c. 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.
   d. 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.

e. Show each circuit individually. No “typical” diagrams or “typical” wire lists will be allowed.
f. Ground wires, surge protectors, and connections.
g. 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 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 01 78 23, 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 will 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. Factory Demonstration Test:
        1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
        2) Final Test Procedures:
            a) Proposed test procedures, forms, and checklists.
            b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
        3) Test Documentation: Copy of signed off test results.
    b. Staging Site Demonstration 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 when tests are completed.
    c. 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.
    d. 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: In accordance with Section 01 43 33, Manufacturers' Field Services.

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 01 31 19, 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 01 61 00, Common Product Requirements.

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 01 33 00, Submittal Procedures.
2. Test Prerequisite: Associated test procedures Submittals completed.
3. Training Prerequisite: Associated training plan Submittal completed.
4. PLC and HMI Installation Prerequisite: Equipment received at Site.
5. Functional Test Prerequisite: PLC and HMI installation complete.
6. Performance Test Prerequisite: Functional Test completed and facility started up.

1.09 MAINTENANCE

A. Maintenance Service Agreement:

1. Duration of 1 year, unless otherwise noted in PIC subsections.
2. Start on date of Substantial Completion.

3. Performed by factory-trained service engineers with experience on PIC systems to be maintained.
4. PIC Systems Covered: PIC components, including PLC, HMI, and applications software.
5. Materials and labor for preventive maintenance and monthly Site visits.
6. Materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m. Monday through Friday.
7. Response Time: Service engineer shall be onsite within 8 hours of request by Owner.
8. Spare Parts: If not stocked onsite, delivered to Site within 24 hours from time of request.
9. Repair or replace components or software found to be faulty.
10. Replace and restock within 1 month onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.
11. Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each Site visit.

B. Telephone Support: As specified in PIC subsections.

C. 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 and Lights	10	5
Surge Suppressors	10	2

D. Expendables: For following items provide manufacturer's recommended 2-year supply, unless otherwise noted.

1. Corrosion-inhibiting vapor capsules.
2. 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 in accordance with the General Conditions, Article 6.05 Substitutes and "Or-Equals".
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. Reference PLC Equipment List in Article, Supplements, and PLC components in Section 40 91 00, Instrumentation and Control Components.

2.04 FIELD BUS, NETWORK, AND HMI COMPONENTS

A. 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-guage 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 Sleev.
      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 nonintrinsically 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:
   a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
   b. Surge suppressors are not shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in installation details in Drawings.
   c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
      1) Connection of ac power to PIC equipment including panels, consoles assembles, and field-mounted analog transmitters and receivers.
      2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
2. Surge Suppressor Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Surge Suppressors.
3. Installation and Grounding of Suppressors:
   a. As shown. See Surge Suppressor Installation Details.
   b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

2.11 PANEL FABRICATION

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. 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.

C. 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.

D. 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.

E. 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.

F. 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 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 100-watt incandescent light.
   b. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI 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

Tag Function	Inscription(s)	Color
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.

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
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

    b. Lettering Color:
       1) Black on white and amber lenses.
       2) White on red and green lenses.

G. 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.

H. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.

I. 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 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsules:

1. Areas Where Required: Refer to Part 3, Article Protection.
2. Manufacturers and Products:
   a. Northern Instruments; Model Zerust VC.
   b. Hoffmann Engineering; Model A-HCI.

2.13 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.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
2. Location: PIC System Integrator's facility.
3. Integrated Test:
    a. Interconnect and test PIC, except for primary elements and smaller panels.
    b. Exercise and test functions.
    c. Provide stand-alone testing of smaller panels.
    d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope:
   a. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
   b. Refer to Control Panel Schedule in Article Supplements for list of panels for which FDT is required.
3. Location: PIC System Integrator's facility.
4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
   a. Simulate each discrete signal at terminal strip.
   b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PLCs and remote I/O and between PLCs and computers.
6. Operation of communications between the PLC system, single loop controllers (SLC).
7. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications:
   a. One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.
   b. One of each type of function in each panel; for example, but not limited to annunciator operation, controller operation, and recorder operation.
   c. All required and shown functions for 25 percent of loops.
8. Nonloop-Specific Functions:
   a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
   b. Timing: Include tests for timing requirements.
   c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
9. Correct deficiencies found and complete prior to shipment to Site.
10. Failed Tests:
    a. Repeat and witnessed by Engineer.
    b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
11. Make following documentation available to Engineer at test site both before and during FDT:
    a. Drawings, Specifications, Addenda, and Change Orders.
    b. Master copy of FDT procedures.
    c. List of equipment to be tested including make, model, and serial number.

d. Approved hardware Shop Drawings for equipment being tested.
e. Approved preliminary software documentation Submittal.

12. Daily Schedule for FDT:
    a. Begin each day with meeting to review day's test schedule.
    b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

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. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.

C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

D. 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. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up 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.

E. 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 Sequence of Work under Section 01 31 13, Project Coordination, for a definition of project milestones.
3. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
4. 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 andRTUs 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. FDT-Repeat:
1) Repeat FDT onsite with installed PIC equipment and software.
2) As listed in PIC subsections, certain portions of FDT may not require retesting.
3) Use FDT test procedures as basis for this test.
4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.
e. 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. PerformanceAcceptance 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 PIC 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: A20 Dissolved Oxygen Element and Transmitter, Nonmembrane Luminescent (LDO).

C. See Sections 01 43 33, Manufacturers' Field Services and 01 91 14, Equipment Testing and Facility Startup.

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 PROTECTION

A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.

B. Periodically replace capsules based on capsule manufacturer's recommendations.

3.08 SUPPLEMENTS

A. Supplements listed below, follows "End of Section," are part of this Specification.

1. Loop Specifications.
2. Instrument List.
3. PLC Equipment List
4. PLC Input/Output List.
5. Network Components List.
6. Control Panel Schedule.
7. 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.
8. 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 Process Instrumentation and Control System shall provide the following minimum functions described hereinafter. These descriptions supplement information presented on the Drawings and in related Specification sections. These Loop Descriptions describe only major loops, unit processes, and functions not obvious on the Drawings. Use the functional requirement descriptions as a guideline for developing PLC and HMI application programs and logic.

PMCS OVERVIEW

The existing SCADA system for the Manatee County SWWRF comprises of Allen-Bradley SLC 5/05 PLCs and HMI client workstations using Citect application software. An additional Allen-Bradley SLC 5/05 PLC with RSLogix500 and panel mounted HMI Citect client are included as part of this Project. The SCADA system hardware and software are provided by the PICS Contractor.

FUNCTION DEFINITIONS

1. Remote/Local: Determines whether the selected equipment is being operated locally at the motor control center or remotely via SCADA commands. A REMOTE input status signifies that the SCADA operator commands the equipment. A loss of the REMOTE signal indicates that the equipment is being controlled locally.
2. Run: Issues a discrete signal output from the PLC to the motor starter. The motor will run as long as the RUN signal is high. A loss of the RUN signal will cause the motor to cease operation. The operator commands to start and stop motorized equipment are as follows:
   a. START: RUN signal issued active.
   b. STOP: RUN signal issued inactive.
3. Run Fail: A condition in which the selected motorized equipment is commanded to run but observed not to be running within a preset time. Unless otherwise noted, running is confirmed by receiving an ON status M-contact from the equipment’s motor starter.
4. Fault: A discrete signal output from the motor control center to the PLC indicating a general hardware fault. The FAULT signal can be triggered by a temperature switch or pressure switch.

5. Elapsed Run Time: The total elapsed time that a motorized device has been in operation. For constant speed equipment, use the ON status M-contacts to detect that the equipment is in operation. The elapsed run time is incremented in tenths of an hour. Unless otherwise noted, the operator shall be able to reset elapsed run time to zero, but reset function shall be password protected.
6. Cycle Count: A count of the number of cycles that the selected equipment transitions from OFF to ON. For constant speed equipment, the cycle count is often considered the number of starts.

GENERAL FUNCTIONS (The requirements stated herein are applicable to the entire system.)

1. Calculate and display elapsed run time of each pump whose ON status is displayed by the PMCS system.
2. Calculate and display Cycle Counts of each pump whose ON status is displayed by the PMCS system.
3. Convert each analog value to appropriate engineering units and significant figures. Do not display raw counts on the HMI client workstation.
4. Trend each process variable that has a PLC analog input.
5. All timer settings, set points, and miscellaneous adjustments will be determined during application software development or plant startup. Allow all settings and adjustments to be easily made through the computer operator interface.

RECOVERY AFTER A POWER OUTAGE

In general, provide the following control actions when power resumes after an outage.

1. For process equipment with small horsepower motors, the equipment shall resume its previous state, e.g., if the motor is running before a power outage, it resumes running after power recovery.
2. For process equipment with large horsepower motors, such equipment shall be controlled in either of two ways as identified in the subsequent specific loop specifications.
    a. The equipment shall not automatically restart after recovery from a power outage. Manual Restart (a Start Command or Manual Reset) must be issued by the operator at the HMI client workstation.

b. The equipment shall automatically restart, but at time staggered intervals. For instance, if Lead and Lag pumps are running prior to an outage, upon recovery the Lead pump shall start after a time delay of say 5 seconds, while the Lag pump shall start at a time delay of say 30 seconds. Power recovery procedures described within the unit process Loop Specifications take precedence over the general guidelines listed above.

POWER MONITORING

For low-voltage MCCs, digital power meters will monitor and display power quality parameters in the system and transmit these parameters to the SCADA system. As defined in section 26 24 19, Low-Voltage Motor Control, the display parameters available to the SCADA system in this project include, but are not limited to, the contents of the I/O table below:

DWG	PLC	Tag	IO Function	Description	AI*
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Phase Current	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Phase-to-Phase Voltage	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Phase-to-Ground Voltage	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Watts	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Phase-to-Phase VA	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Phase-to-Ground VA	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Phase-to-Phase VAR	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Phase-to-Ground VAR	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Watt Hours	Power Monitor (MCC D4, MCC D5)	2
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	VA Hours	Power Monitor (MCC D4, MCC D5)	2
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	VAR Hours	Power Monitor (MCC D4, MCC D5)	2
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Power Factor	Power Monitor (MCC D4, MCC D5)	2
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	THD	Power Monitor (MCC D4, MCC D5)	2
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Frequency	Power Monitor (MCC D4, MCC D5)	2
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Present Demand Current	Power Monitor (MCC D4, MCC D5)	2

DWG	PLC	Tag	IO Function	Description	AI*
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Present Demand Watts	Power Monitor (MCC D4, MCC D5)	2
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Minimum Current	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Maximum Current	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Minimum Voltage	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Maximum Voltage	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Minimum Watts	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Maximum Watts	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Minimum VA	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Maximum VA	Power Monitor (MCC D4, MCC D5)	6
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Minimum Power Factor	Power Monitor (MCC D4, MCC D5)	2
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Maximum Power Factor	Power Monitor (MCC D4, MCC D5)	2
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Minimum Frequency	Power Monitor (MCC D4, MCC D5)	2
008-N-6007	SP-14-PLC-01	MCC-DX-PM-01 X=4,5	Maximum Frequency	Power Monitor (MCC D4, MCC D5)	2

*****All power meter I/O will be interfaced with the Digi IAP Industrial Server via RS-485 Modbus RTU. The communications protocol is converted to A-B Ethernet and linked from the Digi IAP Industrial Server to the SCADA system as shown on the Drawings.

UNIT PROCESS 830 - SLUDGE HOLDING TANKS

Control Strategy Overview: The sludge holding area will consist of four open-top tanks. Each tank will be agitated via jet aeration using a constant speed pump and constant speed blower. An ultrasonic level transmitter will be cantilevered over each tank.

Analog signal readings from the instrument transmitters, along with the field inputs from the constant speed pumps and blowers, will be transmitted to the PLC. The PLC will issue and the HMI will annunciate an alarm if the value of the level transmitter breaches the low or high level set points. The PLC will then transmit the signal interface to the HMI for display and accept commands and setpoints from the HMI.

Provide PLC based Sludge Pump and Jet Aeration control as follows:

Sludge Pumps: Provide HMI operator selectable ON/OFF control of each sludge pump as follows:

1. That DISABLES a pump and provides HMI indication of the DISABLED condition when the associated Sludge Holding Tank LOW LEVEL alarm is PRESENT, the pump FAULT condition is PRESENT or the pump REMOTE mode contact input is NOT PRESENT.
2. That maintains the pump in OFF mode when the ON/OFF selector is in the OFF position.
3. That RUNs the pump continuously when the ON/OFF selector is in the ON position and the pump is NOT DISABLED.
4. Generate a FAIL-TO-START condition and DISABLE the pump when the pump's Check Valve FAIL TO OPEN condition is present, the pump fails to start after a preset but adjustable delay initially set at 5-seconds or the pump stops while running. RESET the FAIL-TO-START condition and pump DISABLED condition when the Check Valve FAIL TO OPEN condition clears and the FAIL-TO-START alarm is ACKNOWLEDGED.

Sludge Holding Blowers: Provide Hand/Off/Auto control of the Sludge Holding Blowers for each of the four Sludge Holding Tanks as follows:

1. That DISABLES a blower and provides HMI indication of the DISABLED condition when the associated Sludge Holding Tank LOW LEVEL alarm is PRESENT, the associated Sludge Pump is NOT RUNNING, the blower FAULT condition is PRESENT or the associated blower REMOTE mode contact input is NOT PRESENT.
2. That maintains the blower in OFF mode when the HAND/OFF/AUTO selector is in the OFF position.
3. That RUNs the blower continuously when the HAND/OFF/AUTO selector is in HAND position and the blower is NOT DISABLED.
4. That RUNs the blower periodically according to a PLC based irrigation type repeat-cycle timer as follows when the HAND/OFF/AUTO selector is in AUTO position the blower is NOT DISABLED:
    a. That includes independent irrigation type repeat-cycle timers for each Sludge Tank that allow the operator to individually select whether or not to RUN the blower for each of the 96 15-minute segments over a 24-hour period which begins at midnight each day.
    b. That RUNs the blower continuously any time the timer RUN command is present.

5. Generate a FAIL-TO-START condition and DISABLE the blower when the blower fails to start after a preset but adjustable delay initially set at 5-seconds or the blower stops while running. RESET the FAIL-TO-START condition and blower DISABLED condition when the FAIL-TO-START alarm is ACKNOWLEDGED.

Provide power recovery in accordance with paragraph Recovery after Power Outage. Equipment interfaced with HOA switches restart automatically provided that the last state of the equipment was ON and in AUTO or HAND mode.

Hardwired Special Functions: Faults within the MCC will be transmitted to the SCADA PLC and HMI graphic as a general FAULT status bit.

PLC Special Functions: Receive the analog signal readings from the level transmitter, convert to appropriate engineering units, and display on HMI graphic. Provide alarm conditions for high and low level set points. Receive the ON, REMOTE, CHECK VALVE FAIL TO OPEN, and FAULT statuses of the sludge pumps and sludge blowers and transmit to HMI graphic. Transmit RUN command signal to the sludge pumps and sludge blowers. Provide an alarm for fail-to-start conditions.

HMI Special Functions: Receive the level values from the PLC in engineering units and display on the HMI graphic. Receive the ON, REMOTE, DISABLED, FAIL-TO-START, CHECK VALVE FAILED TO OPEN and FAULT statuses of the sludge pumps and sludge blowers from the PLC and display on the HMI graphic. Provide a graphic display on the HMI interface for the operator to issue start and stop commands to the sludge pumps and blowers using the RUN command bit. Display all alarms generated from the PLC.

INSTRUMENT LIST

DWG	TAG	QTY	CODE	Code and Description	Options (See P&IDs for Options, unless otherwise noted.)	Standard Details		
	830-AE/AIT-001-01							
	830-AE/AIT-004-01							
	830-AE/AIT-007-01							
008-N-600X, X = 4,5	830-AE/AIT-010-01	1	A20	Dissolved Oxygen, Luminescence	Range: 0-10 mg/l			
					Zero Reference: Bottom of the Tank Range: 0-30 ft Low Level Setpoint: 8 feet from the bottom of the tank, falling. High Level Setpoint: 24.5 feet from the bottom of the tank, rising.			
	830-LE/LIT-001-01				Hazardous area classified for Class 1,	4091-405AG		
	830-LE/LIT-004-01				Div 2 (Explosion Proof)	4091-420BG		
	830-LE/LIT-007-01				Use model XPS-15 transducer with	4091-384		
008-N-600X, X = 4,5	830-LE/LIT-010-01	4	L5	Level Element and Transmitter, Ultrasonic	LUT 400 series level transmitter.	4091-383		
	830-PI-002-01							
	830-PI-005-01					4091-304A		
	830-PI-008-01					4091-305A		
008-N-600X, X = 4,5	830-PI-011-01	4	P4	Pressure Gauge	Range: 0-50 psig	4091-305B		

PLC EQUIPMENT LIST

DWG	PLC	Module Description	Model Number	QTY	Options (See P&IDs for Options, unless otherwise noted.)			
008-N-600X, X = 4,5	SP-14-PLC-01	Allen-Bradley 120VAC 16 Point Digital Input Module	1746-IA16	3				
008-N-600X, X = 4,5	SP-14-PLC-01	Allen-Bradley 24VDC 16 Point Digital Output Module	1746-DB16	1				
008-N-600X, X = 4,5	SP-14-PLC-01	Allen-Bradley 4-20mA 8 channel Analog Input Module	1746-NI8	2				
008-N-600X, X = 4,5	SP-14-PLC-01	Allen-Bradley SLC 5/05 Processor with 64K Memory	1747-L553	1				
008-N-600X, X = 4,5	SP-14-PLC-01	Allen-Bradley 120VAC Power Supply	1746-P4	1				
008-N-600X, X = 4,5	SP-14-PLC-01	Allen-Bradley 10-Slot Chassis	1746-A10	1				

PLC I/O LIST

DWG	PLC	Tag	IO Function	Description	DI	DO	AI	AO
008-N-6004	SP-14-PLC-01	830-LIT-001-01	Level	Level Transmitter (Sludge Holding Tank No. 1)			1	
008-N-6004	SP-14-PLC-01	830-PMP-002-01	Run Command	Sludge Pump 1		1		
008-N-6004	SP-14-PLC-01	830-PMP-002-01	MCC Fault	Sludge Pump 1	1			
008-N-6004	SP-14-PLC-01	830-PMP-002-01	In Remote	Sludge Pump 1	1			
008-N-6004	SP-14-PLC-01	830-PMP-002-01	Power On	Sludge Pump 1	1			
008-N-6004	SP-14-PLC-01	830-PMP-002-01	Check Valve Closed	Sludge Pump 1	1			
008-N-6004	SP-14-PLC-01	830-BLR-003-01	Run Command	Sludge Holding Blower 1		1		
008-N-6004	SP-14-PLC-01	830-BLR-003-01	MCC Fault	Sludge Holding Blower 1	1			
008-N-6004	SP-14-PLC-01	830-BLR-003-01	In Remote	Sludge Holding Blower 1	1			
008-N-6004	SP-14-PLC-01	830-BLR-003-01	Power On	Sludge Holding Blower 1	1			
008-N-6004	SP-14-PLC-01	830-LIT-004-01	Level	Level Transmitter (Sludge Holding Tank No. 4)			1	
008-N-6004	SP-14-PLC-01	830-PMP-005-01	Run Command	Sludge Pump 4		1		
008-N-6004	SP-14-PLC-01	830-PMP-005-01	MCC Fault	Sludge Pump 4	1			
008-N-6004	SP-14-PLC-01	830-PMP-005-01	In Remote	Sludge Pump 4	1			
008-N-6004	SP-14-PLC-01	830-PMP-005-01	Power On	Sludge Pump 4	1			
008-N-6004	SP-14-PLC-01	830-PMP-005-01	Check Valve Closed	Sludge Pump 4	1			
008-N-6004	SP-14-PLC-01	840-BLR-004-01	Run Command	Sludge Holding Blower 4		1		
008-N-6004	SP-14-PLC-01	840-BLR-004-01	MCC Fault	Sludge Holding Blower 4	1			
008-N-6004	SP-14-PLC-01	840-BLR-004-01	In Remote	Sludge Holding Blower 4	1			
008-N-6004	SP-14-PLC-01	840-BLR-004-01	Power On	Sludge Holding Blower 4	1			
008-N-6005	SP-14-PLC-01	830-LIT-007-01	Level	Level Transmitter (Sludge Holding Tank No. 2)			1	
008-N-6005	SP-14-PLC-01	830-PMP-008-01	Run Command	Sludge Pump 2		1		
008-N-6005	SP-14-PLC-01	830-PMP-008-01	MCC Fault	Sludge Pump 2	1			
008-N-6005	SP-14-PLC-01	830-PMP-008-01	In Remote	Sludge Pump 2	1			
008-N-6005	SP-14-PLC-01	830-PMP-008-01	Power On	Sludge Pump 2	1			
008-N-6005	SP-14-PLC-01	830-PMP-008-01	Check Valve Closed	Sludge Pump 2	1			
008-N-6005	SP-14-PLC-01	870-BLR-007-01	Run Command	Sludge Holding Blower 2		1		
008-N-6005	SP-14-PLC-01	870-BLR-007-01	MCC Fault	Sludge Holding Blower 2	1			
008-N-6005	SP-14-PLC-01	870-BLR-007-01	In Remote	Sludge Holding Blower 2	1			
008-N-6005	SP-14-PLC-01	870-BLR-007-01	Power On	Sludge Holding Blower 2	1			
008-N-6005	SP-14-PLC-01	830-LIT-010-01	Level	Level Transmitter (Sludge Holding Tank No. 3)			1	
008-N-6005	SP-14-PLC-01	830-PMP-011-01	Run Command	Sludge Pump 3		1		
008-N-6005	SP-14-PLC-01	830-PMP-011-01	MCC Fault	Sludge Pump 3	1			
008-N-6005	SP-14-PLC-01	830-PMP-011-01	In Remote	Sludge Pump 3	1			
008-N-6005	SP-14-PLC-01	830-PMP-011-01	Power On	Sludge Pump 3	1			
008-N-6005	SP-14-PLC-01	830-PMP-011-01	Check Valve Closed	Sludge Pump 3	1			
008-N-6005	SP-14-PLC-01	840-BLR-010-01	Run Command	Sludge Holding Blower 3		1		
008-N-6005	SP-14-PLC-01	840-BLR-010-01	MCC Fault	Sludge Holding Blower 3	1			

PLC I/O LIST

DWG	PLC	Tag	IO Function	Description	DI	DO	AI	AO
008-N-6005	SP-14-PLC-01	840-BLR-010-01	In Remote	Sludge Holding Blower 3	1			
008-N-6005	SP-14-PLC-01	840-BLR-010-01	Power On	Sludge Holding Blower 3	1			
				SP-14-PLC-1	28	8	4	0
				I/O Total	28	8	4	0

NETWORK COMPONENTS LIST

DWG	TAG	QTY	Code and Description	Options (See P&IDs for Options, unless otherwise noted.)
008-N-600X, X=4,5	SP-14-UPS-01	1	Y40 Uninterruptible Power Supply System	As specified in Section 40 91 00 Instrumentation and Control Components
008-N-6007	SP-14-SW-01	1	Y181 LAN Switch, Industrial Ethernet, Small	As specified in Section 40 91 00 Instrumentation and Control Components
008-N-6007	SP-14-PLC-01	1	Y53 Programmable Controller	As specified in Section 40 91 00 Instrumentation and Control Components and PLC Equipment List Supplement
008-N-6007	SP-14-HMI-01	1	Y172A HMI Client Workstation	As specified in Section 40 91 00 Instrumentation and Control Components
008-N-6007	SP-14-CPC-0X, X=1,2	2	Digi One IAP Industrial Serial Server	Use Digi One IAP Industrial Serial Server to link a network of RS-485 Modbus RTU slave devices (Power Monitors) and A-B Ethernet master device (SCADA PLC).
008-N-6007	SP-14-PP-01	1	Fiber Center	As specified in Section 40 95 80 Fiber Optic Communication System

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-600X, X=4,5	SP-14	SP-14	Sludge Holding Tanks Control Panel	72.06" x 72.06" x 24.06"	12	Hoffman Type 12 Floor Mount with 12 inch Floor Stands Catalog Number A727224ULPG Include in FDT	4091-426BG 4091-408G 4091-382

CH2M HILL **LOOP STATUS REPORT—EXAMPLE FORMAT** **Rev.06.05.92**

Project Name: *Newport News WTP*	Project No. *WDC23456.C1*

FUNCTIONAL REQUIREMENTS:

1. Measure, locally indicate, and transmit RAS flow to LP-10.	
2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.	
3. Provide high RAS flow alarm on LP-10.	

COMPONENT STATUS (Check and initial each item when complete)

Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	
FE/FIT-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Feb-7-90 DWM*	*Mar-5-90 DWM*	*N.A.*	*May-6-90 VDA*	
FIC-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-4-90 VDA*	
FSH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FAH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FCV-10-2	*Mar-2-90 DWM*	*Mar-2-90 DWM*	*Apr-20-90 DWM*	*Apr-30-90 DWM*		*May-16-90 VDA*	

REMARKS: None.

Loop Ready for Operation	By: *D.W. Munzer*	Date: *May-18-90*	Loop No.: *10-2*

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

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/ Convert? Y	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS

REQUIRED			**AS CALIBRATED**			
Input	Indicated	Output	Increasing Input		Decreasing Input	
			Indicated	Output	Indicated	Output
1.0	*1.0*	*4.0*	*1.0*	*4.0*	*1.0*	*3.9*
2.3	*2.3*	*5.6*	*2.2*	*5.5*	*2.3*	*5.6*
7.5	*7.5*	*12.0*	*7.5*	*11.9*	*7.5*	*12.0*
12.7	*12.7*	*18.4*	*12.7*	*18.3*	*12.6*	*18.3*
14.0	*14.0*	*20.0*	*14.0*	*20.0*	*14.0*	*20.0*
CONTROL MODE SETTINGS:			P: *N.A.*	I:	D:	

DISCRETE CALIBRATIONS

REQUIRED			**AS CALIBRATED**		**Note No.**
Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	
	(note rising or falling)		(note rising or falling)		
1.	*N.A.*		*N.A.*		
2.					*1.*
3.					
4.					
5.					
6.					

#	**NOTES:**
	1. Need to recheck low pH calibration solutions.

Component Calibrated and Ready for Start-up

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: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049763-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1003220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear – Modulated*	Model: *4060D*
	Travel: *3-inch*	Serial #: *2007330*
Positioner	Input Signal: *3-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot	Action:	Mfr:
Solenoid	Rating: *None*	Model: Serial #:
I/P	Input: *4-20 mA dc*	Mfr: *Taylor*
Converter	Output: *3-15 psi*	Model: *10-T-576-3*
	Action: *Direct*	Serial #: *1057-330*
Position	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
Switch	Contacts: *Close / Close*	Model: *1049-67-3*
		Serial #: *156 &157*
Power	Type: *Pneumatic*	Air Set Mfr: *Air Products*
Supply	Potential: *40 psi*	Model: *3210D*
		Serial #: *1107063*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-92*	Valve Action	*JDS*	*Jun-03-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-03-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Start-up**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

CH2M HILL PERFORMANCE TEST SHEET - EXAMPLE Rev.06.05.92

Project Name: *SFO SEWPCP Plant Expansion*	Project No.: *SFO12345.C1*

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.

1. MEASURE EFFLUENT FLOW

1.a With no flow, water level over weir should be zero and

FIT indicator should read zero. *Jun-20-92 BDG*

2. FLOW INDICATION AND TRANSMISSION TO LP & CCS

With flow, water level and FIT indicator should be related by expression

*Q(MGD) = 429*H**(2/3) (H = height in inches of water over weir).*

Vary H and observe that following.

2.a Reading of FIT indicator. *Jun-6-92 BDG*

2.b Reading is transmitted to FI on LP-521-1 *Jun-6-92 BDG*

2.c Reading is transmitted and displayed to CCS. *Jun-6-92 BDG*

H(measured)	*0*	*5*	*10*	*15*
Q(computed)	*0*	*47.96*	*135.7*	*251.7*
Q(FIT indicator)	*0*	*48.1*	*137*	*253*
Q(LI on LP-521-1)	*0*	*48.2*	*138*	*254*
Q(display by CCS)	*0*	*48.1*	*136.2*	*252.4*

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report	*J.D. Sewell*	*May-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B. DeGlanville*	*Jun-6-92*	Loop No.: *30-12*

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: Brassed 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. Surge Suppressors:

1. General:
    a. 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.
    b. Response: 5 nanoseconds maximum.
    c. Recovery: Automatic.
    d. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
    e. Enclosure Mounted: Encapsulated inflame retardant epoxy.
2. Suppressors on 120V ac Power Supply Connections (SS1):
    a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
    b. First-Stage Clamping Voltage: 350 volts or less.

c. Second-Stage Clamping Voltage: 210 volts or less.
d. Power Supplies for Continuous Operation:
1) Four-Wire Transmitter or Receiver: Minimum5 amps at 130V ac.
2) All Other Applications: Minimum 30 amps at 130V ac.

3. Suppressors on Analog Signal Lines:
a. Test Waveform: Linear 8-microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
1) dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
2) dc Clamping Voltage Tolerance: Plus or minus 10 percent.
3) Maximum Loop Resistance: 18 ohms per conductor.

4. Manufacturers and Products:
a. Panel Mounted Analog Signals Lines (SS2): Emerson Edco PC-642 or SRA-64 series.
b. 120V ac Lines: Emerson Edco HSP-121.
c. Field Mounted at Two-Wire Instruments (SS3):
1) Encapsulated in stainless steel pipe nipples.
2) Emerson Edco SS64 series.
d. Field Mounted at Four-Wire Instruments (SS4): With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
1) Enclosure:
a) NEMA 4X Type 316 stainless steel with door.
b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
2) Emerson Edco; SLAC series.

D. 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.

E. 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.

F. 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. A20 Dissolved Oxygen Element and Transmitter, Nonmembrane Luminescent (LDO):

1. General:
    a. Function: Portable sample measurement of dissolved oxygen (DO) concentration of process fluid.
    b. Type: Luminescent sensor.
    c. Parts: Element (sensor), indicator (analyzer), interconnecting cable, mounting hardware, and ancillaries.
2. Performance:
    a. Range: As noted.
    b. Sensor Accuracy:
        1) Resolution: 0.1 mg/L.
    c. Response Time: At 20 degrees C; to 95 percent in less than 60 seconds.
3. Element:
    a. Luminescent sensor.
    b. Process Temperature Range: 32 degrees F to 122 degrees F.
    c. Sensor Cable: 3m. Provide additional length as required.

4. Indicator:
   a. Display:
      1) 240 by 160 pixel readings from one or two probes.
      2) Auxiliary Readout:
         a) Temperature.
         b) Pressure.
         c) Error messages.
         d) Average LDO readings.
         e) Other information.
   b. Ambient Conditions:
      1) Temperature minus 32 degrees F to 140 degrees F.
      2) Humidity: 0 to 90 percent, noncondensing.
   c. Data Storage and Transfer:
      1) Data memory: 500 results.
      2) Data export: USB connection to PC operator interface.
      3) Data storage handling:
         a) Automatic: Press to Read mode and Interval Mode.
         b) Manual: Continuous Read mode.
   d. Connections:
      1) Signal Inputs: 2 M12 Digital Inputs.
      2) Data/Power Interface: 1 Type A USB port.
   e. Rating: IP 67 Waterproof rated.
   f. Power Requirements:
      1) Internal: 6VDC, 4 AA batteries.
      2) AC/DC Power Adapter: 120V ac, 60 Hz input.
5. Accessories:
   a. USB connector for portable meter to perform software updates or transfer data to PC operator interface.
   b. Spare sensor cap.
6. Manufacturers and Products: Hach; IntelliCAL LDO Probe Model 10103 with HQ40d portable meter.

B. L5 Level Element and Transmitter, Ultrasonic:

1. General:
   a. Function: Continuous, noncontacting 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:
      1) Transducer: Minus 40 degrees F to plus 203 degrees F.
      2) Transmitter: Minus 4 degrees F to plus 122 degrees F.

3. Performance:
   a. Range: As noted.
   b. Zero Reference: As noted.
   c. Accuracy: At standard operation; Plus or minus 1mm plus 0.17 percent of measured distance.
   d. Resolution: At standard operation; 0.1 percent of range or 2 mm, whichever is greater.
   e. Blanking Distance: Sensor dependent, typically 1 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: If noted.
      1) Face: PTFE, unless otherwise noted.
      2) Size: As noted.
   e. Process Connection:
      1) 1-inch NPT, unless otherwise noted.
      2) Top mounted.
   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: 6 degrees or less.
   h. Integral temperature compensation.
5. Transmitter:
   a. Display.
   b. Integral keypad or nonintrusive external programming.
   c. Enclosure: NEMA 4X polycarbonate, unless otherwise noted.
   d. Power Supply: 115 volts, 50/60-Hz, unless otherwise noted.
   e. Isolated Analog Output:
      1) One Minimum: 4 mA to 20 mA dc for load impedance of 0 to 750 ohms.
   f. Digital Communication: As noted.
   g. 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. Others: As noted.
d. If no integral keypad, furnish one handheld programmer per lot of units furnished.

8. Manufacturers and Products:
a. Siemens; SITRANS LUT 400 Series.

C. P4 Pressure Gauge:

1. General:
a. Function: Local pressure indication.
b. Type: Bourdon tube element.
2. Performance:
a. Scale Range: As noted.
b. Accuracy: Plus or minus 0.50 percent of full scale.
3. Features:
a. Dial: 4-1/2-inch diameter.
b. Pointer Vibration Reduction: Required, unless otherwise noted. Use the following method.
1) Liquid filled gauge front, unless otherwise noted.
a) Glycerin fill, unless otherwise noted.
c. Case Material: Black thermoplastic, unless otherwise noted.
d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
1) Stainless steel, unless otherwise noted.
e. Pointer: Adjustable by removing ring and window.
f. Window: Glass or acrylic, unless otherwise noted.
g. Threaded reinforced polypropylene front ring.
h. Case Type: Solid front with blow-out back.
4. Process Connection:
a. Mounting: Lower stem, unless otherwise noted.
b. Size: 1/2-inch MNPT, unless otherwise noted.
5. Accessories:
a. Throttling Device: Required, unless otherwise noted.
1) Type suitable for the intended service.
2) Install in gauge socket bore.
6. Manufacturers and Products:
a. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!
b. Ametek U.S. Gauge; Solfrunt Model 19XX/1981Advantatge.
c. WIKA, Type 2XX.34.

D. Y40 Uninterruptible Power Supply System

9. General:
   a. Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.
   b. Major Parts: Inverter, battery charger, sealed battery.
10. Performance:
   a. Capacity: As noted.
   b. Input Power:
      1) 120V ac single-phase, 60-Hz, unless otherwise noted.
      2) Connections: Manufacturer's standard, unless otherwise noted.
   c. Output Power:
      1) 120V ac single-phase, 60-Hz, unless otherwise noted.
      2) Connections: Manufacturer's standard, unless otherwise noted.
   d. On-line Efficiency: 85 percent minimum, unless otherwise noted.
   e. Backup Runtime:
      1) Full Load: 9 minutes minimum, unless otherwise noted.
      2) Half Load: 20 minutes minimum, unless otherwise noted.
   f. Continuous no-break power with no measurable transfer time.
   g. Sine-Wave Output Voltage Total Harmonic Distortion (THD): Plus or minus 6 percent or less.
   h. Input Voltage Range: Plus 15 percent, minus 20 percent.
   i. Output Voltage Regulation: Plus or minus 3 percent nominal.
   j. Operating Temperature: 0 degree to 40 degrees C (32 degrees to 104 degrees F).
   k. Operating Relative Humidity: 5 percent to 95 percent without condensation.
   l. Lightning and Surge Protection:
      1) Pass lightning standard IEEE C62.41 Categories A and B tests.
      2) 2000 to 1 attenuation of input spike.
11. Features:
   a. Bypass Switches: As noted.
   b. Enclosure:
      1) Tower, unless otherwise noted.
      2) If rack-mount noted, unit to be suitable for mounting in a 19-inch rack.

12. Manufacturers and Products:
    a. Powerware; FERRUPS FE/Rackmount Uninterruptible Power System.
    b. Controlled Power Company.

E. Y53 Programmable Controller:

1. Programmable Controller: Provide programmable controller with central processor, memory, input/output, interconnecting cables, and optional items as specified:
    a. General Specifications:
        1) Operating Temperature: 0 to 60 degrees C.
        2) Humidity: 5 to 95 percent noncondensing.
        3) Operating Voltage: 24 VDC.
        4) Maximum Scan Time (Ladder Logic): 0.9 mS per 1,000 words.
        5) Controller Connections: 480 minimum.
        6) Network Connections: 32 minimum.
    b. Central Processor:
        1) Minimum 32-bit microprocessor.
        2) User Memory: 16KB, minimum.
        3) Provide CPU capable of performing the same functions as a conventional analog and relay logic system including:
            a) PID Control.
            b) Relays.
            c) Timers.
            d) Counters.
            e) Shift registers.
            f) Drum sequencers.
        4) Provide CPU capable of data word functions such as:
            a) Four-function integer math.
            b) Data shift registers.
            c) Data word move.
            d) Data file compare with pointer.
            e) File move.
        5) Programming Languages:
            a) Relay Ladder.
            b) Function Block.
        6) Provide CPU capable of monitoring the following system failures and alarm operator and shutdown if a failure occurs.
            a) Memory failure.
            b) User program longitudinal redundancy error.
            c) Memory battery low, if applicable.
            d) Input/output subsystem error.
            e) Watchdog timer time out.

7) Memory:
   a) Type: Random Access Memory (RAM).
   b) The programmable control memory shall consist of the following functional types of memory:
      (1) Ladder logic program memory.
      (2) Analog processor memory.
      (3) Variable data memory.
      (4) Input/output data memory.
      (5) Miscellaneous.
   c) Provide nonvolatile user memory to backup PLC program.
8) PLC Communication Ports:
   a) As a minimum provide the following communication ports for each PLC:
      (1) One port for connection to laptop programmer.
9) Provide two copies of professional version PLC programming software and two copies of Professional version PLC communication software and drivers for the PLC and Citect nodes, respectively.
10) Provide software as required for proper operation of HMIs.
11) Manufacturer: Allen-Bradley, Model 1746 Modules.

2. PLC I/O Subsystem:
   a. Input/Output: Provide all hardware necessary for the CPU to communicate with the specified types of input and output modules. Provide remote I/O rack configuration where shown or specified.
   b. Discrete Input Modules:
      1) Type: 120V ac digital input modules.
      2) TTL compatible imposed on the input module.
      3) Inputs per module: 8 minimum and 32 maximum.
      4) Status lights for each input and barrier type terminal blocks for termination of the field wires. Provide module constructed such that the field wires do not have to be removed while replacing the module.
   c. Discrete Outputs:
      1) Type: Contact closure or triac outputs suitable for driving relays, solenoid operated valves.
      2) Rating: 24V dc.
      3) Outputs per module: 8 minimum and 32 maximum.
      4) Provide output modules that are protected from damage by inductively generated, NORMAL mode, and LOW energy common mode transients to 1,500 volts peak.
      5) Provide discrete outputs that fail open when a PLC failure is detected.

6) Provide isolated interposing relays for all discrete outputs.
7) Status lights for each output point, and barrier type terminal blocks for termination of the output wires. Provide module constructed such that the field wires do not have to be removed while replacing the module.

d. Analog Inputs:
1) Type: Isolated Single Ended, accepts a 4 to 20 mA dc signal.
2) Accuracy: Plus or minus 5 percent of full scale.
3) Provide input module capable of withstanding low common mode transients of 1,500 volts peak without catastrophic PLC failure.

e. Analog Outputs:
1) Type: Isolated, Single Ended, output a 4 to 20 mA signal suitable for driving a 0 to 600 ohm load.
2) Accuracy: Plus or minus 5 percent of full scale.

3. Provide each I/O chassis with power supply, Ethernet port, required I/O modules, and required backplane connectors for additional chassis as required to accommodate I/O for a given panel.
4. Industrial Environmentally Hardened Operator Interface: Where shown on the Block Diagram.
5. Manufacturer: Allen-Bradley, SLC 5/05 PLC Modules.

F. Y172A HMI Client Workstation:

1. Provide a panel mount HMI to allow the operator to interface with the control system, view status of and manipulate plant equipment, and manage alarms.
2. Provide industrial panel mount PC manufactured by Phoenix Contact or equivalent so that the following minimum requirements are met.
a. Hardware:
1) Processor: Intel, 1.5 GHz.
2) Memory: 2GB DDR SODIMM.
3) Display: 17-inch minimum TFT active Touchscreen, capable of no less than XGA 1024 by 768 pixels (width by height).
4) Storage: Single hard drive no smaller than 80 GB.
5) Backup:
a) Read/Write DVD-ROM drive.
b) Compact Flash Drive.
6) Communication ports/hardware necessary to communicate with the PLC.
a) 10/100 BASE TX Ethernet.
b) USB.
c) RS-232.
7) Enclosure: NEMA 4.

b. Software: SSI shall provide operating system and application programming software licenses per existing standards. SSI shall provide all application programming for the HMI as described in the PLC Loop Descriptions.

c. Environmental:
   1) Operating Temperature: Minus 20 to 55 degrees C.
   2) Storage Temperature: Minus 40 to 70 degrees C.
   3) Permissible Humidity: 5 percent to 95 percent, noncondensing.

3. Manufacturer and Product:
   a. Phoenix Contact Valueline IPC.
   b. Equivalent Proface.
   c. Equivalent Arista.

G. Y181 LAN Switch, Industrial Ethernet, Small:

1. General: Field Panel mounted Ethernet switch.
   a. Functions:
      1) Managed Industrial Fiber Optic Ethernet Switch that supports redundant ring network configuration.
      2) Fiber Optic Ethernet Switch supporting proprietary redundant ring technology for fast recovery from link loss.
      3) Provides network management features.
   b. Features:
      1) Full-duplex standard: IEEE 802.3X.
      2) MAC Address: 4,000 per 8 ports
      3) Advanced Management Functions:
         a) VLAN.
         b) QoS.
         c) Trunking.
         d) IGMP Snooping.
         e) Port Mirroring.
      4) Indicators:
         a) Link Status.
         b) Speed Status.
         c) Activity Status.
         d) Duplex Status.
   c. Network Interface:
      1) 10/100BaseTX RJ-45 Ports: 6, minimum.
      2) 100BaseFX: 2 SC ports.
   d. Power: Redundant 10-36V dc, connect both power inputs to separate power supplies.
   e. UL 508 Listed.
   f. Mounting: DIN Rail.

g. Environmental:
   1) Operating Temperature: Minus 40 to 165 degrees F.
   2) Storage Temperature: Minus 40 to 185 degrees F.
h. Manufacturer and Product:
   1) Weidmuller: IE-SW6/2SC-M Switches.
   2) N-Tron: 608 MFX-ST Series.
   3) Hirschmann: RS20 Series.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 40 95 80
FIBER OPTIC COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
2. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
3. Insulated Cable Engineers Association (ICEA):
   a. S-83-596, Optical Fiber Premises Distribution Cable.
   b. S-87-640, Optical Fiber Outside Plant Communications Cable.
   c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
4. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
5. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. QuEST Forum (QF): TL 9000, Quality Management Systems.
8. Rural Development Utilities Programs (RDUP):
   a. 7 CFR 1755.902, Minimum Performance Specification for Fiber Optic Cables.
   b. 7 CFR 1755.903, Fiber Optic Service Entrance Cables.
9. Telecommunications Industry Association (TIA):
   a. 526-7, OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
   b. 526-14, OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
   c. 568-C.1, Commercial Building Telecommunications Cabling Standards.
   d. 568-C.3, Optical Fiber Cabling Components Standard.
   e. 598, Optical Fiber Cable Color Coding.
   f. 606, Administration Standard for Commercial Telecommunications Infrastructure.
10. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
    a. 455-78, FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Text Procedures – Attenuation.

b. 455-133, FOTP-133 IEC-60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement.
c. 492AAAA, Detail Specification for 62.5-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
d. 492AAAB, Detail Specification for 50-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
e. 492AAAC, Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
f. 492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
g. 492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
h. 604-2, FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
i. 604-3, FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC.
j. 604-12, FOCIS-12 Fiber Optic Connector Intermateability Standard, Type MT-RJ.
k. 942, Telecommunications Infrastructure Standard for Data Centers.
l. TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems-Contains Color.

11. Underwriter Laboratories (UL): 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

A. ATM: Asynchronous Transfer Mode.

B. AUI: Attachment Unit Interface.

C. dB: Decibel.

D. DNI: Desktop Network Interface.

E. EMB: Effective Modal Bandwidth.

F. ETL: Electrical Test Laboratories.

G. FDDI: Fiber Distributed Data Interface.

H. FIM: Facilities Information Management.

I. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.

J. FOCS: Fiber Optic Communication System.

K. FOIRL: Fiber Optic Inter Repeater Link.

L. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.

M. Hybrid Cable: Cable containing more than one type of fiber.

N. LAN: Local Area Network.

O. m: Micrometer.

P. Mbps: Megabits per Second.

Q. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.

R. Megahertz (MHz): One million cycles per second.

S. MHz: Megahertz.

T. micro: x 10^{-6}.

U. Micron: Micrometer or one millionth meter.

V. MIS: Management Information System.

W. n, nano: x 10^{-9}.

X. N: Newton.

Y. nm: Nanometer—unit of measure equal to one billionth meter.

Z. OFL: Over-filled Launch.

AA. OFN: Nonconductive Optical Fiber Cable.

BB. OFNP: Nonconductive Optical Fiber Plenum Cable.

CC. OFNR: Nonconductive Optical Fiber Riser Cable.

DD. OLTS: Optical Loss Test Sets.

EE. OTDR: Optical Time Domain Reflectometer.

FF. PIC: Process Instrumentation and Control.

GG. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.

HH. RLM: Restricted Mode Launch.

II. ROL: Reverse Oscillation Lay.

JJ. SPC: Super Physical Contact.

KK. UPC: Ultra Physical Contact.

LL. UPS: Uninterruptible Power Supply.

MM. V ac: Volts Alternating Current.

NN. WAN: Wide Area Network.

1.03 SYSTEM DESCRIPTION

A. This section covers requirements for Fiber Optic Communication Subsystem (FOCS) and is in addition to Section 40 90 00, Instrumentation and Control for Process Systems. Key technical definitions and requirements for the FOCS are given in Section 40 90 00, Instrumentation and Control for Process Systems.

B. Refer to P&I Block diagrams and Electrical E-Drawings for additional requirements.

C. The PICS subcontractor is responsible for furnishing, terminating, and testing all fiber optic cable and accessories as shown and specified. Fiber optic cable will be installed by the Electrical Subcontractor under the supervision of the PICS subcontractor.

D. Conduits and innerduct system provided by Division 26, Electrical. Coordinate installation of fiber optic cable with the Electrical Subcontractor.

E. Provide fiber optic cable based on cable lengths provided by the Electrical Subcontractor. Electrical subcontractor is responsible for the installation of the fiber optic cable provided by the PICS subcontractor.

F. Terminate and test all fiber optic cable as shown and specified after fiber optic cable installation by the Electrical Subcontractor.

G. Provide fiber optic components and fiber optic patch panels as shown and specified. Refer to the P&I block diagrams for additional requirements and component locations.

H. Function of FOCS is to transmit digital data between network nodes. Requirements listed identify minimum acceptable system performance.

I. Provide a FOCS based on referenced standards for use in the following local and wide area networks:

1. Fast and Gigabit Ethernet.
2. Ethernet/IP.

J. Network(s) will be used by PIC to distribute data and coordinate Owner's operations.

K. Coordinate fiber optic cable, conduit, and innerduct requirements with Electrical Subcontractor.

L. FOCS to furnish fiber optic cable for installation by the Electrical Subcontractor based on estimated lengths provided by the Electrical Subcontractor.

M. Electrical Subcontractor to furnish and install conduit and innerduct for fiber optic cable.

1.04 SUBMITTALS

A. Action Submittals:

1. Block diagram showing the following:
   a. Provide a completely coordinated diagram showing all communications cabling including fiber optic and category 5 and 6 type Ethernet cabling connections.
   b. Access holes, with identification.
   c. All fiber optic patch panels and fiber optic connected equipment.
   d. Approximate fiber optic cable lengths.
   e. Type of fiber optic cable.
   f. Final O&M diagrams to include IP Addressing and VLAN assignments.
2. Cable schedule showing:
   a. Cable identification.
   b. Fiber counts for each cable and identification of used fiber pairs.
   c. Cable length and attenuation, including connector pairs based on TIA/EIA 568, Annex H.
3. Light budget calculations showing:
   a. Light emitting and receiving device pair power budget in dB.
   b. Attenuation between emitting and receiving device including all fiber optic cables, patch cords, connectors, patches, splices, and repeaters between devices.

c. Reserve light budget required by emitting and receiving device pair.
d. Total remaining power budget in dB after all attenuation and reserve has been subtracted.

4. Component Data:
   a. Manufacturer and model number.
   b. General data and description.
   c. Engineering specifications and data sheet.
   d. Scaled drawings and mounting arrangements.
5. Testing submittals for pre-installation and post-installed cables as specified.

B. Informational Submittals:

1. Manufacturer's statement that installer is certified to perform installation Work.
2. Subcontractor Qualifications:
   a. FOCS Subcontractor: Minimum of 5 years' experience providing, integrating, installing, and commissioning of similar systems.
      1) Statement of Experience: List of at least three fiber optic data communications systems comparable to system specified which have been furnished and placed into operation. For each system, provide following information:
         a) Owner's name, address, telephone number, and name of current operations supervisor or other contact.
         b) Description of system hardware configuration, including major equipment items, number of nodes, and communication standards implemented.
         c) System block diagram.
         d) Dates when contract was signed, equipment was delivered, and system was accepted by Owner. Also, include originally scheduled completion date and if different from actual date, explain why.
         e) Approximate value of listed FOCS provided in dollars.
         f) Detailed horizontal and riser routing.
         g) Distribution frame arrangements.
         h) Fiber and termination identification, including spares.
   b. FOCS Subcontractor's Site Representative: Minimum of 5 years' experience installing similar systems.
   c. Qualification of Personnel:
      1) Resumes identifying management and technical qualifications of supervisory, local service representative, and key personnel.

2) Qualification data of firm and persons to demonstrate capabilities and experience in the following areas:
   a) Fiber optic cable handling and placement techniques.
   b) Fiber optic splicing and installation of connections.
   c) Attenuation testing procedures.

d. Owner acceptance of FOCS Subcontractor does not exempt FOCS Subcontractor or Contractor from meeting Contract Document requirements nor does it give prior acceptance of subsystems, equipment, materials, or services.

e. Sample of Network Test Report, minimum 10 pages, that Contractor generated in a previous project.

f. Testing and acceptance plan, 30 days prior to beginning of testing.

g. Fiber test results. Documentation covering fiber facility testing, not later than 2 days after testing, showing:
   1) Manufacturer's tag of attenuation per fiber as recorded from OTDR reading before shipment.
   2) Attenuation of each fiber upon delivery to Site.
   3) Attenuation of each fiber plus connector after installation as recorded from OTDR with tracing.
   4) Flux Budget calculations with comparison to measured attenuation for each run verifying adequate optical signal strength.

h. For each maintenance organization, identify location of base of service and how required coverage will be achieved.

3. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
4. Manufacturer's suggested installation practice.
5. Testing related submittals.
6. Operation and Maintenance Data:
   a. As specified in Section 01 78 23, Operation and Maintenance Data.
   b. Include the following information as a minimum in addition to the requirements in 01 78 23, Operation and Maintenance Data:
      1) All Submittal Data information revised for as-built conditions.
      2) Manufacturer's user's manuals and installation instructions.
      3) As-Built Drawings.
      4) Fiber Optic Cable test results.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable and Cable Splice Centers:

1. Outside, Underground/Submerged: Minus 20 degrees C to 40 degrees C.
2. Outside, Overhead: Minus 40 degrees C to 80 degrees C.
3. Outside, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.
4. Inside: 0 degree C to 40 degrees C.

B. Equipment:

1. Outside, Aboveground: Minus 40 degrees C to 80 degrees C.
2. Control Rooms, Equipment Rooms, and Telecommunications Closets: 30 percent to 55 percent relative humidity, 18 degrees C to 35 degrees C.
3. Other Interior Areas: 0 percent to 100 percent relative humidity, 5 degrees C to 40 degrees C.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Cable:
   a. ISO 9001 or QF TL 9000 registered, whichever applies to material.
   b. Minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
2. Housing: ISO 9001 and QF TL 9000 registered.
3. Connector:
   a. ISO 9001 or QF TL 9000 registered.
   b. Minimum 10-year history of manufacturing and supporting connector technology that does not require epoxy or polishing in field.
4. Jumper Cable: ISO 9001 and QF TL 9000 registered.

B. Installer Qualifications:

1. Individuals with at least 5 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
2. Certified by fiber cable manufacturer.

C. Tester Qualifications: Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.

1. Technician: Successfully attended training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof. Certificate may have been issued by the following organizations or an equivalent organization:
   a. Manufacturer of fiber optic cable and fiber optic connectors.
   b. Manufacturer of test equipment used for field certification.
   c. Other independent training organizations acceptable to Owner.

D. Provide connectors/coupling, splicing enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.

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 option of Owner, removal and replacement of Work specified in this Specification section found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

1.08 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following materials:

Item	Quantity
Jumpers of each length needed	One complete set

PART 2 PRODUCTS

2.01 MULTIMODE FIBER OPTIC CABLE

A. General: 50/125-micron, graded-index for use in backbone and horizontal distribution subsystems, meets or exceeds the requirements of TIA 568-C.3, including the following specifications:

1. ISO/IEC 11801 Type: OM2.
2. Maximum Mean Fiber Loss:
   a. 3.0 dB per km at 850 nm.
   b. 1.0 dB per km at 1,300 nm.
3. Minimum OFL Bandwidth:
   a. 700 MHz•km minimum at 850 nm.
   b. 500 MHz•km minimum at 1300 nm.
4. Distance Capacity per IEEE 802.3:
   a. 1 Gbit Ethernet: 750m at 850 nm and 600m at 1300 nm.
      1) Type, Armored.
5. Fiber Characteristics: Multimode
   a. Comply with TIA/EIA 568.
   b. 50/125 µm graded-index glass.
   c. Tight-Buffered, 900 µm buffer:
      1) Inner buffer: Acrylate, UV-cured, soft.
      2) Outer buffer: PVC, elastomeric, hard.
   d. Maximum Attenuation:
      1) 850 nm: 3.5 dB/km.
      2) 1300 nm: 1.0 dB/km.

e. Minimum Bandwidth:
   1) 850 nm: 500 MHz-km.
   2) 1300 nm: 500 MHz-km.
f. Color-coded buffer.
g. Minimum Bend Radius, Buffered Fiber: 1 inch.
h. Proof Testing: 100 kpsi.

6. Cable:
   a. Fiber Count:
      1) Multimode Distribution: As noted on drawings, 6 fibers per cable, minimum.
   b. All Dielectric Construction: No electrically conductive components in fiber optic cable are allowed.
   c. Helically Wound: Buffered fibers helically wound; approximately 5 turns per meter.
   d. Gel-Free: Fibers tight-buffered, not in gel-filled loose-tube.
   e. Core-Locked with no separator tape.
   f. Style: Distribution, indoor/outdoor.
   g. Strength Member:
      1) Nonconductive; integral part of cable; supports stress of installation and load during use.
      2) Fiberglass epoxy rod, aramid fiber, kevlar.
      3) Minimum Tensile Strength: 500 pounds.
   h. Protective Covering:
      1) Fluoropolymer, plenum and indoor/outdoor rated.
      2) Continuous and free from holes, splices, blisters, and other imperfections.
   i. Minimum Bend Radius:
      1) Short-Term under Tension: 20 times cable diameter.
      2) Long-Term without Tension: 15 times cable diameter.
   j. Identification:
      1) Identify with tags shown and in accordance with Section 40 90 00, Instrumentation and Control for Process Systems.
      2) Use waterproof tags and identifications.
   k. Special Features: Plenum rated flame-retardant.
   l. Manufacturer:
      1) Optical Cable Corporation.
      2) Corning.

2.02 FIBER OPTIC PATCH PANELS

A. Fiber Optic Patch Panel, Rackmount:

1. Function: Provides industry-standard rack mounting system for interface between fiber optic backbone and equipment cables.

2. Features:
    a. Used in either cross-connect or interconnect configuration.
    b. 23-inch rack for mounting 19-inch rack mount units.
        1) Accommodates up to 576 fiber terminations per frame.
        2) Accepts connector module housing and splice housing within same rack.
        3) Fiber Optic Connectors: LC-duplex.
    c. Fiber/Wire Management System:
        1) Vertical: 3-inch by 4-inch supports on 8-inch centers vertically on four sides (front LHS, back LHS, front RHS, back RHS).
        2) Horizontal: Supports on 4-inch centers horizontally above and below each termination frame front and back. Support may serve frames immediately above and below.
    d. Mounting Hardware: Accepts standard 19-inch rack for integrated fiber optic system (i.e. hubs, routers, patch panels, etc.).
    e. Splice Trays with Coil Former: Former to wind slack cable around, provides controlled long radius bends.
        1) Doors: Pivot down lockable.
        2) Foot and End Caps: Included in final, assembled unit.
        3) Ancillaries: Jumper troughs and covers, cable tie brackets.
3. Manufacturers:
    a. Ortronics.
    b. Siemon.
    c. Corning.

B. Fiber Optic Patch Panels, Surface Mount:

1. Function: Provides a secure place to terminate fiber optic cables.
2. Features:
    a. Compartments: Two; one for fiber optic cable, one for jumpers to individual equipment.
    b. Coil Former: Former to wind slack cable. Provides controlled long-radius bends.
    c. Connectors: Minimum 24 LC-duplex connectors for entry and exit.
    d. Size: Maximum 12 inches by 12 inches by 4 inches.
    e. Construction: 1.5-millimeter steel with noncorrosive finish.
    f. Mountings: Suitable for permanent attachment as shown, or provide separate mountings that do not obscure covers and doors.
3. Manufacturers and Products:
    a. Ortronics.
    b. Siemon.
    c. Corning.

C. Fiber Optic Patch Panels, DIN Rail Mount:

1. Function: Provides a secure place to terminate fiber optic cables.
2. Features:
   a. Compartments: One, removable.
   b. Connectors: Minimum 12 SC-duplex connectors for entry and exit.
   c. Size: Nominally 8 inches by 6 inches by 4 inches.
   d. Construction: 1.5-millimeter steel with noncorrosive finish.
   e. Mountings: Suitable for DIN Rail Mounting.
3. Manufacturers and Products:
   a. DINSpace, SNAP.
   b. Approved equal.

2.03 CONNECTORS

A. General:

1. Comply with TIA/EIA 604-2, TIA/EIA 604-3, TIA/EIA 604-12, and TIA 568-C.3.
2. SC connectors suitable for size and type of fiber being connectorized.
3. Pull Strength: 10 pounds on jacketed cables and 0.5 pounds on 900 micron fiber, minimum.
4. Durability: Sustain minimum 500 mating cycles without violating other requirements.
   a. Ferrules: Free-floating low loss ceramic.
   b. Polish: Ultra Physical Contact (UPC).
5. Attenuation:
   a. Typical: 0.2 dB per pair.
   b. Maximum: 0.5 dB per pair.
6. Manufacturer:
   a. Optical Cable Corporation.
   b. Corning.
   c. AMP.

2.04 PATCHCORDS

A. General:

1. In accordance with TIA 568-C.3.
2. Function: Connect fiber centers to network nodes, such as computer workstations.
3. Fiber Characteristics: In accordance with requirements for fiber optic cable.
4. Cable Configuration:
   a. Individual tight-buffer thermoplastic, fibers single or multimode, to match fibers being jumpered on.

b. Protected with kevlar strength members and enclosed in thermoplastic jacket.

5. Length: Standard, to meet requirements shown, plus minimum 3 meters at workstations.
6. Connectors:
   a. As required by Article Connectors.
   b. On-axial Pull Strength: 33 N.
   c. Normal-to-Axial Pull Strength: 22 N.
7. Cable Rating: OFNR or OFNP.
8. Color: Per standards or as indicated.
9. Measured for insertion loss with the following values for each connector:
   a. Typical of 0.3 dB and maximum of 0.5 dB (LC typical of 0.1 dB and maximum of 0.3 dB).
10. Manufacturers:
    a. Ortronics.
    b. Corning.
    c. Tripp-Lite.

2.05 CONDUIT

A. In accordance with Section 26 05 33, Raceway and Boxes.

2.06 ACCESSORIES

A. Hardware: Provide cable clamps, strain reliefs, blocking and grommet kits, closures, and fan outs for complete installation.

PART 3 EXECUTION

3.01 PREPARATION

A. Conduit provided under Division 26, Electrical:

1. Ensure installed conduit system conforms to fiber optic system requirements, including:
   a. Conduits and Innerducts: Size and number.
   b. Access Holes, Handholes, and Pull Boxes: Location and size, to ensure cables and innerducts may be installed without exceeding manufacturer’s limitations.
   c. Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.
2. Spare Conduit:
   a. No cables shall be pulled into spare conduit.
   b. 100 percent spare conduit capacity required for buried conduit only. For example, for every conduit with one or more cables in it, there shall be one spare equal-size conduit with no cables.
   c. Spare conduits need not have innerduct installed.

3. Expansion Plugs: Seal conduit to stop ingress of water and grit with fabricated expansion plugs.

3.02 INSTALLATION

A. Fiber Optic Cable:

1. Specified fiber counts, routing, origination, and terminating points are indicated on Drawings.
2. Installation by manufacturer certified installer under Division 26, Electrical.
3. Install cables in accordance with manufacturer's requirements
4. Install cable directly from shipping reels. Ensure that cable is not:
   a. Dented, nicked, or kinked.
   b. Subjected to pull stress greater, or bend radius less, than manufacturer's specification.
   c. Subjected to treatment that may damage fiber strands during installation.
5. Cables per Conduit: In accordance with NEC conduit fill limitations.
6. If calculation indicates that cable will attenuate signals more than 8 dB, reroute may be allowed, if approved by Contractor.
7. Splices: Install fiber optic cables in unspliced lengths from fiber centers to switches or hubs.
8. Identification: Identify cable on both ends and in access holes and pull points it goes through.
9. Sealing: Seal cables into innerducts to stop ingress of water and grit with fabricated expansion plugs.
10. Access Holes:
    a. Provide supports for cables in access and handholes.
    b. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

B. Fiber Optic Patch Panels:

1. Install securely in field panels as shown.
2. Minimum, one per facility having one or more network nodes.

C. Cable Terminations:

1. In accordance with TIA 568-C.3.
2. Fan out fiber cable to allow direct connectorization of connectors.
   a. Sleeve over individual fibers with transparent furcation tubes.
   b. At point of convergence of furcation tubes, provide strain relief with metal or high density plastic fan-out collar.
3. Break-out Kits:
   a. Terminate cables using manufacturer-supplied break-out kits.
   b. Terminate in accordance with manufacturer's recommendations.

4. Slack:
   a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
   b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
5. Connectors:
   a. Terminate 100 percent fibers in each cable to specified connector.
   b. Connect into fiber management system.
6. Conduit: Install in accordance with Section 26 05 33, Raceway and Boxes.

3.03 LABELING CONVENTIONS

A. Conform to TIA 606 or to requirements specified by Owner or Owner's representative.

B. Backbone (Riser) Cables:

1. Multiconductor cables connecting main distribution field to an intermediate distribution field, usually a wiring closet or cabinet, and are labeled at each terminating end. Label name identifies each endpoint, cable medium, and number of conductors as follows:
   a. Copper: IDF-MDF-C-PPP-N.
   b. Fiber: IDF-MDF-F-MMM, SSS-N.

Where:

IDF	Is the 3-5 position IDF/wiring closet/building code
MDF	Is the 3-5 position MDF (or IDF) code
F	Fiber
PPP	Is pair count of a copper cable
MMM	Is multimode strand count
SSS	Is single-mode strand count
N	Is a sequential number

C. Horizontal (Station) Cables:

1. Connect jack stations to wiring closets or cabinets and are labeled at each end to identify wiring closet they connect to and sequential jack station number as follows:
   a. Data: IDF-D-NNN-A/B.
   b. Voice: IDF-V-NNN-A/B.

Where:

IDF	Is the 3-5 position IDF/wiring closet/building code
D	Data cable (green)

V Voice cable (gray)
NNN Is the sequence number
A/B Indicates left or right port in faceplate
D and V are provided above for reference. Coordinate types and colors with the Owner.

3.04 FIELD QUALITY CONTROL

A. General:

1. Advise Engineer at least 48 hours in advance of each test. Engineer shall have option to witness and participate actively in tests.
2. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.
3. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
4. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
5. Testing performed on incomplete systems shall be redone on completion of the Work.
6. Document Test Results:
   a. Confirm each cable has at least specified number of fibers that meet standards, in accordance with As-Built Fiber Optic Cable Installation form included as Supplement to this section.
7. Confirm quantities and sizes of conduit and innerduct, in accordance with As-Built Conduit/Innerduct Installation form included as Supplement to this section.

B. Test Equipment:

1. Field test instruments shall have latest software and firmware installed.
2. Optical Fiber Cable Testers:
   a. Field test instrument shall be within calibration period recommended by manufacturer.
   b. Optical Loss Test Set (OLTS):
      1) Single-mode Optical Fiber Light Source:
         a) Provide dual laser light sources with central wavelengths of 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
         b) Output Power: Minus 10 dBm, minimum.
         c) Manufacturer: Fluke Networks.
      2) Multimode Optical Fiber Light Source:
         a) Provide dual LED light sources with central wavelengths of 850 nm (plus or minus 30 nm) and 1,300 nm (plus or minus 20 nm).
         b) Output Power: Minus 20 dBm minimum.

c) Meet launch requirements of TIA/EIA 455-78. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap, as described in Clause 11 of TIA 568-C.3, with Category 1 light source.
d) Manufacturer: Fluke Networks.

3) Power Meter:
a) Provide 850 nm, 1,300/1,310 nm, and 1,550 nm wavelength test capability.
b) Power Measurement Uncertainty: Plus or minus 0.25 dB.
c) Store reference power measurement.
d) Save at least 100 results in internal memory.
e) PC interface (serial or USB).
f) Manufacturer: Fluke Networks.

4) Optional Length Measurement: Capable of measuring optical length of fiber using time-of-flight techniques.

3. Optical Time Domain Reflectometer (OTDR):
a. Bright, color transmissive LCD display with backlight.
b. Rechargeable for 8 hours of normal operation.
c. Weight with battery and module of not more than 4.5 pounds and volume of not more 200 cubic inches.
d. Internal nonvolatile memory and removable memory device with at least 16 MB capacity for results storage.
e. Serial and USB ports to transfer data to PC.
f. Multimode OTDR:
1) Wavelengths: 850 nm (plus or minus 20 nm) and 1,300 nm (plus or minus 20 nm).
2) Event Dead Zone: 1 meter maximum at 850 nm and 2 meters maximum at 1,300 nm.
3) Attenuation Dead Zone: 6 meters maximum at 850 nm and 15 meters maximum at 1,300 nm.
4) Distance Range: 2,000 meters minimum.
5) Dynamic Range: Minimum 10 dB at 850 nm and 1,300 nm.
g. Manufacturer: Fluke Networks.

4. Fiber Microscope:
a. Magnification: 250X or 400X for end-face inspection.
b. Manufacturer: Fluke Networks.

5. Integrated OLTS, OTDR, and Fiber Microscope:
a. Test equipment that combines into one instrument such as OLTS, OTDR, and fiber microscope may be used.
b. Manufacturer: Fluke Networks.

C. Conduit Test:

1. Test and seal spare conduits.
2. Conduit and Innerduct Testing:
   a. Blow full-diameter mouse through each spare conduit and innerduct to verify they are unrestricted over full length.
   b. If conduit is restricted over full length, advise Engineer.
3. Documentation: Confirm conduit test As-Built Conduit/Innerduct Installation form documentation includes details of innerducts.

D. Cable Testing:

1. Test procedures and field test instruments shall comply with applicable requirements of:
   a. LIA Z136.2.
   b. TIA/EIA 455-78.
   c. TIA/EAI 455-133.
   d. TIA 526-7.
   e. TIA 526-14.
   f. TIA 568-C.1.
   g. TIA 568-C.3.
   h. TIA TSB 140.
2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
7. Document Tests:
   a. OLTS dual wavelength attenuation measurements for multimode links and channels.
   b. OTDR traces and event tables for multimode links and channels.

E. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone (single-mode and multimode) Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-C.1.

b) Values for Attenuation Coefficient (dB/km) are listed in the table below:

Attenuation Coefficient				
Type of Optical Fiber	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**
Single-mode	1310	0.5	1550	0.5
Multimode 50/125 µm	850	3.5	1300	1.5

b. OTDR Testing:
   1) Reflective Events: Maximum 0.75 dB.
   2) Nonreflective Events: Maximum 0.3 dB.

c. Magnified Endface Inspection:
   1) Visually inspect fiber connections for end-face quality.
   2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

F. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

G. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Owner.

H. Test Execution:

1. Optical Fiber Cable Testing:
   a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.
   b. Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for subsequent uploading to a PC in which administrative documentation may be generated.
      1) Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.

c. Perform Testing:
    1) On each cabling segment (connector to connector).
    2) On each cabling channel (equipment to equipment).
    3) Using high-quality test cords of same fiber type as cabling under test.
        a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
        b) Test cords for OTDR testing shall be approximately 100 meter for launch cable and at least 25 meters for receive cable.

2. Optical Loss Testing (OLTS):
    a. Backbone Link:
        1) Test single-mode at 1,310 nm and 1,550 nm in accordance with TIA 526-7, Method A.1, One Reference Jumper or equivalent method.
        2) Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.
        3) Perform tests in both directions.
3. OTDR Testing:
    a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
        1) Multimode: 850 nm and 1,300 nm.
    b. Test each fiber link and channel in one direction.
    c. Install launch cable between OTDR and first link connection.
    d. Install receive cable after last link connection.
4. Length Measurement:
        1) Record length of each fiber.
        2) Measure optical length using OLTS or OTDR.
5. Polarity Testing:
    a. Test paired duplex fibers in multifiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-C.1.
    b. Verify polarity of paired duplex fibers using OLTS.
6. Test Results Documentation:
    a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
    b. Available for inspection by Owner or Owner’s representative during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.

c. Database for project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of building. CD-ROM shall include software tools required to view, inspect, and print test reports.
d. Circuit IDs reported by test instrument shall match specified label identification.
e. Provide in electronic database for each tested optical fiber with the following information:
    1) Identification of Site.
    2) Name of test limit selected to execute stored test results.
    3) Name of personnel performing test.
    4) Date and time test results were saved in memory of tester.
    5) Manufacturer, model, and serial number of field test instrument.
    6) Version of test software and version of test limit database held within test instrument.
    7) Fiber identification number.
    8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.
    9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
    10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
    11) Length for each optical fiber as calculated by the OTDR.
    12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.

I. Drawings:

1. Record Copy: Provide at end of Project on CD-ROM.
    a. CAD format and include notations reflecting as-built conditions of additions and variations from Drawings provided, such as to cable path and termination point.
    b. CAD drawings are to incorporate test data imported from test instruments.
2. As-built Drawings:
    a. Include, but not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts, and frame installation details.
    b. Include field changes made up to construction completion:
        1) Field directed changes to pull schedule.
        2) Field directed changes to cross connect and patching schedule.

3) Horizontal cable routing changes.
4) Backbone cable routing or location changes.
5) Associated detail drawings.

3.05 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are part of this Specification.

1. As-Built Fiber Optic Cable Installation Form.
2. As-Built Conduit Installation Form.

END OF SECTION

PROJECT:

Contractor:

Signed by:

AS-BUILT FIBER OPTIC CABLE INSTALLATION

Cable Identification:
Routing: From: In:
(Identify field panel, control room, etc. in building)

Through: 1
(Identify access hole, building, gallery, etc.)
Through: 2 Through: 5
Through: 3 Through: 6
Through: 4 Through: 7
To: In:
See As-Built Conduit Installation forms for identification of conduits cable is routed through.

Acceptable Attenuation:
Multimode Fibers

		cable length*	
850 nm:	3.5 dB/km x	km + 1.5 dB =	dB
1300 nm:	1.0 dB/km x	km + 1.5 dB =	dB

*Contractor to provide actual length installed, within ±0.1 km.

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
		850 nm	1,300 nm	850 nm	1,300 nm

PROJECT:

Contractor:

Signed by:

AS-BUILT CONDUIT INSTALLATION

From: To:

(Identify building, access hole, field panel, etc.) Sheet 1 of 1

Conduits:
Used: 4 inches; 2 inches
Spare: 4 inches; 2 inches Confirm all spares unrestricted: Yes/No
(Provide number of conduits in each category)

Conduit ID	Cable ID / Spare

(Continued overleaf delete if not applicable)

END OF SUPPLEMENT

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.
3. Manufacturer's Certificate of Proper Installation in accordance with Section 01 00 01, General Requirements for Jet Aeration 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 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering; Model A-HCI.

2.03 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: Type 316 stainless steel construction unless otherwise specified.

E. Doors:

1. Three-point latching mechanisms in accordance with NEMA 250 Type 1 and 12 panels with doors higher than 18 inches.
2. For other doors, stainless steel quick release clamps.

F. Cutouts shall be cut, 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.

2.04 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: 300-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.

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. Manufacturer and Product: Allen-Bradley; Bulletin 800H.
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. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
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. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
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. Manufacturer and Products:
      1) Square D; Class 9001, Type SK.
      2) Allen-Bradley; Type 800H.

2.05 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

2.06 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: White with black 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 white with black 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.

2.07 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. Analog Signals Lines: Emerson Edco PC-642 or SRA-64 series.
2. 120V ac Lines: Emerson Edco HSP-121.
3. 480-Volt, Three-Phase Power Supplies: Square D Model SDSA3650.
4. Field Mounted at Two-Wire Instruments:
   a. Encapsulated in stainless steel pipe nipples.
   b. Emerson Edco SS64 series.
5. Field Mounted at Four-Wire Instruments: 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.

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.

3.02 PROTECTION

A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. During Work, periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules at Substantial Completion.

3.03 SUPPLEMENTS

A. The supplement listed below, following "END OF SECTION," is part of this Specification.

1. I&C Components.

END OF SECTION

SUPPLEMENT: I&C COMPONENTS

A. P4 Pressure Gauge:

1. General:
   a. Function: Local pressure indication.
   b. Type: Bourdon tube element.
2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: Plus or minus 1 percent of full scale.
3. Features:
   a. Dial: 4-1/2-inch diameter.
   b. Pointer Vibration Reduction: Required, unless otherwise noted. Use the following method.
      1) Liquid filled gauge front, unless otherwise noted.
         a) Glycerine fill, unless otherwise noted.
   c. Case Material: Black thermoplastic, unless otherwise noted.
   d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
      1) Stainless steel, unless otherwise noted.
   e. Pointer: Adjustable by removing ring and window.
   f. Window: Glass or acrylic, unless otherwise noted.
   g. Threaded reinforced polypropylene front ring.
   h. Case Type: Solid front with blow-out back.
4. Process Connection:
   a. Mounting: Lower stem, unless otherwise noted.
   b. Size: 1/2-inch MNPT, unless otherwise noted.
5. Accessories:
   a. Throttling Device: Required, unless otherwise noted.
      1) Type suitable for the intended service.
      2) Install in gauge socket bore.
6. Manufacturers and Products:
   a. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!
   b. Ametek U.S. Gauge; Solfrunt Model 19XX/1981Advantatge.
   c. WIKA, Type 2XX.34.

B. P7 Pressure Switch, Adjustable Deadband:

1. General:
   a. Function: Monitor pressure, activate switch at setpoint, and deactivate switch at reset point.

b. Type:
   1) Piston-actuated.
   2) Both setpoint and deadband (the differential between setpoint and reset point) adjustable.

2. Performance:
   a. Setpoint:
      1) As noted.
      2) Repeatability: Plus or minus 1 percent of range.
   b. Reset Point: As noted.
   c. Range: The noted setpoint shall fall between 20 percent and 80 percent of the range.
   d. Deadband: Adjustable within nominally 25 percent and 85 percent of range.
   e. Overpressure Proof Pressure:
      1) Pressure psi Ranges: At least 400 percent of rated maximum static pressure.
      2) Pressure Inches of Water Ranges: 20 psig.
      3) Compound Range: 250 psig.
      4) Vacuum Range: 250 psig.
   f. Operating Temperature Range:
      1) Dependent on actuator seal materials.
      2) For Buna-N seal, 0 degree F to 150 degrees F.
3. Features:
   a. Actuator Seal: Buna-N, unless otherwise noted.
   b. Adjustable deadband.
   c. Mounting: Surface, unless otherwise noted.
4. Process Connection:
   a. 1/4-inch NPT female connections, unless otherwise noted.
   b. Materials:
      1) Pressure psi Ranges: Type 316 stainless steel, unless otherwise noted.
      2) Pressure Inches of Water Ranges: Epoxy coated carbon steel, unless otherwise noted.
5. Enclosure: NEMA 4X, unless otherwise noted.
6. Signal Interface:
   a. Contact Type:
      1) SPDT.
      2) Rated for 10 amps minimum at 120V ac.
   b. Hermetically Sealed Switch: If noted.
7. Manufacturers and Products:
   a. Ashcroft; L or P Series.
   b. United Electric; J6 Series.
   c. If NEMA 7, explosion-proof enclosure specified; Ashcroft; P Series only.

C. T5 Temperature Switch:

1. General:
   a. Function: Provide change in contacts as temperature rises or falls through noted setpoint.
   b. Type:
      1) Vapor pressure thermal bulb sensing element.
      2) Fixed differential, unless otherwise noted.
   c. Parts: Switch/element assembly and thermowell.
2. Performance:
   a. Setpoint: As noted.
   b. Range: Such that noted setpoint falls between 30 percent and 70 percent of range.
   c. Repeatability: Plus or minus 1 percent of span.
3. Switch:
   a. Type: Snap action, SPDT, sealed environment proof, unless otherwise noted.
   b. Rating: 125V ac 15A, unless otherwise noted.
   c. Reset: Automatic.
   d. Enclosure:
      1) Type: NEMA 4X, unless otherwise noted.
      2) Mounting:
         a) Direct mount, unless otherwise noted.
         b) If remote mounted, furnish capillary with length either as noted or as required.
4. Element:
   a. Type: Bulb.
   b. Stem mounted to thermowell.
   c. Length: Coordinate with thermowell insertion length.
5. Thermowell:
   a. Process Connection: 1/2-inch NPT(M).
   b. Material: Type 316 stainless steel or Type 304 stainless steel.
   c. Insertion Length: 3-1/2-inch minimum immersion for liquids and 5-1/2-inch minimum immersion for gases, unless otherwise noted.
6. Electrical Connections:
   a. Conduit: 1/2-inch NPT(F).
7. Manufacturers:
   a. Ashcroft; B Series (Type 400 NEMA 4X, Type 700 NEMA 7 and NEMA 9).
   b. Barksdale; ML1H, MT1H.

D. T14 Thermometer, Bimetallic, Adjustable Angle:

1. General:
   a. Function: Indicate process temperature.
   b. Type: Bi-metallic, circular dial.
   c. Parts: Temperature gauge and thermowell.
2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: 1 percent of full scale.
3. Thermometer Features:
   a. Stem Length: 4 inches, unless otherwise noted.
   b. Stem Type:
      1) Every angle, unless otherwise noted.
         a) Adjustable 90 degrees vertical, 360 degrees horizontal.
   c. Dial:
      1) Heavy-duty glass, unless otherwise noted.
      2) 5-inch circular, unless otherwise noted.
      3) Hermetically sealed.
   d. Construction: All-welded, stainless steel.
4. Thermowell:
   a. Type: 1/2-inch NPT connection, Type 304 stainless steel.
   b. Extension Neck: When noted, with length as noted.
5. Manufacturers and Products:
   a. Ashcroft; Series EI bimetal thermometer.
   b. WIKA; Type S5301 bimetal thermometer.

DRAWINGS