ARLINGTON COUNTY, VIRGINIA
OFFICE OF THE PURCHASING AGENT
2100 CLARENDON BOULEVARD, SUITE 500
ARLINGTON, VA 22201
(703) 228-3410

REQUEST FOR QUALIFICATIONS No. 24-DES-RFQ-399

THERMAL HYDROLYSIS PROCESS (THP) EQUIPMENT AND SERVICES

ELECTRONIC SEALED APPLICATIONS WILL BE RECEIVED BY ARLINGTON COUNTY VIA VENDOR REGISTRY, UNTIL 1:00 P.M. ON THE 30TH DAY OF NOVEMBER 2023. VENDORS ARE REQUIRED TO REGISTER ON VENDOR REGISTRY IN ORDER TO SUBMIT A RESPONSE TO THIS REQUEST FOR QUALIFICATIONS. NO RESPONSE WILL BE ACCEPTED AFTER THE APPLICATION DUE DATE AND TIME.

The County will not publicly open the Applications.

The County reserves the right to reject any and all Applications, cancel this solicitation and waive any informalities or irregularities in procedure. Arlington County does not discriminate against faith-based organizations.

Arlington County, Virginia
Office of the Purchasing Agent

Tomeka D. Price, VCO, VCA
Procurement Officer
tprice@arlingtonva.us

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I. INSTRUCTIONS TO APPLICANTS

1. GENERAL

Applicants interested in providing thermal hydrolysis process (THP) equipment and services as part of the Arlington Water Pollution Control Plant Phase 10C/D – Comprehensive Biosolids Upgrade Project (Biosolids Upgrades) must respond to this Request for Qualification. The County will evaluate applications based upon the identified evaluation criteria and will select those Applicants it deems qualified. Final selection of the THP Supplier from the Suppliers prequalified under this RFQ will be determined by the Design-Build Contractor (Contractor) awarded under Contract No. 22-DES-RFPW-672.

2. QUESTIONS AND ADDENDA

APPLICANTS MUST BE REGISTERED IN VENDOR REGISTRY TO SUBMIT A QUESTION FOR THIS REQUEST FOR QUALIFICATIONS (RFQ).

All communications relating to this solicitation must be submitted online using Vendor Registry**.** For a question to be considered, the question must be entered in the Question Section of RFQ No. 24-DES-RFQ-399. Applicants must be registered to respond and/or submit questions to this RFQ. Prior to the award of a contract resulting from this solicitation, Applicants are prohibited from contacting any County staff other than those assigned to the Office of the Purchasing Agent.

RFQ No. 24-DES-RFQ-399 – TENTATIVE SCHEDULE

RFQ ISSUANCE	OCTOBER 31, 2023
QUESTION DEADLINE	NOVEMBER 15, 2023 at 5:00 p.m.
APPLICATIONS DUE	**NOVEMBER 30, 2023 at 1:00 p.m.**

QUESTIONS REGARDING THE ORIGINAL SOLICITATION MUST BE SUBMITTED BY NOVEMBER 15, 2023, AT 5:00 PM EASTERN TIME TO BE CONSIDERED. ALL QUESTIONS RECEIVED BY THE QUESTION DEADLINE WILL BE RESPONDED TO WITHIN VENDOR REGISTRY AND POSTED FOR ALL APPLICANTS. THE SYSTEM WILL NOT ACCEPT ANY QUESTIONS AFTER THIS DATE AND TIME.

If any questions or responses require revisions to this solicitation, such revisions will be by formal Addendum only. Applicants are cautioned not to rely on any written, electronic, or oral representations made by any County representative or other person, including the County's technical contact, that appear to change any portion of the solicitation, unless the change is ratified by a written Addendum to this solicitation issued by the Office of the Purchasing Agent.

3. NOTICE REQUIRED OF SUBSTANTIAL CHANGES

If an Applicant experiences a material change in its corporate structure after applying for prequalification and before the award of any contract for the Biosolids Upgrades Project, if applicable, the Applicant must notify the County of the change in writing within five business days. If the Applicant fails to do so, the County may rescind the Applicant's prequalification or reject the Applicant's proposal.

4. AUTHORITY TO TRANSACT BUSINESS

Any Applicant organized as a stock or nonstock corporation, limited liability company, business trust, or limited partnership or registered as a registered limited liability partnership must be authorized to transact business in the Commonwealth of Virginia as a domestic or foreign business entity if so required by Title 13.1 or Title 50 of the Code of Virginia, or as otherwise required by law. The proper and full legal name of the entity and the identification number issued to the Applicant by the Virginia State Corporation

Commission must be included on the Proposal Form. Any Applicant that is not required to be authorized to transact business in the Commonwealth must include in its proposal a statement describing why the Applicant is not required to be so authorized. The County may require an Applicant to provide documentation that 1) clearly identifies the complete name and legal form of the entity and 2) establishes that the entity is authorized by the State Corporation Commission to transact business in the Commonwealth of Virginia. Failure of an Applicant to provide such documentation will be a ground for rejection of the proposal or cancellation of any award. For further information refer to the Commonwealth of Virginia State Corporation Commission website at: www.scc.virginia.gov.

5. NOTICE OF PREQUALIFICATION DECISION

When the County has made a decision in regards to prequalifying the Applicants, the County will send a Notice of Prequalification Decision to all Applicants using the e-mail addresses provided on the Application Form.

II. SCOPE OF WORK

PROJECT DESCRIPTION

The intent of this solicitation is to pre-qualify Suppliers to supply equipment and services for a thermal hydrolysis process (THP) for the Arlington County (County) Water Pollution Control Bureau (WPCB) through a Design Build Contractor.

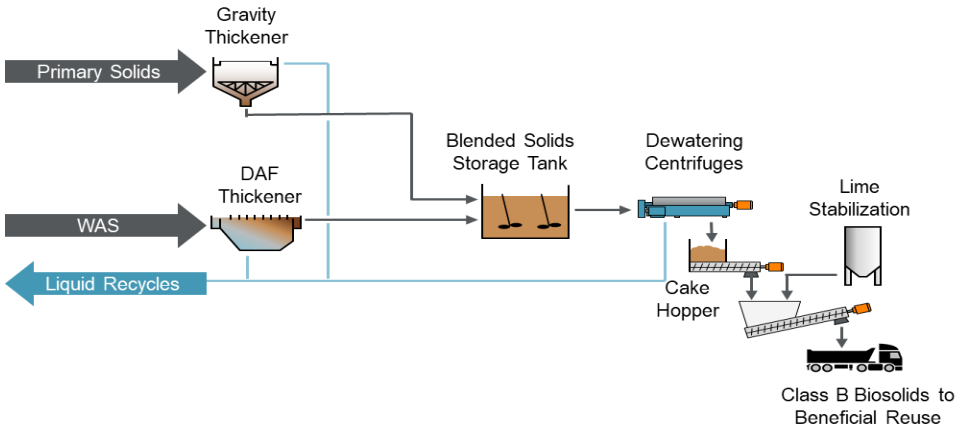
The THP will be implemented at the Arlington Water Pollution Control Plant (WPCP), located at 3402 S. Glebe Road, Arlington, VA 22202. The THP will be part of a Biosolids Upgrade that includes all necessary facilities to create a thermally hydrolyzed, Class A biosolids product as well as biogas that can be upgraded to create renewable natural gas (RNG). The Design-Build Contractor awarded under Contract No. 22-DES-RFPW-672 will negotiate an agreement, including initial equipment and services pricing, with a THP Supplier from one of the Suppliers prequalified under this solicitation.

BACKGROUND

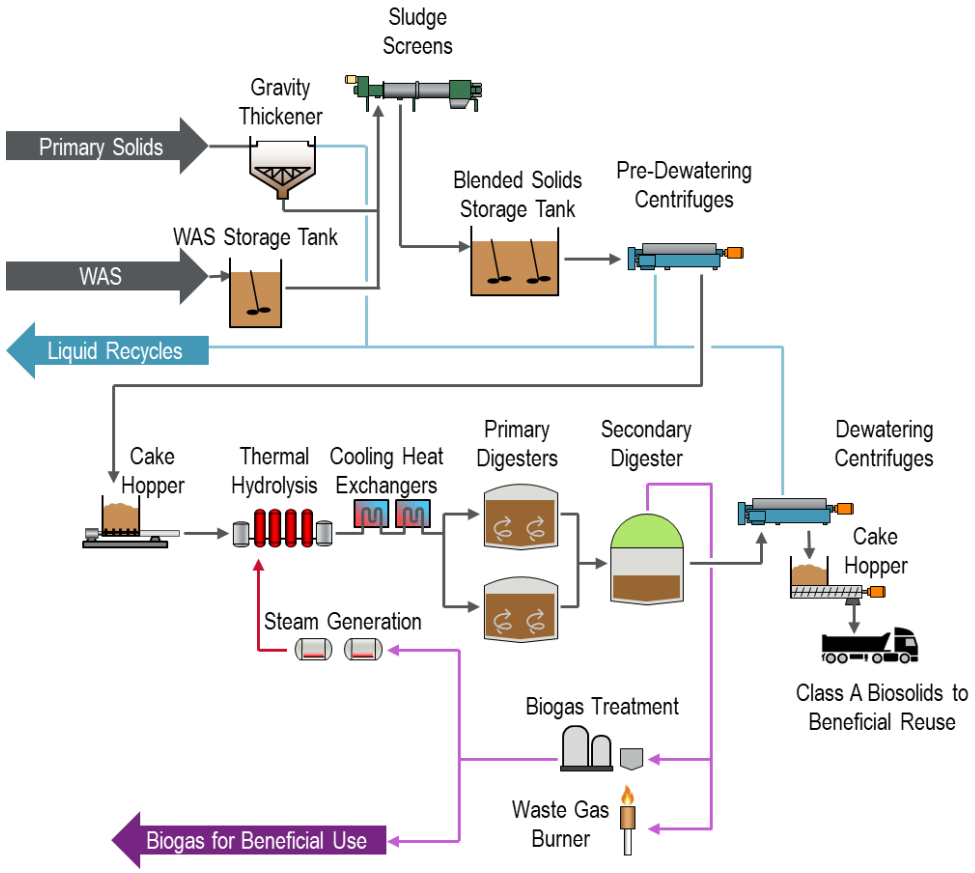
The Arlington WPCP is an advanced wastewater treatment plant with enhanced nutrient removal to meet stringent discharge permit limits. The permitted capacity of the WPCP is 40 million gallons per day (mgd) with a current average daily flow of approximately 22 mgd. The existing Arlington WPCP liquid treatment process generally includes:

- Preliminary treatment (screenings and grit removal)
- Primary settling with ferric chloride addition for phosphorus removal
- Primary effluent flow equalization
- Step-feed activated sludge process for nutrient removal
- Secondary clarification with ferric chloride addition for phosphorus removal
- Effluent denitrification filters
- Sodium hypochlorite disinfection
- Sodium bisulfite dechlorination
- Associated wet weather facilities
- Associated ancillary facilities

Solids are produced from the primary settling tanks and waste activated solids (WAS) from the activated sludge process. The existing solids handling processes include thickening, dewatering, and Class B lime stabilization as depicted in the figure below.



The new solids handling processes are to be implemented under the Comprehensive Biosolids Upgrades. THP followed by anaerobic digestion (AD) form the backbone of the new solids handling processes.



SCOPE OF SERVICES

General Requirements

The selected pre-qualified Supplier shall furnish Free on Board (FOB) destination, all services, equipment, and materials required for the supply of the THP Equipment specified for the County's Arlington WPCP located in Arlington County, Virginia. The Supplier shall provide services over the duration of each project phase, as defined Exhibit A: Specifications. The following equipment and services shall be provided:

1. Equipment: All equipment related to the THP to be provided by the Supplier, as described in Exhibit A: Specifications and Exhibit B: Drawings, including but not limited to:
    a. The THP Train, including redundant reactor pre-heating tank and depressurization tanks, THP pre-heating tank recirculation/reactor feed pumps, digester feed pumps, process gas unit and air compressors
    b. THS flow control valves and flow meters
    c. THP Feed Pumps
    d. Spare Parts Package
    e. All other necessary components for a complete and fully functional THP system as specified in the Exhibit A: Specifications and Exhibit B: Drawings.

2. Design Phase Services: Services performed during the design phase, after execution of an agreement between the Supplier and Design-Build Contractor, as specified in Exhibit A: Specifications, Section 01 11 00 – Summary of Work.
3. Construction Phase Services: Services performed during the construction phase, as specified in Exhibit A: Specifications, Section 01 11 00 – Summary of Work.
4. Maintenance Assistance Services: Services provided following THP Mechanical Completion to assist the County in planning and executing the first two scheduled equipment shutdowns, as specified in Exhibit A: Specifications, Section 01 11 00 – Summary of Work.
5. Work Not Included: Unloading of equipment at project site, mechanical installation, and portions of the electrical installation of the equipment to be furnished hereunder as coordinated with the Contractor, and other services specifically delineated as the responsibility of the Contractor.

Design

Exhibit A: Specifications and Exhibit B: Drawings reflect the current preferred configuration from the County. These documents will be updated as mutually agreed to by the Supplier, County, and the Design-Build Contractor prior to execution of an Agreement with the Design-Build Contractor. Prior to fabrication, the Supplier must notify the County and the Design-Build Contractor of any modifications, updates, or enhancements to the equipment. The County shall have the opportunity to evaluate the newer equipment offerings and retain the right to keep the initially specified equipment if it remains available.

During the design phase of the Project, Exhibit A: Specifications and Exhibit B: Drawings may be modified with the approval of the County, the Design-Build Contractor, and the Supplier.

TENTATIVE PROJECT SCHEDULE

The approximate schedule for the Design-Build work, including final procurement of the THP Equipment, is provided below:

- Design-Build Contractor Notice to Proceed: January 2024
- Selection of THP Supplier and Initiation of Design Phase Services: May 2024
- Construction Notice to Proceed: Summer 2025
- Start-up and Commissioning: 2028
- Final Completion: 2029

III. APPLICATION REQUIREMENTS

1. GENERAL

FAILURE TO SUBMIT AN APPLICATION WITH A FULLY COMPLETED APPLICATION FORM USING THE APPLICATION FORM PROVIDED IN THIS SOLICITATION MAY BE CAUSE FOR REJECTION OF THE APPLICATION. THE APPLICATION FORM MUST BE SIGNED BY A PERSON LEGALLY AUTHORIZED TO BIND THE APPLICANT.

The Application must address the Application Submittal Elements below, in the order listed, and must not exceed the stated page limitations. The application must be on single-spaced, and the type size must not be less than 10-point.

Applications and all documents related to this solicitation uploaded/submitted to Arlington County by an Applicant become the property of the County upon receipt.

2. APPLICATION FORM SUBMISSION

The submitted Application Form must be signed and fully executed. The Application Form must be submitted electronically via Vendor Registry no later than the date and time specified in this solicitation. The Vendor Registry system will not accept responses after the close date and time. The County will not accept emailed or faxed applications.

The Applicant name on the electronic application submittal shall be the same as the Contractor/Vendor name as the registration in Vendor Registry for the upload to be considered a valid response. ONLY ELECTRONIC SUBMISSION IS ALLOWED, NO APPLICATION SUBMITTED OTHER THAN A VENDOR REGISTRY ELECTRONIC UPLOAD WILL BE ACCEPTED. **Arlington County is not responsible for late submissions, missed Addendums, or questions not submitted before the end date and time.**

Timely submission is solely the responsibility of the Applicant. The Vendor Registry System will not accept applications after the publicly posted date and time. An application may be rejected if the Application Form is not signed in the designated space by a person authorized to legally bind the Applicant.

The County may reject any application that modifies or supplements the solicitation requirements.

3. APPLICATION STANDARDS

Applications submitted in response to this solicitation should be accurate and grammatically correct and should not contain spelling errors. Submitted applications must contain the following sections listed and, in the order, below:

I. APPLICATION FORM
II. APPLICANT'S PREQUALIFICATION STATEMENT
III. SURETY STATEMENT
IV. PROJECT SPECIFIC QUALIFICATIONS
V. STATEMENT REGARDING JUDGMENTS
VI. STATEMENT REGARDING COMPLIANCE
VII. STATEMENT REGARDING CONVICTIONS
VIII. STATEMENT REGARDING DEBARMENTS

4. **UNNECESSARILY ELABORATE RESPONSES**

The County may view unnecessarily elaborate brochures or other presentations, including elaborate or expensive artwork, and visual and other presentations, as an indication of the Applicant's lack of cost consciousness.

5. **EVALUATION CRITERIA**

The County will be evaluating applications for compliance with items I. through VIII. under Prequalification Application Submittal Elements below. Only applications that comply with all requirements will be deemed prequalified.

6. **PREQUALIFICATION APPLICATION SUBMITTAL ELEMENTS:**

Applicants must submit Attachments A – I of the solicitation, except Attachment C if used as a guide.

I. APPLICATION FORMS: Applicants must submit Attachment A.

II. APPLICANT'S PREQUALIFICATION STATEMENT: Applicants must complete and submit Attachment B.

III. SURETY STATEMENT:

The Applicant must have sufficient financial ability to supply the equipment and services under the contract with the Design-Build Contractor. *The Applicant must provide, on a Surety's letterhead, a signed Surety Statement that indicates that the Surety knows of no reason why the Surety could not provide a performance bond in the amount of 100% of the Supplier's Agreement with the Design-Build Contractor in connection with the Project. The letter must also state that the Surety has certificates of authority as an acceptable surety authorized to do business in the Commonwealth of Virginia, as published annually in the Federal Register, Department of Treasurer, Fiscal Service, Department Circular 570. The Surety may use Attachment C as a guide.*

IV. PROJECT SPECIFIC QUALIFICATIONS:

Unless specified otherwise, all projects listed as qualifying experience for items must have been performed by the Applicant, its affiliate, or a subsidiary company to qualify. The Applicant shall use ***Attachment D*** to document their project specific experience.

Note: *The Applicant must submit all referenced projects using form of Attachment D. The Applicant must use a separate form for each project listed and may also attach supplemental information on the projects. Use form included as Attachment E as a cover sheet for the reference projects to indicate which projects are used to qualify under specific experience requirements.*

In order for the Applicant to be prequalified to serve as the THP Supplier for this Project, the Applicant must have successfully provided THP equipment of the same size and model proposed here for use at municipal wastewater treatment plants in the United States and provide the number of operational and maintenance support staff available in the United States. Further, the Applicant must show qualifications to provide future service to meet the County needs.

Applicants are encouraged to submit projects with technical scope most similar to this Project, including experience with thermal hydrolysis processing. Only thermal hydrolysis systems that use steam for heating and pressure will be considered. Chemicals or other additives shall not be used in the hydrolysis process.

One representative project may qualify for both criteria listed below. At a minimum, the representative projects must include the following:

- A minimum of five (5) wastewater treatment plants worldwide where Supplier's thermal hydrolysis equipment has been in service as a pre-conditioning step for anaerobic digestion of municipal wastewater solids residuals. Plants referenced shall have a capacity greater than 30 dry tons per day feed to the THP system. Supplier's THP system at each referenced plant must have been in operation for more than three years.

- A minimum of two (2) wastewater treatment plants in the United States where Supplier's thermal hydrolysis equipment has been used to provide time and temperature for Class A biosolids through a batch treatment process as defined by the United States Environmental Protection Agency (EPA) as a pre-conditioning step for anaerobic digestion of municipal wastewater solids residuals. Plants referenced may be of any capacity over 5 dry tons per day fed to the THP system with a representative Class A sewage sludge utilization permit. Supplier's THP system at each referenced plant must have been in operation for more than one year.

Clients may be contacted to confirm the Applicant's compliance with the minimum experience requirements, performance, workmanship, quality, and ability to meet scheduled completion dates and budget at any time during the procurement process. All reference clients' phone numbers and e-mail addresses must be valid. Any references which include invalid phone numbers or e-mail addresses may be considered as non-responsive.

V. STATEMENT REGARDING JUDGMENTS: The Applicant or any officer, director, or owner thereof must not have had judgments entered against him within the past ten years from the date of issuance of this solicitation for the breach of contracts for governmental or nongovernmental construction, including, but not limited to, design build or construction management.

The Applicant shall include a certification to that effect, or provide a detailed explanation on a separate sheet, if necessary.

VI. STATEMENT REGARDING COMPLIANCE: The Applicant must not have been in substantial noncompliance (without good cause) with the terms and conditions of prior contracts with the County, or, if the County has not contracted with the Applicant in any prior contracts, of comparable contracts with another public body.

The Applicant shall include a certification to that effect, or provide a detailed explanation on a separate sheet, if necessary.

VII. STATEMENT REGARDING CONVICTIONS: The Applicant or any owner, officer, director, owner, project manager, procurement manager or chief financial official thereof must not have been convicted within the past ten years from the date of issuance of this solicitation of a crime related to governmental or nongovernmental construction or contracting, including, but not limited to, a violation of Article 9 of the Arlington County Purchasing Resolution, the Virginia Governmental Frauds Act (§ 18.2-498 et seq.),Chapter 4.2 (§ 59.1-68.6 et seq.) of Title 59.1, or any substantially similar law of the United States or another state. Additionally, within the past three years, the Applicant must not have been found in violation of any law applicable to its contracting business, including, but not limited, to licensing laws, tax laws, wage and hour laws, prevailing wage laws, environmental laws or others, where the result of such violation was the payment of a fine, back pay damages or any other type of penalty in the amount of $5,000) or more.

The Applicant shall include a certification to that effect, or provide a detailed explanation on a separate sheet, if necessary.

VIII. STATEMENT REGARDING DEBARMENT: The Applicant or any officer, director or owner thereof may not currently be debarred, enjoined, or suspended pursuant to an established bidding or contracting procedure by any public body, agency of another state or agency of the federal government.

The Applicant shall include a certification to that effect, or provide a detailed explanation on a separate sheet, if necessary.

REQUEST FOR QUALIFICATIONS No. 24-DES-RFQ-399
ARLINGTON COUNTY, VIRGINIA

ATTACHMENT A – APPLICATION FORM

APPLICATIONS WILL BE RECEIVED ELECTRONICALLY VIA VENDOR REGISTRY NOT LATER THAN 1:00 P.M., NOVEMBER 30, 2023.

PREQUALIFICATION OF FIRMS FOR THERMAL HYDROLYSIS PROCESS (THP) EQUIPMENT AND SERVICES IN ARLINGTON COUNTY, VIRGINIA.

THE FULL LEGAL NAME OF THE ENTITY SUBMITTING THIS APPLICATION MUST BE WRITTEN IN THE SPACE BELOW. THIS APPLICATION FORM AND ALL OTHER DOCUMENTS THAT REQUIRE A SIGNATURE MUST BE FULLY AND ACCURATELY COMPLETED AND SIGNED BY A PERSON WHO IS AUTHORIZED TO BIND THE APPLICANT, OR THE APPLICATION MAY BE REJECTED.

SUBMITTED BY:
(legal name of entity) _____

AUTHORIZED SIGNATURE: _____

PRINT NAME AND TITLE: _____

ADDRESS: _____

CITY/STATE/ZIP: _____

TELEPHONE NO.: _____ **E-MAIL ADDRESS:** _____

THIS ENTITY IS INCORPORATED IN: _____

THIS ENTITY IS A:
(check the applicable option)

CORPORATION	❑	LIMITED PARTNERSHIP	❑
GENERAL PARTNERSHIP	❑	UNINCORPORATED ASSOCIATION	❑
LIMITED LIABILITY COMPANY	❑	SOLE PROPRIETORSHIP	❑

IS APPLICANT AUTHORIZED TO TRANSACT BUSINESS IN THE COMMONWEALTH OF VIRGINIA? YES ❑ NO ❑

VIRGINIA STATE CORPORATION COMMISSION (SCC) IDENTIFICATION NUMBER: _____

Any Applicant that is exempt from the SCC authorization requirement must include a statement with its application explaining why it is exempt.

THE UNDERSIGNED UNDERSTANDS AND ACKNOWLEDGES THE FOLLOWING:

THE OFFICIAL COPY OF THE SOLICITATION DOCUMENTS, WHICH INCLUDES ANY ADDENDA, IS THE ELECTRONIC COPY THAT IS AVAILABLE FROM THE VENDOR REGISTRY WEBSITE.

VENDORS ARE REQUIRED TO REGISTER ON VENDOR REGISTRY IN ORDER TO SUBMIT A RESPONSE TO THIS REQUEST FOR QUALIFICATIONS. **NO RESPONSES WILL BE ACCEPTED AFTER THE APPLICATION DUE DATE AND TIME**.

POTENTIAL APPLICANTS ARE RESPONSIBLE FOR DETERMINING THE ACCURACY AND COMPLETENESS OF ALL SOLICITATION DOCUMENTS THEY RECEIVE FROM ANY SOURCE, INCLUDING THE COUNTY.

1. APPLICANT MUST SUBMIT: ONE ELECTRONIC COMPLETE SIGNED APPLICATION THAT INCLUDES AS ITS FIRST PAGE THIS APPLICATION FORM.

2. INDICATE THE NAME AND CONTACT INFORMATION OF THE PERSON WHO CAN RESPOND AUTHORITATIVELY TO QUESTIONS REGARDING THIS APPLICATION.

NAME (PRINTED): _____ TITLE: _____

E-MAIL ADDRESS: _____ TEL. NO.: _____

TRADE SECRETS OR PROPRIETARY INFORMATION:
Trade secrets or proprietary information submitted by an Applicant in connection with a procurement transaction will not be subject to public disclosure under the Virginia Freedom of Information Act. Pursuant to Section 4-111 of the Arlington County Purchasing Resolution, however, an Applicant seeking to protect submitted data or materials from disclosure must, before or upon submission of the data or materials, identify the data or materials to be protected and state the reasons why protection is necessary.

Please mark one:

❑ No, the application that I have submitted does not contain any trade secrets and/or proprietary information.

❑ Yes, the application that I have submitted does contain trade secrets and/or proprietary information.

If Yes, you must clearly identify below the exact data or materials to be protected and list all applicable page numbers of the application that contain such data or materials:

_____

_____

_____

State the specific reason(s) why protection is necessary:

_____

_____

_____

_____

If you fail above to identify the data or materials to be protected or to state the reason(s) why protection is necessary, you will not have invoked the protection of Section 4-111 of the Purchasing Resolution. Accordingly, upon the award of a contract, the application will be open for public inspection consistent with applicable law.

CERTIFICATION OF NON-COLLUSION: The undersigned certifies that this application is not the result of or affected by (1) any act of collusion with another person engaged in the same line of business or commerce (as defined in Virginia Code §§ 59.1-68.6 *et seq*.) or (2) any act of fraud punishable under the Virginia Governmental Frauds Act (Virginia Code §§ 18.2-498.1 *et seq*.).

APPLICANT NAME: _____

REQUEST FOR QUALIFICATIONS No. 24-DES-RFQ-399
ARLINGTON COUNTY, VIRGINIA

SUBMIT COMPLETED APPLICANT'S PREQUALIFICATION STATEMENT ELECTRONICALLY VIA VENDOR REGISTRY

ATTACHMENT B – APPLICANT'S PREQUALIFICATION STATEMENT

Applicant Name: _____

Applicant Address: _____

_____

Person who can respond authoritatively to any questions about this statement:

Name: _____ Title: _____

Phone number: _____ E-mail address: _____

1. Provide a brief company history, year your organization was established and how many years has your organization been in business providing the type of services for which you are requesting to be pre-qualified? _____

2. How many years has your organization been in business under its present name? _____

3. Has your firm been involved in any reorganization, acquisition, or merger within the past three (3) years? If so, please provide details and under what other names has your organization operated?

   _____

   _____

4. If your organization is a corporation, indicate:

   Date of incorporation: _____

   State of incorporation: _____

   President's name: _____

   Vice President's name(s): _____

   _____

   Secretary's name: _____

Treasurer's name: _____

5. If your organization is a partnership, indicate:

   Date of organization: _____

   Type of partnership (if applicable): _____

   Name(s) of general partners: _____

   _____

   _____

6. If your organization is a sole proprietorship, indicate:

   Date of organization: _____

   Name of owner: _____

7. If the form of your organization is other than those listed above, describe it and name the principals:

   _____

   _____

   _____

8. Is the Applicant related to another firm as a parent, subsidiary or affiliate?

   ❑ Yes
   ❑ No

   If yes, give names and addresses of all affiliated parent and/or subsidiary companies. Indicate which companies are subsidiaries.

   _____

   _____

   _____

9. **Submittal Elements**: Each of the submittal elements should be provided in the order listed below:
   A. ***Qualifications and Experience of Firm (Maximum 2 pages + appendices)***
   Describe your experience in development and supply of thermal hydrolysis equipment for municipal biosolids applications. Provide the total number of worldwide and United States installations currently in operation of the model being proposed for thermal hydrolysis of

municipal wastewater residuals at the WPCP. As an appendix, provide a complete list of all installations of the model being proposed, including date of installation, date of commissioning, current operational status, and capacity (in dry tons per day). Indicate the number of years the model being proposed has been offered by the Supplier.

Provide the number of operational and maintenance support staff available in the United States, including location. Describe approach for providing spare and replacement parts for pumps and critical components, including the location where parts are stored, typical quantity stocked and turnaround time for shipment to Arlington WPCP.

B. ***Thermal Hydrolysis Process and Controls Details (Maximum 2 pages)***

Provide a description of the proposed thermal hydrolysis process and controls. Describe the evolution of the process and unique features of the proposed system. Describe how sludge is fed and distributed to the process reactors and approach to depressurization and digester feed. Describe controls for steam, including balancing of the steam loads. Describe approach to capturing and treating process gases and preventing odor release. Describe upcoming innovations that may be implemented in future systems.

C. ***Performance Guarantees (Maximum 1 page)***

Provide information to aid the County and Contractor in establishing appropriate performance guarantees. Describe how the Offeror will meet these requirements.

- Class A biosolids:
    - Meet all requirements for producing a Class A, pathogen free product as defined by the United States Environmental Protection Agency as defined in 40 CFR Part 503.
        - Confirm agreement for reactor hold time of 20 minutes at 6 bar pressure.
        - Confirm agreement to a fecal coliform limit of 1000 MPN/gram dry solids or salmonella less than 3 MPN per 4 grams dry solids, tested as described in Attachment A: Specifications, Section 46 34 50.
- Steam Usage
    - Provide guarantees for steam usage, in tons of steam per dry ton of solids.
    - Confirm instantaneous demand is less than 4.4 tons of steam per hour.
- Thermally Hydrolyzed Solids (THS) Flow Control
    - Confirm agreement with demonstrated accuracy of THS flow control rate of +/- 5% between the two digesters being fed (comparing one digester flow rate to the other).

REQUEST FOR QUALIFICATIONS No. 24-DES-RFQ-399
ARLINGTON COUNTY, VIRGINIA

SUBMIT COMPLETED SAMPLE SURETY STATEMENT ELECTRONICALLY VIA VENDOR REGISTRY

ATTACHMENT C – SAMPLE SURETY STATEMENT

APPLICANT NAME: _____

(Name of Applicant) has been a client of (Name of Surety Company) for (_____) years. During that time, we have supported this firm in its pursuit of projects in the $_____ range and in total programs in excess of $_____.

We are prepared to provide a performance bond on the project for which Arlington County seeks prequalification through RFQ No. 24-DES-RFQ-399 if (name of Applicant) accepts an award of the contract and applies to us on or about the time that the work is to begin and if we are satisfied with the prevailing underwriting conditions, including but not limited to, contract terms and job specifications, bond forms and financing.

We possess certificates of authority as an acceptable surety authorized to do business in the Commonwealth of Virginia as published annually in the Federal Register, Department of Treasurer, Fiscal Service, Department Circular 570.

Sincerely,

_____
Attorney-In-Fact

_____
Name of Surety

_____
Signature

_____
Typed Signature

_____
Date

_____
Address

_____
Telephone

Companies who wish to implement digital signatures may do so, along with a SURETY BOND SEAL ADDENDUM which contains an electronic corporate seal [Surety Company] has authorized its Attorney-in-Fact to affix [Surety Company's] corporate seal to any bond executed on behalf of [Surety Company] by any such Attorney-in-Fact by attaching this Addendum to said bond.

To the extent this Addendum is attached to a bond that is executed on behalf of [Surety Company] by its Attorney-in-Facts, [Surety Company\ hereby agrees that the seal below shall be deemed affixed to said bond to the same extent as if its raised corporate seal was physically affixed to the face of the bond."

REQUEST FOR QUALIFICATIONS No. 24-DES-RFQ-399
ARLINGTON COUNTY, VIRGINIA

SUBMIT COMPLETED PROJECT SPECIFIC EXPERIENCE STATEMENT ELECTRONICALLY VIA VENDOR REGISTRY

ATTACHMENT D – PROJECT SPECIFIC QUALIFICATIONS

Provide all information required below. The County will consider for prequalification only information that is included in the application. One representative project may qualify for both criteria listed below.

Provide references for a minimum of five (5) wastewater treatment plants worldwide where the Supplier's thermal hydrolysis equipment has been in service as a pre-conditioning step for anaerobic digestion of municipal wastewater solids residuals. Plants referenced shall have a capacity greater than 30 dry tons per day fed to the THP system. Supplier's THP system at each referenced plant must have been in operation for more than three years.

Provide references for a minimum of two (2) wastewater treatment plants in the United States where the Supplier's thermal hydrolysis equipment has been used to provide time and temperature for Class A biosolids through a batch treatment process as defined by the United States Environmental Protection Agency as a pre-conditioning step for anaerobic digestion of municipal wastewater solids residuals. Plants referenced may be of any capacity over 5 dry tons per day fed to the THP system with a representative Class A sewage sludge utilization permit. Supplier's THP system at each referenced plant must have been in operation for more than one year.

Applicant Name: _____

1. **Name of Project**: _____

   Contract No. or Project No. (if applicable) _____

   Project Location: _____

2. **Project Owner**: _____

   Contact Person: _____ Telephone: (_____) _____

   Email address: _____

3. **Contract Dates:** Attach explanation if project was not on schedule.

   Started: _____

   Contractual Completion Date: _____

   Actual Completion Date: _____

4. **Original Contract Value:** $_____

Final Contract Value: $_____

Value of Change Orders to Date: $_____

Outstanding Claims to Date: $_____

5. **Project Manager and Project Superintendent:** List all Project Managers and Project Superintendents who had substantive work or responsibilities on this project:

Name:_____ Responsibility _____

Name:_____ Responsibility _____

Name:_____ Responsibility _____

6. **Project description and Applicant's scope of work within the project:** Describe the dry tons per day fed to the THP system for each represented project.

_____

_____

_____

_____

_____

7. **If Applicant's work for this project was performed under the management of a General Contractor or Construction Management firm, provide the following**:

Firm Name:_____

Contact Person: _____ Telephone: (_____) _____

Email address:_____

8. **If Applicant used sub-contractor(s) in the performance of this project provide the following**:

Firm Name:_____ Responsibility _____

Firm Name:_____ Responsibility _____

Firm Name:_____ Responsibility _____

Firm Name:_____ Responsibility _____

REQUEST FOR QUALIFICATIONS No. 24-DES-RFQ-399
ARLINGTON COUNTY, VIRGINIA

SUBMIT COMPLETED QUALIFYING EXPERIENCE CHART ELECTRONICALLY VIA VENDOR REGISTRY

ATTACHMENT E – QUALIFYING EXPERIENCE CHART

NAME OF PROJECT	QUALIFYING EXPERIENCE	
	minimum of five (5) wastewater treatment plants worldwide where the Supplier's thermal hydrolysis equipment has been in service as a pre-conditioning step for anaerobic digestion of municipal wastewater solids residuals	minimum of two (2) wastewater treatment plants in the United States where the Supplier's thermal hydrolysis equipment has been used to provide time and temperature for Class A biosolids through a batch treatment process as defined by the United States Environmental Protection Agency as a pre-conditioning step for anaerobic digestion of municipal wastewater solids residuals
	☐	☐
	☐	☐
	☐	☐
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	☐	☐
	☐	☐
	☐	☐
	☐	☐

REQUEST FOR QUALIFICATIONS No. 24-DES-RFQ-399
ARLINGTON COUNTY, VIRGINIA

ATTACHMENT F – PRIOR JUDGMENTS CERTIFICATION

Has the Applicant, or any officer, director or owner thereof, had any judgments entered against it within the past ten years for the breach of any contract for governmental or nongovernmental construction, including, but not limited to, design-build and construction management contracts?

Yes ___ No ___

If yes, then attach a separate sheet(s) of paper that identifies and explains all such judgments.

The Applicant understands that its failure to complete and sign this Certification shall render its Submittal non-responsive and the Applicant unqualified.

Signed: _____ **Date:** _____

Name of Applicant: _____

REQUEST FOR QUALIFICATIONS No. 24-DES-RFQ-399
ARLINGTON COUNTY, VIRGINIA

ATTACHMENT G –

COMPLIANCE WITH PRIOR CONTRACTS WITH PUBLIC BODIES CERTIFICATION

Has the Applicant, except for good cause, substantially complied with the terms and conditions of all prior contracts with Arlington County? If the Applicant has not previously contracted with Arlington County Government contracts, then has the Applicant, except for good cause, substantially complied with the terms and conditions of all prior contracts with other "public bodies" as that term is defined in the Virginia Public Procurement Act?

Yes ___ No ___

If no, then attach a separate sheet(s) of paper that identifies and explains all such instances of substantial non-compliance.

The Applicant understands that its failure to complete and sign this Certification shall render its Submittal non-responsive and the Applicant unqualified.

Signed: _____ **Date:** _____

Name of Applicant: _____

REQUEST FOR QUALIFICATIONS No. 24-DES-RFQ-399
ARLINGTON COUNTY, VIRGINIA

ATTACHMENT H – PRIOR CONVICTIONS CERTIFICATION

Has the Applicant, or any officer, director, owner, project manager, procurement manager or chief financial officer thereof, been convicted within the past ten years of a crime related to governmental or nongovernmental construction or contracting, including, but not limited to, a violation of (i) Article 6 of the Virginia Public Procurement Act, (ii) the Virginia Governmental Frauds Act, (iii) Chapter 4.2 of title 59.1 of the Code of Virginia, or (iv) any substantially similar law of the United States or another state?

Yes ___ No ___

If yes, then attach a separate sheet(s) of paper that identifies and explains all such convictions.

Within the past three years, has the Applicant been found in violation of any law applicable to its contracting business, including, but not limited, to licensing laws, tax laws, wage and hour laws, prevailing wage laws, environmental laws or others, where the result of such violation was the payment of a fine, back pay damages or any other type of penalty in the amount of $5,000) or more.

Yes ___ No ___

If yes, then attach a separate sheet(s) of paper that identifies and explains all such violations.

Signed: _____ **Date:** _____

Name of Applicant: _____

REQUEST FOR QUALIFICATIONS No. 24-DES-RFQ-399
ARLINGTON COUNTY, VIRGINIA

ATTACHMENT I – DEBARMENT CERTIFICATION

Is the Applicant, or any officer, director or owner thereof, currently debarred, enjoined, or suspended pursuant to an established bidding or contracting procedure with any "public body" as that term is defined in the Virginia Public Procurement Act, agency of another state, or agency of the federal government?

Yes ___ No ___

If yes, then attach a separate sheet(s) of paper that identifies and explains all such debarments.

The Applicant understands that its failure to complete and sign this Certification shall render its Submittal non-responsive and the Applicant unqualified.

Signed: _____ **Date:** _____

Name of Applicant: _____

Arlington County Water Pollution Control Bureau

Arlington Re-Gen Biosolids Upgrades

Phase 10B – THP Equipment Pre-qualification

Volume 1

Specifications

September 2023

HDR Project No. 10263882

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 GENERAL

A. The Supplier shall furnish freight on board (FOB) jobsite, all services, equipment and materials required for supply of the Thermal Hydrolysis Process (THP) Equipment specified for the Owner's Arlington County Water Pollution Control Plant (WPCP) Re-Gen Project located in Arlington County, Virginia.

1.2 SCOPE OF WORK

A. The Work includes furnishing equipment, submittals, start-up, training, field testing services, and acceptance testing for a complete THP system, as defined in these specifications.

B. Supplier shall provide design consultation services over the duration of each project phase, as defined herein. The Arlington Water Pollution Control Plant Phase 10C/D – Comprehensive Biosolids Upgrades Project is currently in the Preliminary Design and Proposal stage. Upon award of the project's Contract to the Contractor, the Design Phase will begin. The Contractor will select and contract with a pre-qualified THP supplier to provide the equipment and services. In order to complete design and ensure proper coordination between the project's facilities, Supplier will provide services as follows:
   1. Design Phase Services:
      a. Coordinate three (3) separate engineering consultation site visits by Supplier's Project Manager and lead Contractor's Engineer to the WPCP in Arlington, Virginia for a period of 2 working days each (travel time excluded). The purpose of each workshop will be to provide engineering support input, especially in mechanical coordination and instrumentation and control, to the design team during final design. All decisions of whether to accept or reject Supplier recommendations shall reside entirely with the Owner and Contractor.
      b. In addition to each site visit, the Supplier shall provide a minimum of 80 hours of remote engineering support (telephone, conference call, virtual meeting and email from Supplier's offices, both in the United States and abroad when required) to the Owner and Contractor up through issuance of final Design Documents in 2025. Within this 80 hours of support, Supplier shall provide P&ID development assistance, detailed equipment layout drawings, electrical schematic assistance, outside of those already included in required submittals, and other support as needed.
      c. Supplier shall provide Design Phase submittals to Contractor, Specification Section 01 33 00 and Specification Section 46 34 50.
   2. Construction Phase Services
      a. Supplier shall provide Construction Phase submittals to Contractor, Specification Section 01 33 00 and Specification Section 46 34 50.
      b. Supplier shall furnish operation, maintenance and technical manuals (Owner's Manuals) pertaining to the equipment supplied in accordance with Specification Section 01 33 00 and Specification Section 46 34 50.
      c. Supplier shall fabricate equipment and provide delivery, storage and handling, in accordance with Contractor's schedule requirements, as set forth in Specification Section 01 65 00 and Specification Section 46 34 50.
      d. The Supplier shall be responsible for:
         1) Complete assemblies in accordance with the intent of these Documents.

2) Coordinating the details of equipment which affect the Work covered under these Documents.
3) Furnishing all incidental items not actually shown or specified, but which are required by standard practice to provide complete and properly functioning assemblies.

e. Supplier shall provide technical assistance for the integration of the THP PLC with the PCS. The Owner will perform the integration activities, with the technical assistance of the Supplier. Provide 80 hours of technical assistance on site, over at least four (4) separate trips to the site.

f. Supplier shall provide Factory Testing, Personnel Training, and Equipment Installation and Commissioning Services per Specification Section 01 75 00 and Specification Section 46 34 50. The Training Schedule included in Specification 01 75 00 is a guide for the total number of hours to be provided. Owner reserves the right to modify training topics at no additional compensation to Supplier.

g. Supplier shall provide Factory Representative Services and Equipment Field Testing, in accordance with Paragraph 1.3 and Paragraph 1.4 of this Specification Section.

C. Work Not Included: Unloading of equipment at project site, mechanical installation, and portions of the electrical installation of the equipment to be furnished hereunder as coordinated with the Contractor, and other services specifically delineated as the responsibility of the Contractor.

1.3 FACTORY REPRESENTATIVE

A. The Supplier shall provide the services of a qualified representative as specified in Specification Section 46 34 50 during the Construction Phase. Supplier shall submit qualifications of representative for acceptance by Owner, and Owner reserves the right to request alternative representation at no cost to Owner. Such services shall include installation coordination, startup, operator training assistance and performance testing. Services of the representative required because of deficiencies in materials and workmanship shall be borne by the Supplier.

1.4 EQUIPMENT FIELD TESTING

A. During the Construction Phase and following installation, the entire THP system shall be field tested in accordance with Specification Section 46 34 50. The Supplier's representative shall inspect the equipment installation, perform final adjustments, and confirm the system readiness for startup. All component parts of the system shall function as specified. If any component part of the system shows evidence of unsatisfactory performance during the testing, then the Supplier shall make adjustments or repairs and the test will be repeated.

1.5 MAINTENANCE ASSISTANCE SERVICES

A. Supplier shall provide a qualified representative to coordinate and lead the shutdown, inspection, and maintenance procedures as necessitated for high pressure vessels, and as described below.

B. Within the first three years from THP Mechanical Completion, Supplier assist with planning and execution of the first two scheduled equipment shutdowns as follows:

1. For the first scheduled equipment shutdown, the Supplier shall coordinate and execute all work related to the shutdown either with the Supplier's own workforce or with a subconsultant performing required activities including, but not limited to the following:
   a. Remove the equipment from service and perform all cleaning activities to ready the equipment for inspection.
   b. Arrange for, facilitate, and/or perform all required inspections, corrective maintenance, and preventative maintenance activities.
   c. Perform all required equipment checkouts following the shutdown and certify that the equipment is ready to return to service.

d. Return the equipment to service, initiate THP operations and assist the Owner with resuming THS feed to the digesters until the system is operating to the Owner's satisfaction at the pre-shutdown solids throughput rate.
e. Provide a detailed invoice to the Owner itemizing all costs for each subcontractor involved.

2. For the second scheduled equipment shutdown, the Supplier shall coordinate with the Owner to provide up to two days of planning and scheduling assistance and up to two weeks on-site assistance to the Owner. With the Supplier's representative's assistance, the Owner will execute a complete shutdown, inspection, and maintenance of the THP Train.

1.6 BEGINNING AND COMPLETION OF WORK

A. Schedule for completion of the work shall be as agreed to with the Contractor.

B. The Supplier shall coordinate shop drawing and submittal review scheduling independently with the Contractor for all submittals not otherwise scheduled for submittal in Specification Sections 01 33 00 and 46 34 50.

PART 2 - PRODUCTS - (NOT USED IN THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT USED IN THIS SPECIFICATION SECTION)

END OF SECTION

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General requirements and procedures related to preparation and transmittal of Submittals to include Schedules, Supplier's Drawings, Samples, Manuals, Methods of Construction, and Record Drawings to Owner demonstrating performance of Work.
      a. Other requirements for submittals are specified under applicable sections of the Specifications.

1.2 DEFINITIONS

A. Shop Drawings:
   1. Product data and samples are Shop Drawing information.

1.3 SUBMITTAL REQUIREMENTS

A. General.
   1. Submit each under separate cover or transmittal.
   2. Furnish neat, legible, and sufficiently explicit detail to enable proper review for Contract compliance.
   3. Show complete and detailed fabrication; assembly and installation details; wiring and control diagrams; catalog data; pamphlets; descriptive literature; and performance and test data.
   4. Include calculations or other information sufficient to show comprehensive description of structure, machine, or system provided and its intended manner of use.
      a. With each submission, furnish Owner's specific written notation and justification of each variation in Supplier's Submittals from requirements of Contract Documents.
      b. Fabrication, purchase or delivery of materials to the site, and installation of materials or Work performed before approval, or not conforming to approved submittals, shall be at Supplier's risk.
   5. Owner's review and approval of submittals shall not relieve Supplier from responsibility for fulfillment of the Work, unless Owner has received specific written notice of each variation and has given specific written approval.
   6. Supplier assumes all risks of error and omission.
   7. Work, Materials, Fabrication, and Installation: Following approved submittals.

B. Process and Requirements.
   1. Coordinate and schedule submittals with construction schedule and Owner and Contractor.
   2. With the first submittal, but not later than 30 days after Owner's Notice to Proceed with the Contractor, submit a complete submittal schedule, listing as near as practicable and by specification section number, submittals required and date submittal will be forwarded. Schedule shall indicate the submittals to be submitted within 70 calendar days, in accordance with the requirements of Specification Section 46 34 50.
      a. Arrange submittals schedule so that related equipment items are submitted concurrently.
      b. Owner and/or Contractor may require changes to submittal schedule to permit concurrent review of related equipment.

3. To each submittal affix the following signed Certification Statement.
    a. "Certification Statement: By this submittal, we hereby represent that we have determined and verified all materials, dimensions, catalog numbers and pertinent data and we have checked and coordinated each item with other applicable approved drawings and all Contract requirements."
4. Identification.
    a. Submit identification data, as applicable, contained thereon or permanently adhered thereto:
        1) Owner's Name.
        2) Project designation
        3) Contract name and location.
        4) Submittal Numbers:
            a) Number by specification section followed by sequential number. Number format example is 01 61 03-01.
            b) Resubmittals shall bear original submittal number and be sequentially lettered (Example 01 61 03-01A).
        5) Product identification.
        6) Drawing title, drawing number, revision number, and date of drawing and revision.
        7) Applicable Contract Drawing Numbers and Specification Section and Paragraph Numbers.
        8) Supplier's name, address and phone number.
        9) Supplier's Certification Statement.
    b. Identify on exterior, catalog product data or brochures submitted in packages of multiple items. Include page and catalog item numbers for items submitted.
        1) Highlight catalog, product data, or brochures containing various products, sizes, and materials to show particular item submitted.
        2) Mark items not applicable to Contract "not applicable" or cross out.
5. Stamp Space: Blank space of approximately 2-1/2 IN high by 4 IN wide adjacent to the identification data to receive Owner's status stamp.
6. Number of Copies: See requirements in Submittals specified herein.
7. Approval Process.
    a. Follow submittal schedule provided to Owner. Owner will return submittal within 30 days.
    b. Submittals will be returned, marked with one of following classifications:
        1) APPROVED: Requires no corrections, no marks.
        2) APPROVED AS NOTED: Requires minor corrections. Items may be fabricated as marked without further resubmission. Resubmit 2 corrected copies to the Owner for record.
        3) APPROVED AS NOTED - RESUBMIT: corrections. Items not marked may be fabricated. Resubmit entire submittal following original submission with corrections noted. Allow 30 days for checking and Owner's appropriate action.
        4) REVISE AND RESUBMIT – Requires corrections. No items may be fabricated. Resubmit entire submittal following original submission with corrections noted.
        5) REJECTED: Requires major corrections or is otherwise not following Contract Documents. No items shall be fabricated. Resubmit entire submittal following original submission with corrections noted. Allow 30 days for checking and Owner's appropriate action.
        6) INFORMATION ONLY: Items specified by Contract Documents.
    c. The Supplier shall be allowed up to three submissions (initial plus two resubmittals) of the same submittals for review. The Supplier shall bear all costs for reviews beyond three submissions.

C. Electronic Submittals: PDF Format, as approved by Owner.
1. PDF files shall be bookmarked and fully searchable.

1.4 SUBMITTALS

A. Shop Drawings.
   1. For original submittal and each subsequent re-submittal required, submit both electronic (via E-Builder) and 6 hard copies. Owner will respond to submittal with approval status electronically via E-Builder; no hard copies will be returned.
   2. Show types, sizes, accessories, and layouts, including plans, elevations, and sectional views; component, assembly, and installation details; and all other information required to illustrate how applicable portions of Contract requirements will be fabricated and/or installed.
   3. In case of fixed mechanical and electrical equipment, submit layout drawings drawn to scale, to show required clearances for operation, maintenance, and replacement of parts. Include manufacturer's certified performance curves, catalog cuts, pamphlets, descriptive literature, installation, and application recommendations, as required. Submit together shop drawings for closely related items such as a pump and its motor. Additional shop drawings and information required for electrical and mechanical equipment are listed in appropriate specification sections.

B. Catalog Data.
   1. For original submittal and each subsequent re-submittal required, submit both electronic (via E-Builder) and 6 hard copies of catalog data. Owner will respond to submittal with approval status electronically via E-Builder; no hard copies will be returned.
   2. Manufacturer's Catalog, Product, and Equipment Data: Certified and include material type, performance characteristics, voltage, phase, capacity, and similar data.
      a. Furnish wiring diagrams when applicable.
      b. Indicate catalog, model, and serial numbers representing specified equipment.
      c. Submit complete component information to verify specified required items.

C. Working Drawings.
   1. For original submittal and each subsequent re-submittal required, submit both electronic (via E-Builder) and 6 hard copies of working drawings. Owner will respond to submittal with approval status electronically via E-Builder; no hard copies will be returned.
   2. Submit working drawings as required for changes, substitutions, Supplier design items, and Supplier designed methods of construction. Requirements for working drawings are listed in appropriate specification sections or in Special Provisions.
   3. Include with drawings calculations or other information to completely explain structure, machine, or system described and its intended use. Review or approval of drawings by Owner shall not relieve Supplier from responsibility for fulfillment of terms of Contract. Supplier assumes risks of error, and Owner shall have no responsibility.
   4. Submit working drawings and calculations sealed, dated, and signed by Professional Engineer registered in the Commonwealth of Virginia and experienced in the work or discipline involved.

D. Manufacturer's Installation Recommendations.
   1. For original submittal and each subsequent re-submittal required, submit both electronic (via E-Builder) and 6 hard copies of manufacturer’s installation recommendations. Owner will respond to submittal with approval status electronically via E-Builder; no hard copies will be returned.
   2. Furnish written detail for step by step preparation and installation of the materials and products, including recommended tolerances and space for maintenance and operation.
   3. Approval Process.
      a. Allow 30 days for Owner’s checking and appropriate action. Certain samples may be tested for specified requirements by the Owner before approval. Failure of sample to pass tests will be sufficient cause for refusal to consider further samples of same brand and make of that material.
      b. Rejected samples will be returned upon request, and resubmittals required shall consist of 3 new samples and an additional 30 days for review. Only 1 test of each sample

proposed for use will be made at expense of the Owner. When originally submitted sample fails, retesting of additional samples will be made by the Owner at expense of Supplier. Upon approval, 1 sample so noted will be returned, and remainder will be retained by Owner until completion of Work.

c. Samples of various material or equipment delivered to site or during placement may be taken by Owner for testing. Samples failing to meet Contract requirements will automatically void previous approvals, and resubmittal of samples will be required.

E. Record Drawings (As-builts).
   1. Prepare and maintain record drawings for work performed.
   2. Maintain one record copy of Contract Documents at site in good order and annotated to show revisions made during construction. Upload to E-Builder after Supplier's system is installed. Make record drawings available to Owner and Contractor's Engineer at all times during life of Contract.
      a. Drawings: Made part of record drawings and to include:
         1) Contract Drawings: Annotate or redraft, as required, to show revisions, substitutions, variations, omissions, and discrepancies made or discovered during construction concerning location of utilities, piping, ductbanks, conduits, pumps, valves, and other equipment. Make revisions and show on all drawing views with actual dimensions established to permanent points.
      b. Before preliminary inspection, furnish reproducible of record drawings. At completion of Contract and before final payment is made, furnish Owner 1 set of reproducibles of finally approved record drawings reflecting revisions herein described. Furnish Owner record drawing data on disk or CD, in format compatible with the County's software.

F. Operation and Maintenance Manuals.
   1. Furnish Operation and Maintenance Manuals for various types of equipment and systems, as required by Contract Documents.
   2. Unless otherwise indicated, furnish separate manual for each piece of equipment and system. If manual contains other items or equipment, indicate where specified items are located in manual. Include in manual complete information necessary to operate, maintain, and repair specific equipment and system furnished under this Contract, and include the following specific requirements:
      a. Contents.
         1) Table of Contents and Index.
         2) Brief description of equipment/system and principal components.
         3) Starting and stopping procedures, both normal and emergency.
         4) Installation, maintenance, and overhaul instructions including detailed assembly drawings with parts list and numbers, and recommended spare parts list with recommended quantity, manufacturer's price, supplier's address, and telephone number.
         5) Recommended schedule for servicing, including technical data sheets that indicate weights and types of oil, grease, or other lubricants recommended for use and their application procedures.
         6) One copy of each component wiring diagram and system wiring diagram showing wire size and identification.
         7) One approved copy of each submittal with changes made during construction properly noted, including test certificates, characteristic curves, factory and field test results.
         8) For electrical systems, include dimensioned installation drawings, single line diagrams, control diagrams, wiring and connection diagrams, list of material for contactors, relays and controls, outline drawings showing relays, meters, controls and indication equipment mounted on equipment or inside cubicles, control and protective schematics, and recommended relay settings.

9) One (1) electronic copy of the manual in PDF format submitted on CD with each final hard copy of the manual.

b. Material:
   1) Covers: Oil, moisture, and wear resistant 9 IN by 11 1/2 IN size.
   2) Pages: 24 pound paper or heavier 8 1/2 IN by 11 IN size with 3 punched holes reinforced with plastic, cloth, or metal.
   3) Fasteners: 3-hole binder.
   4) Diagrams and Illustrations.
   5) Legible.
   6) Original Quality: Reproduced by dry copy method.

c. Electronic Format (final approved manuals):
   1) CD or DVD labeled to identify project name, contract number, specification section product, and manufacturer.
   2) Format PDF. PDF files shall be fully searchable.
   3) Drawings: AutoCad, most recent version, in dwg; and in .tiff or .pdf format
   4) Photographs and Pictures: in .jpeg and .pdf.

3. Copies:
   a. Submit 6 (six) hard copies of preliminary manuals, and one electronic copy via e-Builder, for review and approval no later than date of shipment of equipment. Installation and preliminary testing shall not begin until manuals are accepted by the Owner. Include in preliminary copies all items required under "Contents" above. No hard copies will be returned to Supplier.
   b. Submit 5 (five) hard copies, one electronic copy via e-Builder, and 2 (two) electronic copies on CD / DVD, of final manuals to the Owner before Owner's inspections and tests required in Specifications Section 46 34 50. Update manuals for changes made during inspections and testing, and resubmit.
   c. Cover page – each paper and electronic copy shall be labeled with equipment name, Operation and Maintenance manual phase, the County's project name, the County's Contract number, the County's facility name and address, manufacturer's name, manufacturer's address, phone number, website; and date.

PART 2 - PRODUCTS - (NOT USED IN THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT USED IN THIS SPECIFICATION SECTION)

END OF SECTION

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SECTION 01 61 03
EQUIPMENT: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements of this Specification Section apply to all equipment provided on the Project including those found in other Divisions even if not specifically referenced in individual "Equipment" Articles of those Specification Sections.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 05 50 00 - Metal Fabrications.
   3. Section 09 96 00 - High Performance Industrial Coatings.
   4. Section 10 14 00 - Identification Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
   3. ASTM International (ASTM):
      a. E1934, Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography.
      b. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   4. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6, Enclosures for Industrial Control and System.
      c. MG 1, Motors and Generators.
   6. InterNational Electrical Testing Association (NETA):
      a. ATS, Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 430, Motors, Motor Circuits, and Controllers.
   8. National Institute for Certification in Engineering Technologies (NICET).
   9. National Institute of Standards and Technology (NIST).
   10. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
   11. Underwriters Laboratories, Inc. (UL).
      a. 508, Standard for Safety Industrial Control Equipment.
      b. 508A, Standard for Safety Industrial Control Panels.

B. Supplier’s Vibration Analyst:
   1. Supplier’s vibration analyst shall prepare pre-Shop Drawing vibration analysis of equipment.
   2. Where required, Supplier’s vibration analyst shall be either equipment manufacturer’s qualified employee or independent business entity whose sole business, or principal part of its business, is evaluating and determining natural frequencies of rotating equipment.
   3. Shall possess not less than 10 years’ relevant experience.

4. Supplier's Vibration Analyst's Professional Engineer:
    a. Vibration analysis shall be performed by, or under the direct, personal supervision of, professional engineer licensed and registered in the Commonwealth of Virginia, experienced in preparing finite element analyses, rotordynamic analyses, and experimental modal analysis similar to that required for the Work.
    b. Professional engineer shall possess not less than five years' combined experience in field testing and data analysis for vibration analysis.
    c. Vibration analysis professional engineer's seal and signature, with indication of date seal and signature were applied to the subject document, shall clearly appear on all results and reports furnished as Submittals.

C. Field Vibration Testing Subcontractor:
1. Field vibration testing Subcontractor shall, where required by the Contract Documents, perform vibration testing of equipment installed at the Site and perform associated vibration analyses.
2. Vibration testing Subcontractor shall be an independent entity that has performed as its sole business, or principal part of its business, for not less than 10 years, inspection, testing, calibrating, adjusting equipment and systems, and performing vibration testing of equipment.
3. Entities whose principal business is one or more of the following are not considered independent vibration testing entities and, therefore, shall not be field vibration testing Subcontractor:
    a. Motor sales, service, or repairs.
    b. Process equipment sales, service, or repairs.
4. Acceptable entities include, but are not necessarily limited to:
    a. AVS Engineering: https://www.avsengineering.net/
    b. Engineering Testing Services: https://etestinc.com/
    c. Maritech, LLC: http://www.maritech-llc.com/contact.html
5. Field vibration testing Subcontractor must have an established program for monitoring and testing equipment calibration, with accuracy traceable in an unbroken chain, in accordance with NIST requirements.
6. Field Personnel: Each person employed for field vibration testing on the Work shall possess not less than the following qualifications:
    a. Three years' field experience covering all phases of field vibration testing and data gathering.
    b. Current, valid Vibration Category II certification from Vibration Institute or a licensed, registered professional engineer.
7. Analysis Personnel: Personnel performing analysis for field vibration testing Subcontractor shall possess not less than the following qualifications:
    a. Five years' combined field testing and data analysis experience.
    b. Current, valid Vibration Category III certification from the Vibration Institute or a professional engineer licensed and registered in in the same jurisdiction as the Site. Where required by Laws and Regulations, field vibration analysis report shall be sealed, signed, and dated by professional engineer who personally prepared, or exercised personal, supervisory control over subordinates in preparing, the field vibration analysis report].
8. Analysis Equipment: Field vibration testing Subcontractor shall have access to and use, where appropriate, the following testing equipment, properly maintained and calibrated:
    a. Impact Hammer:
        1) Frequency Range: 1 kHz.
        2) Range (5v output) 5,000 pounds-force (22,200 newtons).
        3) Hammer sensitivity (approx.) 1mV/lbf (0.23 mV/N).

b. Analyzer:
    1) Frequency Range: 1 Hz to 10,000Hz.
    2) Frequency Accuracy: 0.02 percent.
    3) Non-Integrated Spectral Amplitude Accuracy: 5 percent, 3 Hz to 65 Hz.
    4) Single Integrated Spectral Amplitude Accuracy: 5 percent, 10 Hz to 20 Hz.
    5) Supports measurements of acceleration, velocity, and displacement.
c. Vibration Sensor:
    1) Sensitivity: ±5 percent = 100 mV/g.
    2) Acceleration Range: ±5 g.
    3) Amplitude Nonlinearity: ±1 percent.
    4) Frequency Response: ±10Hz to 7kHz (±3 dB).
d. Data logging equipment for simultaneous recording of the following data points:
    1) Vibration in the X, Y, and axial planes (for all pumps pursuant to ANSI/HI Standard).
    2) Digital tachometer recording RPM.
    3) Discharge Pressure Transmitter:
        a) Accuracy: 0.3 percent of range
        b) Fluid Temperature Range: 32 to 100 DegF.
    4) Suction Pressure Transmitter (when other than submersible pump or vertical turbine (suspended) pump.
        a) Accuracy 0.35 percent of range.
        b) Fluid Temperature Range: 32 to 100 DegF.
        c) For submersible pumps and vertical turbine (suspended) type pumps, suction liquid surface level signal from Site's monitoring and control system (e.g., plant PLC/SCADA system).
    5) For pumps, pumping rate (flow) signal from Site's monitoring and control system (e.g., plant PLC/SCADA system).
    6) Equipment/motor bearing temperature signal from Site's monitoring and control system (e.g., plant PLC/SCADA system).
    7) Pump/motor vibration signal from Site's monitoring and control system (e.g., plant PLC/SCADA system).

D. Infrared Thermography Testing Program:
1. Testing firm:
    a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
    b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
2. Field personnel:
    a. Minimum of one year field experience covering all phases of field thermography testing and data gathering.
    b. Supervisor certified by NETA or NICET.
3. Analysis personnel:
    a. Minimum three years combined field testing and data analysis experience.
    b. Supervisor certified by NETA or NICET.

E. Electrical Equipment and Connections Testing Program:

F. Qualification requirements as specified in section 26 08 13 - Acceptance Testing.

G. Miscellaneous:
1. A single manufacturer of a "product" shall be selected and utilized uniformly throughout Project even if:
    a. More than one (1) manufacturer is listed for a given "product" in Specifications.
    b. No manufacturer is listed.

2. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification and to NEMA 250 designations as indicated in individual specification sections.

1.3 DEFINITIONS

A. Product: Manufactured materials and equipment.

B. Major Equipment Supports - Supports for Equipment:
   1. Located on or suspended from elevated slabs with supported equipment weighing 2000 LBS or greater, or;
   2. Located on or suspended from roofs with supported equipment weighing 500 LBS or greater, or;
   3. Located on slab-on-grade or earth with supported equipment weighing 5000 LBS or more.

C. Equipment:
   1. One (1) or more assemblies capable of performing a complete function.
   2. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection.
   3. Not limited to items specifically referenced in "Equipment" articles within individual Specifications.

1.4 SUBMITTALS

A. Shop Drawings:
   1. General for all equipment:
      a. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
      b. Data sheets that include manufacturer's name and complete product model number.
         1) Clearly identify all optional accessories that are included.
      c. Acknowledgement that products submitted comply with the requirements of the standards referenced.
      d. Manufacturer's delivery, storage, handling, and installation instructions.
      e. Equipment identification utilizing numbering system and name utilized in Drawings.
      f. Equipment installation details:
         1) Location of anchorage.
         2) Type, size, and materials of construction of anchorage.
         3) Anchorage setting templates.
         4) Manufacturer's installation instructions.
      g. Equipment area classification rating.
      h. Shipping and operating weight.
      i. Equipment physical characteristics:
         1) Dimensions (both horizontal and vertical).
         2) Materials of construction and construction details.
      j. Equipment factory primer and paint data.
      k. Manufacturer's recommended spare parts list.
      l. Equipment lining and coatings.
      m. Equipment utility requirements include air, natural gas, electricity, and water.
      n. Ladders and platforms provided with equipment:
         1) Certification that all components comply fully with OSHA requirements.
         2) Full details of construction/fabrication.
         3) Scaled plan and sections showing relationship to equipment.
   2. Mechanical and process equipment:
      a. Operating characteristics:
         1) Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.

2) Brake horsepower requirements.
3) Copies of equipment data plates.

b. Piping and duct connection size, type and location.
c. Equipment bearing life certification.
d. Equipment foundation data:
1) Equipment center of gravity.
2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.

3. Electric motor:
a. Motor manufacturer and model number.
b. Complete motor nameplate data.
c. Weight.
d. NEMA design type.
e. Enclosure type.
f. Frame size.
g. Winding insulation class and temperature rise.
h. Specific data for motors driven by variable frequency drives.
i. Starts per hour.
j. Performance data:
1) Guaranteed minimum efficiencies at 100 percent, 75 percent, and 50 percent of full load
2) Guaranteed minimum power factor at 100 percent, 75 percent, and 50 percent of full load.
3) Locked rotor and full load current at rated terminal voltage and minimum permissible or specified terminal voltage.
4) Starting, full load, and breakdown torque at rated terminal voltage and minimum permissible or specified terminal voltage.
k. Bearing data and lubrication system.
l. Thermal protection system (thermistors or temperature switches) for all VFD driven motors.
m. Fabrication and/or layout drawings:
1) Dimensioned outlined drawing.
2) Connection diagrams including accessories (strip heaters, thermal protection, etc.).
n. Certifications:
1) When utilized with a reduced voltage starter, certify that motor and driven equipment are compatible.
2) When utilized with a variable frequency controller include minimum speed at which the motor may be operated for the driven machinery.
o. Electrical gear:
1) Unless specified in a narrow-scope specification section, provide the following:
a) Equipment ratings: Voltage, continuous current, kVA, watts, short circuit with stand, etc., as applicable.
2) Control panels:
a) Panel construction.
b) Point-to-point ladder diagrams.
c) Scaled panel face and subpanel layout.
d) Technical product data on panel components.
e) Panel and subpanel dimensions and weights.
f) Panel access openings.
g) Nameplate schedule.
h) Panel anchorage.

4. Systems schematics and data:
a. Provide system schematics where required in system specifications.
1) Acknowledge all system components being supplied as part of the system.

2) Utilize equipment, instrument and valving tag numbers defined in the Contract Documents for all components.
3) Provide technical data for each system component showing compliance with the Contract Document requirements.
4) For piping components, identify all utility connections, vents and drains which will be included as part of the system.

5. For factory painted equipment, provide paint information in submittal.

B. Factory Test Reports:
1. Equipment performance tests.
a. As listed in individual equipment specifications.

C. Operation and Maintenance Manuals:
1. See Specification Section 01 33 00 for requirements for:
a. The mechanics and administration of the submittal process.
b. The content of Operation and Maintenance Manuals.

D. Informational Submittals:
1. Sample form letter for equipment field certification.
2. Certification that equipment has been installed properly, has been initially started up, has been calibrated and/or adjusted as required, and is ready for operation.
3. Certification for major equipment supports that equipment foundation design loads shown on the Drawings or specified have been compared to actual loads exhibited by equipment provided for this Project and that said design loadings are equal to or greater than the loads produced by the equipment provided.
4. Field noise testing reports if such testing is specified in narrow-scope specification sections.
5. Notification, at least one (1) week in advance, that motor testing will be conducted at factory.
6. Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the Equipment Supplier of those interfacing systems.
7. Motor test reports.
8. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-made modifications.
9. Provide three (3) bound final written reports documenting vibration monitoring and testing for specified equipment.
a. Include the acceptance criteria of all equipment tested.
b. Provide individual tabbed sections for information associated with each piece of tested equipment.
10. Preliminary field quality control testing format to be used as a basis for final field quality control reporting.
11. Testing and monitoring reports in accordance with PART 3 of this Specification Section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Motors:
a. General Electric.
b. Marathon Electric.
c. Reliance Electric.
d. Teco-Westinghouse.
e. U.S. Motors.

2.2 MANUFACTURED UNITS

A. Electric Motors:
   1. Where used in conjunction with adjustable speed AC drives, provide motors that are fully compatible with the speed controllers.
   2. Design for frequent starting duty equivalent to duty service required by driven equipment.
   3. Design for full voltage starting.
   4. Design bearing life based upon actual operating load conditions imposed by driven equipment.
   5. Size for altitude of Project.
   6. Furnish with stainless steel nameplates which include all data required by NEC Article 430.
   7. Use of manufacturer's standard motor will be permitted on integrally constructed motor driven equipment specified by model number in which a redesign of the complete unit would be required in order to provide a motor with features specified.
   8. AC electric motors less than 1/3 HP:
      a. Single phase, 60 Hz, 120 volt.
      b. Permanently lubricated sealed bearings conforming to ABMA standards.
      c. Built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element with stainless steel enclosure.
   9. AC electric motors 1/3 to 1 HP:
      a. Single or 3 PH, 60 Hz, 120, 208, or 240 volt as determined by Owner.
      b. Permanently lubricated sealed bearings conforming to ABMA standards.
         1) For single phase motors, provide built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element.
   10. AC electric motors 1-1/2 to 10 HP:
      a. 3 PH, 60 Hz, 480 volt.
      b. Permanently lubricated sealed bearings conforming to ABMA standards.
      c. For vertical motors provide 15-year, average-life thrust bearings conforming to ABMA standards.
   11. AC electric motors greater than 10 HP:
      a. Single or 3 PH, 60 Hz, 480V.
      b. Oil or grease lubricated antifriction bearings conforming to ABMA standards.
         1) Design bearing life for 90 percent survival rating at 50,000 HRS of operation for motors up to and including 100 HP.
      c. For vertical motors provide 15-year, average-life thrust bearings conforming to ABMA standards.
   12. Thermal protection:
      a. For motors 5 HP and above controlled from a variable frequency drive and for all other motors 100 HP and above, provide integral thermal detectors with normally closed contacts that will open on overtemperature or thermistor type sensor.
         1) Incorporate temperature sensing device into motor starter circuit.
   13. Severe duty motor to have the following minimum features:
      a. All cast iron construction.
      b. Gasketed conduit box.
      c. Epoxy finish for corrosion protection.
      d. Hydroscopic varnish on windings for corrosion protection.
      e. Drain plug and breather.

B. NEMA Design Squirrel Cage Induction Motors:
   1. Provide motors designed and applied in compliance with NEMA and IEEE for the specific duty imposed by the driven equipment.
   2. Motors to meet NEMA MG 1 (NEMA Premium) efficiencies.
   3. Do not provide motors having a locked rotor kVA per HP exceeding the NEMA standard for the assigned NEMA code letter.

4. For use on variable frequency type adjustable speed drives, provide:
   a. Induction motors that are in compliance with NEMA MG 1, Part 31.
   b. Nameplate identification meeting NEMA MG 1 Part 31 requirements.
   c. Insulated drive end bearing on all motors.
   d. Shaft grounding ring on all motors rated 5 HP and greater:
      1) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
      2) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.
5. Design motor insulation in accordance with NEMA standards for Class F insulation with Class B temperature rise above a 40 DegC ambient.
6. Design motors for continuous duty. NEMA Design A motors not permitted.
7. Size motors having a 1.0 service factor so that nameplate HP is a minimum of 15 percent greater than the maximum HP requirements of the driven equipment over its entire operating range.
   a. As an alternative, furnish motors with a 1.15 service factor and size so that nameplate HP is at least equal to the maximum HP requirements of the driven equipment over its entire operating range. Motors shall not operate into the service factor rating over the entire operating range.
8. Motor enclosure and winding insulation application:
   a. The following shall apply unless modified by specific specification sections:

Motor Location	Motor Enclosure / Winding Insulation
Outdoor Areas where motor is within the driven equipment enclosure (packaged air compressors, etc.)	TEFC, Extra Dip and Bake for Moisture
Outdoor Areas	TEFC, Severe/ Chemical Duty

NOTE: Provide TENV motors in the smaller horsepower ratings where TEFC is not available.

9. Provide oversize conduit box complete with clamp type grounding terminals inside the conduit box.
10. Provide 75C minimum rated motor terminations.
11. Balance motors to ISO G2.5 level.
    a. Submit prior to shipping to OEM or job site.

C. V-Belt Drive:
1. Provide each V-belt drive with sliding base or other suitable tension adjustment.
2. Provide V-belt drives with a service factor of at least 1.6 at maximum speed.
3. Provide static-proof belts.

2.3 COMPONENTS

A. Gear Drives and Drive Components:
1. Size drive equipment capable of supporting full load including losses in speed reducers and power transmission.
2. The reduction ratio shall be that required to operate the pump at its maximum operating speed when the motor is operating at its nominal rated full speed.
3. Provide nominal input horsepower rating of each gear or speed reducer at least equal to nameplate horsepower of drive motor.
4. Design drive units for 24-HR continuous service, constructed so oil leakage around shafts is precluded.
5. Utilize gears, gear lubrication systems, gear drives, speed reducers, speed increasers and flexible couplings meeting applicable standards of AGMA.

6. Gear reducers:
    a. Provide gear reducer totally enclosed and oil lubricated.
    b. Utilize antifriction bearings throughout.
    c. Provide worm gear reducers having a service factor of at least 1.20.
    d. Furnish other helical, spiral bevel, and combination bevel-helical gear reducers with a service factor of at least 1.50.
    e. If specified in narrow scope pump sections, provide anti-rotation backstop to allow rotation in one direction. Backstop shall be installed internally to the reducer and will hold the speed reducers rated torque.
    f. Provide oil expansion chamber for all vertically mounted input shaft and motors or if recommended by the manufacturer based on gearbox size and or output speeds.
    g. Provide oil sight glass mounted to the reducer. Provide sealed porthole to add oil through the sight glass.
    h. Provide automatic vent that prevents entry of foreign material, water, and dust. Vent shall have a ball check valve that opens when the gearbox is in operation and closes when it cools.
    i. Provide magnetic drain plug to attract and hold ferrous metal particles inside the reducer's lubrication system.
    j. Provide drain plug valve to easily drain the gearbox oil.

2.4 ACCESSORIES

A. Motor Space Heaters:
    1. Provide motor space heater for all motors rated 1 HP and larger.
    2. Space heater rating: 120VAC.

B. Guards:
    1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
    2. Interior applications:
        a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
        b. Utilize non-flattened type 16 GA galvanized steel with nominal 1/2 IN spacing.
        c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.
    3. Exterior applications:
        a. Construct from 16 GA stainless steel or aluminum.
        b. Construct to preclude entrance of rain, snow, or moisture.
        c. Roll to conform to shaft or coupling surface.
        d. Connect to equipment frame with stainless steel bolts and wing nuts.

C. Anchorage:
    1. Provided by Contractor.

D. Data Plate:
    1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment.
    2. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.

E. Gages:
    1. Provide gages in accordance with Specification Section 40 79 00 – Miscellaneous Instruments and Appurtenances.
    2. Provide at the following locations:
        a. Suction and discharge piping of all reciprocating, centrifugal and positive displacement mechanical and process equipment.

F. Lifting Eye Bolts or Lugs:
    1. Provide on all equipment 50 LBS or greater.

2. Provide on other equipment or products as specified in the narrow-scope specification sections.

G. Platforms and Ladders:
   1. Design and fabricate in accordance with OSHA Standards.
   2. Fabricate components from galvanized steel.
   3. Provide platform surface: Non-skid grating.

2.5 FABRICATION

A. Design, fabricate, and assemble equipment in accordance with modern engineering and shop practices.

B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.

C. Furnish like parts of duplicate units to be interchangeable.

D. Ensure that equipment has not been in service at any time prior to delivery, except as required by tests.

E. Furnish equipment which requires periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts.
   1. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.

F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option.
   1. Provide drain connection for 3/4 IN PVC tubing.

G. Machine the mounting feet of rotating equipment.

H. Fabricate equipment which will be subject to Corrosive Environment in such a way as to avoid back to back placement of surfaces that cannot be properly prepared and painted.
   1. When such back to back fabrication cannot be avoided, provide continuous welds to seal such surfaces from contact with corrosive environment.
   2. Where continuous welds are not practical, after painting seal the back to back surfaces from the environment in accordance with sealant.

I. Control Panels Engineered and Provided with the Equipment by the Manufacturer:
   1. Manufacturer’s standard design for components and control logic unless specific requirements are specified in the specific equipment specification section.
   2. NEMA rated components are acceptable, whichever is used in the manufacturer’s standard engineered design, unless specific requirements are required in the specific equipment specification section.
   3. Affix entire assembly with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to delivery.
      a. Control panels without an affixed UL 508A label shall be rejected.

2.6 SHOP OR FACTORY PAINT FINISHES

A. Electrical Equipment:
   1. Provide factory-applied paint coating system(s) for all electrical equipment components.

B. Field paint other equipment in accordance with Specification Section 09 96 00 - High Performance Industrial Coatings.
   1. See Specification Section 09 96 00 - High Performance Industrial Coatings for factory applied primer/finish paint compatibility requirements.

2.7 SOURCE QUALITY CONTROL

A. Motor Tests:
   1. Test motors in accordance with NEMA and IEEE standards.
   2. Provide routine test for all motors 10 HP and above.
   3. The Owner reserves the right to select and have tested, either routine or complete, any motor included in the project.
      a. The Owner will pay all costs, including shipping and handling, for all motors successfully passing the tests.
      b. The Supplier shall pay all costs, including shipping and handling, for all motors failing the tests.
      c. If two (2) successive motors of the same manufacturer fail testing, the Owner has the right to reject all motors from that manufacturer.

B. Balance:
   1. Unless specified otherwise, for all equipment 10 hp or greater, all rotating elements in motors, pumps, blowers, and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. Balance all rotating elements to the following criteria, per ISO 21940-11:

$$Uper = \frac{G\ x\ 6.015\ x\ W/2}{N}$$

Where:
Uper = Permissible residual unbalance for each correction plane in ounce-inches (OZ-IN). See ISO 21940-11 for acceptable values.
G = ISO Balance Quality Grade Number, per ISO 21940-11
W = Rotor weight in pounds
N = Maximum continuous operating RPM

   a. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data.

PART 3 - EXECUTION

3.1 INSTALLATION (APPLIES TO SUPPLIER INSTALLED EQUIPMENT ON THP TRAIN ONLY)

A. Install THP equipment as shown on Drawings and in accordance with manufacturer's directions.

B. Utilize templates for anchorage placement for slab-mounted equipment.

C. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings from closest operating floor level.

D. Equipment Base:
   1. Construct level in both directions.

E. Machine Base:
   1. Mount machine base of rotating equipment on equipment base.
      a. Level in both directions, using a machinist level, according to machined surfaces on base.
   2. Level machine base on equipment base and align couplings between driver and driven unit using steel blocks and shims.
      a. Size blocks and shims to provide solid support at each mounting bolt location.
         1) Provide area size of blocks and shims approximately 1-1/2 times area support surface at each mounting bolt point.

b. Provide blocks and shims at each mounting bolt.
    1) Furnish blocks and shims that are square shape with "U" cut out to allow blocks and shims to be centered on mounting bolts.
c. After all leveling and alignment has been completed and before grouting, tighten mounting bolts to proper torque value.

F. Rotating equipment couplings:
1. Align in the annular and parallel positions.
    a. For equipment rotating at 1200 rpm or less, align both annular and parallel within 0.001 IN tolerance for couplings 4 IN size and smaller.
    b. Couplings larger than 4 IN size: Increase tolerance 0.0005 IN per inches of coupling diameter, i.e., allow 6 IN coupling 0.002 IN tolerance, and allow a 10 IN coupling 0.004 IN tolerance.
    c. For equipment rotating at speeds greater than 1200 rpm allow both annular and parallel positions within a tolerance rate of 0.00025 IN per inch coupling diameter.
2. If equipment is delivered as a mounted unit from factory, verify factory alignment on site after installation and realigned if necessary.
3. Check surfaces for runout before attempting to trim or align units.

G. Grouting:
1. After machine base has been shimmed, leveled onto equipment base, couplings aligned and mounting bolts tightened to correct torque value, place a dam or formwork around base to contain grouting between equipment base and equipment support pad.
    a. Extend dam or formwork to cover leveling shims and blocks.
    b. Do not use nuts below the machine base to level the unit.
2. Saturate top of roughened concrete subbase with water before grouting.
    a. Add grout until entire space under machine base is filled to the top of the base underside.
    b. Puddle grout by working a stiff wire through the grout and vent holes to work grout in place and release any entrained air in the grout or base cavity.
3. When the grout has sufficiently hardened, remove dam or formwork and finish the exposed grout surface to fine, smooth surface.
    a. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout.
    b. When the grout has fully hardened (after a minimum of seven days) tighten all anchor bolts to engage equipment base to grout, shims, and equipment support pad.
    c. Recheck driver-driven unit for proper alignment.

3.2 INSTALLATION CHECKS

A. For all equipment specifically required in detailed specifications, secure services of experienced, competent, and authorized representative(s) of equipment manufacturer to visit site of work and inspect, check, adjust and approve equipment installation.
1. In each case, representative(s) shall be present during placement and start-up of equipment and as often as necessary to resolve any operational issues which may arise.

B. Secure from equipment manufacturer's representative(s) a written report certifying that equipment:
1. Has been properly installed and lubricated.
2. Is in accurate alignment.
3. Is free from any undue stress imposed by connecting piping or anchor bolts.
4. Has been operated under full load conditions and that it operated satisfactorily.
    a. Secure and deliver a field written report to Owner immediately prior to leaving jobsite.

C. No separate payment shall be made for installation checks.
1. All or any time expended during installation check does not qualify as Operation and Maintenance training or instruction time when specified.

3.3 IDENTIFICATION OF EQUIPMENT AND HAZARD WARNING SIGNS

A. Identify equipment and install hazard warning signs in accordance with Specification Section 10 14 00 - Identification Devices.

3.4 WIRING CONNECTIONS AND TERMINATION

A. Clean wires before installing lugs and connectors.

B. Coat connection with oxidation eliminating compound for aluminum wire.

C. Terminate motor circuit conductors with copper lugs bolted to motor leads.

D. Tape stripped ends of conductors and associated connectors with electrical tape.
   1. Wrapping thickness shall be 150 percent of the conductor insulation thickness.

E. Connections to carry full ampacity of conductors without temperature rise.

F. Terminate spare conductors with electrical tape.

3.5 FIELD QUALITY CONTROL

A. General:
   1. Furnish equipment manufacturer's field quality control services and testing as specified in the individual equipment specification sections.
   2. Execute pre-demonstration requirements in accordance with Specification Section 01 75 00 – Facility and System Start-up.
   3. Perform and report on all tests required by the equipment manufacturer's Operation and Maintenance Manual.
   4. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
      a. Contract Drawings and Specifications.
      b. Related construction change documentation.
      c. Approved Shop Drawings.
      d. Approved Operation and Maintenance Manuals.
      e. Other pertinent information as required.

B. Testing and Monitoring Program Documentation:
   1. Provide reports with tabbed sections for each piece of equipment tested.
   2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
      a. Include legible copies of all forms used to record field test information.
   3. Prior to start of testing, submit one (1) copy of preliminary report format for Owner review and comment
      a. Include data gathering and sample test report forms that will be utilized.
   4. In the final report, include as a minimum, the following information for all equipment tested:
      a. Equipment identification, including:
         1) Name and tag numbers identified in the Contract Documents.
         2) Manufacturer's serial numbers.
         3) Other pertinent manufacturer identification.
      b. Date and time of each test.
      c. Ambient conditions including temperature, humidity, and precipitation.
      d. Visual inspection report.
      e. Description of test and referenced standards, if any, followed while conducting tests.
      f. Results of initial and all retesting.
      g. Acceptance criteria.
      h. "As found" and "as left" conditions.
      i. Corrective action, if required, taken to meet acceptance.

j. Verification of corrective action signed by the Equipment Supplier, equipment, and Owner's representative.
k. Instrument calibration dates of all instruments used in testing.

5. Provide three (3) bound final reports prior to Project final completion.

C. Other Testing:
1. Perform tests and inspections not specifically listed but required to assure equipment is safe to energize and operate.

3.6 DEMONSTRATION

A. Demonstrate equipment in accordance with Specification Section 01 75 00 – Facility and System Start-up.

END OF SECTION

SECTION 01 65 00
PRODUCT DELIVERY REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

A. Equipment shall be delivered and stored in accordance with the Delivery and Storage requirements set forth by the Contractor and the requirements of this specification.

B. Payment: No payment will be made to Contractor for equipment or materials not properly stored and insured, or without approved shop drawings. Previous payments for items will be deducted from subsequent progress estimate(s) if proper storage procedures are not observed or maintained.

1.2 DELIVERY

A. Scheduling: Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.

B. Packaging: Deliver products or equipment in manufacturer's original unbroken cartons or other containers designed and constructed to protect the contents from physical or environmental damage.

C. Identification: Clearly and fully mark and identify as to manufacturer, item and installation location.

D. Protection and Handling: Provide manufacturer's instructions for storage and handling to Owner when material is delivered to the site:
   1. Comply with manufacturer’s requirements for maintenance of equipment that is in storage.
   2. Submit monthly reports indicating manufacturer’s storage requirement compliance.

PART 2 - PRODUCTS - (NOT USED IN THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 PROTECTION, STORAGE AND HANDLING

A. Do not store products or equipment in structures being constructed.

B. Protect all products or equipment in accordance with manufacturer's written directions.

C. Store products or equipment in location to avoid physical damage to items while in storage.

D. Handle products or equipment in accordance with manufacturer's recommendations and instructions.

E. The following types of materials may be stored out-of-doors without cover. Store these materials on wood blocking so there is no contact with the ground.
   1. Reinforcing steel.
   2. Structural steel.
   3. Non-plastic piping.

F. Fully Protected Cover:
   1. Protect equipment from exposure to elements and keep thoroughly dry.

2. Store all products not named in the Section F in buildings or trailers which have a concrete, steel or wooden floor, a roof, and fully closed walls on all sides to protect from exposure to elements and to keep thoroughly dry.
3. Provide heated storage space for materials which would be damaged by freezing.
4. Protect mechanical and electrical equipment from being contaminated by dust, dirt and moisture. When space heaters are provided in equipment, connect and operate heaters during storage until equipment is placed in service.
5. Primary Elements and Transmitters shall be stored in buildings or fully protected enclosures that are temperature, humidity and dust controlled.
6. Maintain humidity at levels recommended by manufacturers.

G. Reference individual product and equipment specification sections for additional storage requirements.

END OF SECTION

SECTION 01 75 00
FACILITY AND SYSTEM START-UP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Procedures and actions, required by the Supplier which are necessary to achieve and demonstrate THP Acceptance.
   2. Requirements for THP Acceptance Submittals.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 61 03 - Equipment - Basic Requirements.
   3. Section 46 34 50 - Pre-Engineered, Fabricated Thermal Hydrolysis Process System.

1.2 DEFINITIONS

A. Mechanical Completion Period: The period of time, of unspecified duration after initial construction and installation activities during which the Contractor and the Supplier, with assistance from manufacturers, performs in the following sequence:
   1. Completion of the filing of all required submittals.
   2. Mechanical and Electrical Installation Checkout.
   3. Functional Testing with Steam and Plant Effluent Water.
   4. Personnel training.

B. Commissioning on Solids Period: A period of time, of duration specified in Specification Section 46 34 50, following the Mechanical Completion Period, during which the Owner, with the Contractor and the Supplier's assistance, initiates process flow through the facility and starts up and operates the facility, without exceeding specified downtime limitations, to prove:
   1. Functional integrity of the system operating on biosolids through Solids Handling Functional Tests.
   2. Proper integration of the mechanical, electrical and control components and functions of the system.

C. Acceptance Tests for demonstrating Performance Guarantees: Acceptance Tests required for each Performance Guarantee, as described in Specification Section 46 34 50.

1.3 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Submit in the chronological order listed below, prior to the completion of the Mechanical Completion Period:
   1. Master Operation and Maintenance Training Schedule:
      a. Submit at least 30 days prior to first training session for the Owner's personnel.
      b. Schedule to include:
         1) Date and time for the Owner witnessing of each equipment and system initial start-up.
         2) Date and time for Operation and Maintenance training for each system, both field and classroom, with time budgeted to include all four day and night shifts.
         3) Target date for initiation of Commissioning on Solids Period.
      c. Submit for review and approval by the Owner.
      d. Include holidays observed by the Owner.

e. Attend a schedule planning and coordination meeting 21 days prior to first scheduled training session.
    1) Provide a status report and schedule-to-complete for requirements prerequisite to manufacturer's training.
    2) Identify final dates for individual manufacturer's training sessions.
f. Owner reserves the right to insist on a minimum seven days' notice of rescheduled training session not conducted on master schedule for any reason.
g. Schedule to be resubmitted until approved and re-submitted when changes are required.

2. Mechanical Completion Submittals:
    a. Approved Final Operation and Maintenance manuals must be received by the Owner minimum two weeks prior to scheduled training.
        1) Written request for the Owner to witness each system mechanical completion start-up. Request to be received by the Owner minimum one week before scheduled training of the Owner's personnel on that system.
    b. Equipment installation and mechanical completion start-up certifications.
    c. Letter verifying completion of all mechanical completion start-up activities including receipt of all specified items from manufacturers or suppliers as final item prior to initiation of Commissioning on Solids Period.

C. Submittals for Personnel Training Requirements: See Part 3 of this Section.

PART 2 - PRODUCTS - (NOT USED IN THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 GENERAL

A. Facility Start-up is divided into two periods: Mechanical Completion Period and Commissioning and Testing Period. See Paragraph 1.2 Definitions.

3.2 MECHANICAL COMPLETION PERIOD

A. Complete the submittal and approval process of all required submittals:
    1. Shop Drawings.
    2. Operation and Maintenance Manuals.
    3. Training schedule, agenda and materials.

B. Initial Equipment Start-up:
    1. Requirements for individual items of equipment are included in Divisions 01 through 46 of these Specifications.
    2. Ensure the equipment is prepared so it will operate properly and safely and be ready to demonstrate functional integrity during the Commissioning on Solids Period.
    3. Perform Equipment Start-up to the extent possible without introducing product flow.
        a. Test tanks, pumping and similar equipment requiring a fluid, using plant effluent water provided by the Owner.
    4. Dispose of water used for Equipment Start-up in a manner dictated by the Owner.
    5. Procedures include but are not necessarily limited to the following:
        a. Work with Contractor to test or check and correct deficiencies of:
            1) Power, control, and monitoring circuits for continuity prior to connection to power source.
            2) Voltage of all circuits.
            3) Phase sequence.
            4) Cleanliness of connecting piping systems.
            5) Alignment of connected machinery.

6) Vacuum and pressure of all closed systems.
7) Lubrication.
8) Valve orientation and position status.
9) Tankage for integrity and water tightness.
10) Pumping equipment.
11) Instrumentation and control signal generation, transmission, reception, and response.
12) Tagging and identification systems.
13) Proper connections, alignment, calibration and adjustment of all equipment.

b. Calibrate all safety equipment.
c. Manually rotate or move moving parts to assure freedom of movement.
d. "Bump" start electric motors to verify proper rotation.
e. Perform other tests, checks, and activities required to make the equipment ready for Commissioning on Solids.
f. Documentation:
1) Prepare a log showing each equipment item and listing what is to be accomplished during Equipment Start-up.
2) Provide a place for the Contractor to record date and person accomplishing required work.
3) Submit completed document before requesting inspection for Mechanical Completion.

C. Personnel Training:
1. See Table 01 75 00A: Training Schedule at the end of this Section and individual equipment specifications sections.
2. Conduct all personnel training after completion of Initial Equipment Start-up for the equipment for which training is being conducted
a. Personnel training on individual equipment or systems will not be considered completed unless:
1) All pre-training deliverables are received and approved before commencement of training on the individual equipment or system.
2) No system malfunctions occur during training.
3) All provisions of field and classroom training specifications are met.
b. Training not in compliance with the above will be performed again in its entirety by the manufacturer at no additional cost to the Owner.
3. Field and classroom training requirements:
a. Hold classroom training on-site.
b. Notify each manufacturer specified for on-site training that the Owner reserves the right to video record any or all training sessions.
1) Organize each training session in a format compatible with video recording.
c. Training instructor qualification: Factory trained and familiar with giving both classroom and "hands-on" instructions.
d. Training instructors:
1) Be at classes on time.
2) Session beginning and ending times to be coordinated with the Owner and indicated on the master schedule. Normal time lengths for class periods can vary.
3) Submit qualifications and resume of proposed training instructor for approval. Replace proposed training instructor if not acceptable to the Owner.
e. Organize training sessions as shown in the Training Schedule (Operations, Maintenance and Electrical; Process Control and I&C). Provide general training to all sessions as part of the specific training required for each group. Training material and sessions shall be specifically developed and tailored to the group being trained.

f. Plan for minimum class attendance of 12 people at each session and provide sufficient classroom materials, samples, and handouts for those in attendance.
    1) Instructors to have a typed agenda, outline and well prepared instructional material. The use of visual aids, e.g., films, pictures, and slides is recommended for use during the classroom training programs. Submit proposed training agendas and outlines to the Owner for approval a minimum of 21 days prior to the training. Revise until acceptable. Training materials shall be related to the specific equipment; general sales brochures are not acceptable.
g. Provide equipment required for presentation of films, slides, and other visual aids. In the on-site training sessions, cover the information required in the Operation and Maintenance manuals and the following areas as applicable to the THP Equipment.
    1) Operation of equipment.
    2) Lubrication of equipment.
    3) Maintenance and repair of equipment.
    4) Troubleshooting of equipment.
    5) Preventive maintenance procedures.
    6) Instrument maintenance and calibration procedures.
    7) Adjustments to equipment.
    8) Inventory of spare parts.
    9) Optimizing equipment performance.
    10) Capabilities.
    11) Operational safety.
    12) Emergency situation response.
    13) Takedown procedures (disassembly and assembly).
h. Provide an electronic copy (pdf or PowerPoint format) of the training handouts.

3.3 COMMISSIONING ON SOLIDS PERIOD

A. General:
1. Demonstrate the functional integrity of the mechanical, electrical and control interfaces of the respective equipment and components comprising the facility.
2. Duration of Commissioning on Solids Period: as described in Specification Section 46 34 50.
3. If, during the Commissioning on Solids Period, the aggregate amount of time used for repair, alteration, or unscheduled adjustments to any equipment or systems that renders the affected equipment or system inoperative exceed 10 percent of the Commissioning on Solids Period, the demonstration of functional integrity will be deemed to have failed.
    a. In the event of failure, a new Commissioning on Solids Period will recommence after correction of the cause of failure.
    b. The new Commissioning on Solids Period shall have the same requirements and duration as the Commissioning on Solids Period previously conducted.
4. Conduct the demonstration of functional integrity under full operational conditions.
    a. Owner will provide operational personnel to operate the equipment and system with the Contractor and Supplier. The Contractor and Supplier will perform all equipment repair, maintenance and corrective actions until successful completion of the Commissioning on Solids Period.
5. Owner reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, etc., to verify the functional integrity of automatic and manual backup systems and alternate operating modes.
6. Time of beginning and ending any Commissioning on Solids Period shall be agreed upon by the Contractor, Supplier and Owner in advance of initiating the Commissioning on Solids Period.
7. Throughout the Commissioning on Solids Period, provide knowledgeable personnel and manufacturer’s representatives to answer the Owner's questions, provide final Personnel

Training on select systems and to respond to any equipment or system problems or failures which may occur. Provide final Personnel Training as indicated in the Training Schedule.

8. Provide all labor, supervision, utilities, chemicals, maintenance, equipment, vehicles or any other item necessary to operate and demonstrate all systems being demonstrated.

B. Once demonstrated to the satisfaction of the Owner, as agreed to in writing by the Owner upon request by the Contractor, Commissioning on Solids shall be considered complete and acceptance testing for the purposes of proving achievement of Performance Guarantees may begin.

3.4 THP ACCEPTANCE TESTS FOR DEMONSTRATING PERFORMANCE GUARANTEES

A. Refer to Specification Section 46 34 50 for the Acceptance Tests required for each Performance Guarantee.

B. Filing of the Contractor's Notice of THP Acceptance and Request for Inspection of the THP Equipment:
   1. File the notice when the following have been completed:
      a. Construction work (brought to state of Mechanical Completion).
      b. Equipment Start-up.
      c. Commissioning on Solids.
      d. Personnel Training.
      e. Submittal of required documents.
      f. Successful completion of THP Acceptance Tests for demonstrating Performance Guarantees.
   2. Owner will review required submittals for completeness.
   3. Owner will inform the Contractor and Supplier in writing of the status of the Work reviewed.
      a. Work determined not meeting state of THP Acceptance:
         1) Owner: Submit notice of correction of deficiencies to Contractor and Supplier.
         2) Contractor with Supplier: Correct deficiencies noted or submit plan of action for correction.
         3) Owner: Re-inspect work within after notice of correction of deficiencies.
         4) Re-inspection costs incurred by the Owner will be deducted from final payment due Supplier.
      b. Work determined to be in state of tentative THP Acceptance: Owner to prepare tentative "Certificate of THP Acceptance."
      c. Certificate of THP Acceptance:
         1) Certificate tentatively issued subject to successful demonstration of functional integrity.
         2) Issued subject to completion or correction of items cited in the certificate (punch list).
         3) Issued with responsibilities of the Owner, Contractor and Supplier cited.
         4) Executed by the Owner.
         5) Accepted by the Owner.
         6) Accepted by the Contractor.
         7) Accepted by Supplier.
      d. Upon successful completion of THP Acceptance Tests, the Owner will endorse certificate attesting to the successful demonstration, and citing the hour and date of completion of the successful THP Acceptance Tests for demonstrating Performance Guarantees as the effective date of THP Acceptance.

END OF SECTION

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Specification Section	Equipment Description	Training Requirements		Hrs. of Mechanical Completion Period Training						Hrs. of Commissioning on Solids Period Training						Hrs. of Training Following Commissioning Testing					
				Operations and Maintenance, Electrical			Process Control and I&C			Operations and Maintenance, Electrical			Process Control and I&C			Operations and Maintenance, Electrical			Process Control and I&C		
		Days	Trips	S	H/S	Total	S	H/S	Total	S	H/S	Total	S	H/S	Total	S	H/S	Total	S	H/S	Total
01 61 03	Equipment: Basic Requirements	4	2	2	4	8	2	4	8	2	4	8	2	4	8	0	0	0	0	0	0
40 61 13	General Requirements for Instrumentation and Control	2	2	2	2	4	2	2	4	2	2	4	2	2	4	0	0	0	0	0	0
40 63 43	Programmable Logic Controller (PLC) Control System	4	3	2	2	4	2	4	8	2	1	2	2	2	4	2	1	2	2	2	4
40 79 00.2.2.A	Pressure Switches for THP	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.2.B	Temperature Transmitters for THP	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.2.C	Flow Meters for THP	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.2.D	Pressure Transmitters for THP	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.2.E	Level/Pressure Transducer/Transmitter for THP	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.2.F	Capacitance Type Level Switch for THP	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.3.A	Pressure Switches	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.3.B	Temperature Transmitters	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.3.C	Magnetic Flow Meters	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.3.D	Pressure Transmitters	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.3.E	Pressure Gages	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.3.H	Level/Pressure Transducer/Transmitters	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
40 79 00.2.3.I	Level Switch	2	2	0	0	0	2	1	2	0	0	0	2	1	2	0	0	0	0	0	0
43 39 00	Progressing Cavity Pumps for Hydrolyzed Solids	2	2	2	2	4	2	1	2	2	2	4	2	1	2	0	0	0	0	0	0
43 39 01	Progressing Cavity Pumps for Pre-Dewatered Pulper Feed Solids	2	2	2	2	4	2	1	2	2	2	4	2	1	2	0	0	0	0	0	0

Specification Section	Equipment Description	Training Requirements		Hrs. of Mechanical Completion Period Training						Hrs. of Commissioning on Solids Period Training						Hrs. of Training Following Commissioning Testing					
				Operations and Maintenance, Electrical			Process Control and I&C			Operations and Maintenance, Electrical			Process Control and I&C			Operations and Maintenance, Electrical			Process Control and I&C		
		Days	Trips	S	H/S	Total	S	H/S	Total	S	H/S	Total	S	H/S	Total	S	H/S	Total	S	H/S	Total
46 34 50	Fabricated Thermal Hydrolysis System	52	6	2	32	64	2	32	64	2	32	64	2	32	64	2	40	80	2	40	80
Notes:																					
1. S = Number of Training Session																					
H/S = Hours per Session																					

SECTION 05 12 00
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Structural steel, including the fabrication and erection of support and bracing members, including connections.
   2. Connection detail design as required.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 46 34 50 - Pre-Engineered, Fabricated Thermal Hydrolysis Process System.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Institute of Steel Construction (AISC):
      a. 303, Code of Standard Practice for Steel Buildings and Bridges.
      b. 360, Specifications for Structural Steel Buildings.
      c. Quality Certification Program for Fabricators.
   2. American Society of Civil Engineers (ASCE).
   3. American Society of Mechanical Engineers (ASME):
      a. B18.21.1, Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series).
   4. ASTM International (ASTM):
      a. A2, Standard Specification for Carbon Steel Girder Rails of Plain, Grooved, and Guard Types.
      b. A6/A6M, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
      c. A36/A36M, Standard Specification for Carbon Structural Steel.
      d. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      e. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      f. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      h. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      i. A325, Standard Specification of Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      j. A490, Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
      k. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
      l. A563, Standard Specification for Carbon and Alloy Steel Nuts.
      m. A992/A992M, Standard Specification for Structural Steel Shapes.
      n. A1064/A1064M, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
      o. F436, Standard Specification for Hardened Steel Washers.
      p. F593, Standard Specification for Stainless Steel Bolts, Hex Caps Screws, and Studs.
      q. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.

r. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
s. F1852, Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

5. American Welding Society (AWS):
   a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. A5.5/A5.5M, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
   c. A5.17/A5.17M, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   d. A5.18/A5.18M, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding.
   e. A5.20/A5.20M, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   f. A5.23/A5.23M, Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding.
   g. A5.28/A5.28M, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding.
   h. A5.29/A5.29M, Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding.
   i. D1.1/D1.1M, Structural Welding Code - Steel.
      1) Steel stud connectors and their installation to comply with requirements of AWS D1.1/D1.1M.
6. National Institute of Steel Detailing (NISD).
7. Research Council on Structural Connections (RCSC):
   a. Specification for Structural Joints Using High-Strength Bolts.
8. Building code:
   a. Virginia Building Performance Standards.
   b. International Code Council (ICC):
      1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
1. Steel fabricator:
   a. Minimum of 10 years' experience in fabrication of structural steel and participate in the AISC Certification program and is designated an AISC Certified Plant, Category STD at time of bid.
   b. Fabricator plant quality control and inspection program: Meet requirements of the Building Code and/or be approved by the project's governing authority to self perform the Building Code required Special Inspections.
   c. Use a professional engineer on fabrication staff.
2. Steel erector:
   a. Minimum of five years of experience in erection of structural steel similar in the scope of this project and certified as CSE under the AISC Quality Certification Program.
   b. With an active and enforced quality assurance program in place, as described in the applicable Codes.
3. Qualify welding procedures and welding operators in accordance with AWS.
4. Structural steel connections design: Professional engineer registered in the Commonwealth of Virginia.
5. Testing Agency shall meet the following requirements:
   a. "Recommended Requirements for the Independent Laboratory Qualifications," latest edition, as published by the American Council of Independent Laboratories.
   b. ASTM E329, Standard specifications for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

c. Testing Agency shall be licensed and authorized to work in the Commonwealth of Virginia.

1.3 DEFINITIONS

A. Owner: May mean the Owner's Designated Representative for Construction as defined by the AISC 303.

B. Galvanizing: Hot-dipped galvanizing per ASTM A153/A153M and/or ASTM A123/A123M with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by aforementioned standards.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Detailed supplemental specification relating to load indicator washers or high-strength bolts.
         1) Alternate design for Owner approval (submitted at Supplier's option if desired by Supplier for use).
      d. Source and certification of quality for high-strength bolts, nuts and washers.
   3. Fabrication and/or layout drawings:
      a. Prepare Shop Drawings under NISD Quality Procedures Program certification.
      b. Complete Shop Drawings for all of the work showing clearly all pieces, sizes, dimensions, details, connections materials and shop coatings.
         1) All Shop Drawings must be checked and signed "approved" before submittal.
         2) Show all cuts, copes, and holes.
         3) Indicate all shop and field bolts.
         4) Indicate all shop and field welds using AWS symbols.
         5) Be reviewed and sealed by a Professional Engineer registered in the Commonwealth of Virginia retained by Supplier to verify conformance with design criteria stipulated in the Contract Documents.
      c. Prepare complete erection drawings showing the location and marks of all pieces.
         1) Copies of up-to-date erection drawings shall accompany the Shop Drawings.
         2) Use match marks on the erection drawings to indicate the sheet number on which each particular member is detailed.
      d. Correct any incorrect or unacceptable material or fabrication due to incorrect detailing, shop work, or erection, without additional charge.
   4. Certifications:
      a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
      b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
      c. Welder qualification data and prequalified procedures.
      d. Special Inspections reports.
      e. Third party welding testing agency’s credentials.
   5. Test reports:
      a. Certified copies of mill tests.
      b. Manufacturer's load test and temperature sensitivity data for post-installed anchor bolts.
      c. Inspection and Test reports for all structural steel work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and store steel members above ground on skids or other supports.
   1. Keep free of dirt and other foreign material and protect against corrosion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. High-strength bolts:
      a. Portland Bolt and Manufacturing Company.
      b. Lewis Bolt & Nut Company.
      c. Nucor Fasteners.
      d. St. Louis Screw and Bolt Company.
   2. Load indicator washers for high-strength bolts:
      a. Portland Bolt and Manufacturing Company.
      b. Mid-South Bolt and Screw Co., Inc.
      c. J and M Turner, Inc.
   3. Alternate design high-strength bolts:
      a. T. C. Bolt Corporation.
      b. Construction Fastener Systems Division of Bristol Machine Company.
      c. LeJuene Bolt Co.
   4. Headed studs and deformed bar anchors:
      a. Nelson Stud Welding Division, TRW, Inc.
      b. Stud Welding Products, Inc.
   5. Expansion anchor bolts:
      a. Kwik Bolts by Hilti, Inc.
      b. Trubolt by ITW Ramset/Red Head.
      c. Powerbolt by Powers Rawl.
   6. Adhesive anchors bolts:
      a. HVA Adhesive Anchor System by Hilti.
      b. HIT HY 150 Max Adhesive Anchor by Hilti.
      c. HSE 2411 Epoxy Adhesive Anchor by Hilti.
      d. EPCON Ceramic 6 Epoxy by ITW Ramset/Red Head.
      e. Power Fast by Powers Rawl.
      f. Needle Capsule Anchor Systems by Powers Rawl.
   7. Anchor bolt sleeves:
      a. Sinco/Wilson.
   8. Galvanized repair paint:
      a. ZRC “ZRC Cold Galvanizing.”
      b. Clearco “High Performance Zinc Spray.”
   9. Nonshrink Grout:
      a. Master Builders Technology “Master Flow, 713 Plus.”
      b. Guilford Hill “Supreme Grout.”
      c. U.S. Grant “Five Star Grout.”
      d. Sika “Sika Grout 212.”
      e. L&M, “Crystex.”
      f. Or approved equal.

2.2 MATERIALS

A. Steel, Structural Shapes and Plate (unless noted otherwise on Drawings):
   1. All W-shapes and WT-shapes: ASTM A992/A992M.
   2. All other plates, bars and rolled shapes: ASTM A36/A36M.

B. Pipe: ASTM A53/A53M, Grade B (Type E or S) (Fy=35).

C. Hollow Structural Sections (HSS):
   1. Round: ASTM A500/A500M, Grade B (Fy=42).
   2. Square or rectangular: ASTM A500/A500M, Grade B (Fy=46).

D. High-Strength Bolts, Nuts and Washers:
   1. ASTM A325 with ASTM A563 nuts galvanized:
   2. High-strength bolts:
      a. Provide two (2) ASTM F436 washers for all bolts galvanized.
      b. Provide beveled washers at connections of sloped/tapered sections.
   3. High-strength bolts with load indicating devices, ASTM F959, Type 325.
      a. Provide at Supplier's option and subject to approval of Owner.
   4. Alternate high-strength design: Provide at Supplier's option and subject to approval of Owner.

E. Bolts and Nuts, Non-high Strength: ASTM A307, Grade A or ASTM F1554, Grade 36.

F. Washers, Plain (for Non-high Strength Bolts): ASME B18.21.1, Type B.

G. Welding Electrodes:
   1. Shielded metal arc: AWS A5.1/A5.1M or AWS A5.5/A5.5M, E70XX or E801X-X.
   2. Submerged arc: AWS A5.17/A5.17M or AWS A5.23/A5.23M, F7XX-EXXX or F8XX-EXXX-XX.
   3. Gas metal arc: AWS A5.18/A5.18M, E70S-X or E70U-1 or AWS A5.28/A5.28M, ER80S-XX, E80C-XXX.
   4. Flux cored arc: AWS A5.20/A5.20M, E7XT-X (except 2, 3, 10, GS), AWS A5.29/A5.29M, E7XT-X or E8XTX-X, E8XTX-XM.

H. Anchor Rods and Bolts:
   1. ASTM F1554, Grade 55 with weldability supplement S1 or ASTM A36/A36M for threaded rods galvanized.
   2. ASTM A307, Grade A for headed bolts galvanized.
   3. ASTM F593, Type 304 or 316 stainless steel with matching nut and washer.

I. Headed Studs and Deformed Bar Anchors:
   1. Headed studs:
      a. ASTM A108, complying with AWS D1.1/D1.1M, Section 7, Type B; minimum yield strength 50,000 psi, minimum tensile strength 60,000 psi.
      b. Uniform diameter.
      c. Heads: Concentric and normal to shaft.
      d. Weld end: Chamfered and solid flux.
   2. Deformed bar anchor:
      a. ASTM A1064/A1064M, complying with AWS D1.1/D1.1M, Section 7, Type C.
      b. Minimum yield strength: 70,000 psi.
      c. Minimum tensile strength: 80,000 psi.
      d. Straight, unless indicated otherwise.
      e. Solid flux.
   3. After welding, remove ceramic ferrules and maintain free from any substance which would interfere with function, or prevent bonding to concrete.

J. Galvanized Repair Paint
   1. High Zinc dust content for regalvanizing welds and abrasions.
   2. ASTM A780.
   3. Zinc content: Minimum 92 percent on dry film.

2.3 FABRICATION

A. Comply with requirements of applicable Building Code and AISC 360 with modifications and additional requirements specified herein.
   1. Identify high-strength steel material in fabricated members in accordance with ASTM A6/A6M.

B. Minimize the amount of field welding.
   1. Shop assemble components into largest size possible commensurate with transportation and handling limitations.
   2. Shop connections: Bolted with high-strength bolts or welded.

C. Connection Details:
   1. Connections not fully detailed on Drawings shall be designed by a Professional Engineer registered in the Commonwealth of Virginia, retained by Supplier, based on requirements of Contract Documents.
   2. Where beam reactions are shown on Drawings, design beam connection to support specified loads.
   3. Where no reactions are shown, design each beam connection to support one-half of total uniform load capacity tabulated in AISC tables for "Uniform Load Constants for Beams" for the given shape, span and steel grade specified.
   4. Where indicated on the Drawings, design beam connections for the axial load or transfer forces indicated in addition to the shear value indicated above.
   5. Design bracing connections for loads indicated on the Drawings.
   6. Design girt connections for required lateral wind and/or seismic horizontal load acting either inward or outward in addition to vertical load due to panel and girt weight.
   7. Provide as a minimum, two (2) 3/4 IN DIA, high-strength bolts for all bolted connections unless otherwise specified.

D. Provide bearing type connections for all bolted connections, unless specified otherwise or required to be slip-critical by the RCSC Specification for Structural Joints Using High-Strength Bolts.

E. One-sided or other types of eccentric connections not indicated will not be permitted without prior approval.

F. Field Connections:
   1. Provide bolts for all field connections except where shown otherwise on the Drawings.
   2. Use high-strength bolts unless shown or specified otherwise.
   3. Use of high-strength bolts: Conform to RCSC Specification for Structural Joints Using High-Strength Bolts.
   4. Unfinished bolts may be used for attaching stair treads to stringers.
   5. If structural steel details (field welds versus shop welds, etc.) shown on design Drawings are not compatible with selected erection procedures, submit proposed modifications for review.
   6. Connections to structural steel provided by others: Provide all connectors and coordinate location of bolt holes to match connection holes in steel provided by others.

G. Accurately mill column end bearing surfaces to true plane.

H. Fabricate and erect beams with non-specified camber in accordance with AISC 360, Chapter L1.

I. Cut, drill, or punch holes at right angles to surface of metal.
   1. Do not make or enlarge holes by burning.
   2. Make holes clean cut, without torn or ragged edges.
   3. Remove outside burrs resulting from drilling or reaming operations with tool making 1/16 IN bevel.
   4. Provide holes in members to permit connection of work of other trades or Supplier.

J. Make allowance for draw in all cross bracing to provide small amount of initial tension in members.

K. Make splices only where indicated or where approved.

L. Cope at 45 degrees, corners of stiffener plates at junction of member flanges with webs.

M. Flame cut bevels for welds, provided such cutting is done automatically.
   1. Leave free of burrs and slag by grinding or planing the cut edges.

N. Grind smooth all rough welds and sharp steel edges shall be ground to approximately 1/8 IN radius.

O. Tolerances (unless noted otherwise on Drawings):
   1. When material received from the mill does not satisfy ASTM A6/A6M tolerances for camber, profile, flatness or sweep, Supplier is permitted to perform corrective work by the use of controlled heating, and mechanical straightening, subject to the limitations of the AISC 360.
   2. Fabrication tolerance:
      a. Member length:
         1) Both ends finished for contact bearing: 1/32 IN.
         2) Framed members: 30 FT or less: 1/16 IN. Over 30 FT: 1/8 IN.
      b. Member straightness:
         1) Compression members: 1/1000 of axial length between points laterally supported.
         2) Non-compression members: ASTM A6/A6M tolerance for wide flange shapes.
      c. Specified member camber (except compression members):
         1) 50 FT or less: -0/+1/2 IN.
         2) Over 50 FT: -0/+1/2 IN (plus 1/8 IN per 10 FT over 50 FT).
         3) Members received from mill with 75 percent of specified camber require no further cambering.
         4) Fabricate beams/trusses without specified camber so after erection, camber is upward.
         5) Measure camber in fabrication shop in unstressed condition.
      d. Use filler plates at bolted splices to take up depth deviation.
         1) At welded joints, adjust weld profile to conform to variation in depth.
         2) Slope weld surface per AWS requirements.
      e. Free finished members from twists, bends and open joints.
         1) Sharp kinks, bends and deviation from the above tolerances are cause for rejection of material.

2.4 WELDING

A. Comply with AWS D1.1/D1.1M, and other requirements indicated herein, for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.
   1. Qualify joint welding procedures or test in accordance with AWS qualification procedures.

B. Test and qualify welders, welding operators and tackers in compliance with AWS D1.1/D1.1M for position and type of welding to which they will be assigned.
   1. Conduct tests in presence of approved testing agency.
   2. Certification within previous 12 months will be acceptable, provided samples of the welder's work are satisfactory.

C. Before Starting Welding:
   1. Carefully plumb and align members in compliance with specified requirements.
   2. Fully tighten all bolts.
   3. Comply with AWS D1.1/D1.1M, Section 5 for assembly and surface preparation.
   4. Preheat base metal to temperature stated in AWS D1.1/D1.1M.

a. When no preheat temperature is given in AWS D1.1/D1.1M and base metal is below 50 DegF, preheat base metal to at least 70 DegF.
b. Maintain temperature during welding.
c. Preheat surface of all base metal within distance from point of welding equal to thickness of thicker part being welded or 3 IN, whichever is greater, to specified preheat temperature.
d. Maintain this temperature during welding.

5. Mark welds with an identifying mark unique to each welder.

D. Make flange welds before making web welds.

E. Where groove welds have back-up plates, make first three (3) passes with 1/8 IN round electrodes.
1. Use backup plates in accordance with AWS D1.1/D1.1M, extending minimum of 1 IN either side of joint.

F. Flame cut edges of stiffener plates at shop or field butt weld.
1. Do not shear.

G. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.

H. Low Hydrogen Electrodes: Dry and store electrodes in compliance with AWS D1.1/D1.1M.

I. Do not perform welding when ambient temperature is lower than 0 DegF or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.

J. Headed Studs and Deformed Bar Anchors:
1. Automatically end welded in accordance with the AWS D1.1/D1.1M and manufacturer's recommendations.
2. Fillet welding of headed studs and deformed bar anchors is not allowed unless approved by Owner.

K. Test in-place studs in accordance with requirements of AWS D1.1/D1.1M to ensure satisfactory welding of studs to members.
1. Replace studs failing this test.

L. When headed stud-type shear connectors are to be applied, clean top surface of members to receive studs in shop to remove oil, scale, rust, dirt, and other materials injurious to satisfactory welding.
1. Do not shop paint or galvanize metal surfaces to receive field applied studs.

2.5 SHOP COATING

A. Coordinate shop primer, surface preparation and coating with field applied primers and coatings where specified.

B. Provide suitable methods of handling and transporting painted steel to avoid damage to coating.

C. Do not coat following surfaces:
1. Machined surfaces, surfaces adjacent to field welds, and surfaces fully embedded in concrete.
2. All other members for which no coating is specified.
3. Contact surfaces at bolted slip-critical connections, unless surface condition conforms to the RCSC Specification for Structural Joints Using High-Strength Bolts, Part 3.2.2.

D. Clean thoroughly all surfaces not coated before shipping.
1. Remove loose mill scale, rust, dirt, oil and grease.
2. Protect machined surfaces.
3. Galvanize all structural and miscellaneous steel after fabrication per ASTM A123/A123M.

2.6 SOURCE QUALITY CONTROL

A. Testing Agency Responsibilities:
   1. Inspect shop and field welding in accordance with AWS D1.1/D1.1M, Section 6 including the following non-destructive testing:
      a. Visually inspect all welds.
      b. In addition to visual inspection, test 50 percent of full penetration welds and 20 percent of fillet welds with liquid dye penetrant.
      c. Test 20 percent of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
   2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
      a. Verify proper pretension for slip-critical bolted connection.
      b. Verify direct tension indicator gaps.
   3. Inspect structural steel which has been erected.
   4. Inspect stud welding in accordance with AWS D1.1/D1.1M, Section 7.8.
   5. Prepare and submit inspection and test reports to Owner.
      a. Assist Owner to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 GENERAL

A. Supplier is solely responsible for safety.
   1. Supplier means and methods and sequencing of work is the prerogative of the Supplier.
   2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, bracing or rigid connections are installed.
   3. Partially complete structural members shall not be loaded without an investigation by the Supplier.
   4. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished, and installed by the Contractor for the partially complete structure.

B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including wind, construction activities, and operation of equipment, is the responsibility of the Contractor.
   1. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
   2. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
   3. Design of the temporary bracing system and consideration of the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades, is the Contractor's responsibility.
      a. If not obvious from experience or from the Drawings, the Contractor shall confer with the Owner to identify those structural steel elements that must be complete before the temporary bracing system is removed.
   4. Remove and dispose of all temporary work and facilities off-site.

C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
   1. Report defects in work-in-place which may influence satisfactory completion of the work.
   2. Absence of such notification will be construed as acceptance of work-in-place.

D. Field Measurement:
   1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
   2. Supplier is responsible for the accurate fit of the work.

E. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.
   1. Notify Owner of any errors or deviations found by such checking.

3.2 ERECTION

A. Framing member location tolerances after erection shall not exceed the frame tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

B. Erect plumb and level; introduce temporary bracing required to support erection loads.

C. Use light drifting necessary to draw holes together.
   1. Drifting to match unfair holes is not allowed.

D. Welding:
   1. Conform to AWS D1.1/D1/1M and requirements of this Specification Section.
   2. Join two (2) sections of steel of different ASTM designations using welding techniques in accordance with a qualified AWS D1.1/D1.1M procedure.

E. Shore existing members when unbolting of common connections is required.
   1. Use new bolts for rebolting connections.

F. Clean stored material of all foreign matter accumulated during erection period.

G. Clean bearing and contact surfaces before assembly.

H. Set beam and column base and bearing plates accurately, as indicated, on nonshrink grout.
   1. Set and anchor each base plate to proper line and elevation.
   2. Use metal wedges, shims or setting nuts as required and tighten anchor bolts.
      a. Use same metal as base plate.
      b. Cut off protrusions of wedges and shims flush with edge of base plate.
   3. Fill sleeves around anchor bolts with nonshrink grout.
   4. Pack grout solidly between bottom of plate and bearing surface.

I. Anchor Bolts:
   1. Anchor bolt location tolerance per AISC 303, Section 7.5.
   2. Tie anchor bolts in position to embedded reinforcing steel using wire.
   3. Welding or tack welding is prohibited.
   4. Provide steel templates for locating anchor bolts.
   5. Coat bolt threads and nuts with heavy coat of clean grease.

J. Install high strength bolts with hardened washers.
   1. Install and tighten in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 8.
   2. Coordinate installation with inspection.
      a. Do not start installation until coordination with Testing Agency is complete.
   3. Bearing-type connections: High-strength bolts shall be tightened to snug-tight condition.
   4. Slip-critical connections:
      a. Perform calibration testing for all methods of installation of high-strength bolts in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts, Section 8.2.
      b. Turn-of-nut tightening:
         1) Inspector shall observe the pre-installation verification testing.
         2) Subsequently, ensure by routine observation that the bolting crew properly rotates the turned element relative to the unturned element by the amount specified.

3) Alternatively, when fastener assemblies are match-marked after the initial fitup of the joint but prior to pretensioning, visual inspection after pretensioning is permitted in lieu of routine observation.

c. Calibrated wrench tightening: Calibrate on a daily basis.

d. Direct tension indicator tightening: If previously approved by Owner.

e. Installation of alternate design bolts: If previously approved by Owner.

5. In the event any bolt in a connection is found to be defective, check and retighten all bolts in the connection.

K. Do not use gas cutting to correct fabrication errors.

1. In case members do not fit or holes do not match, ream out the holes and insert the next larger size bolt.
   a. Drill new holes if the connections require new holes.
   b. Make no such corrections without prior approval of the Owner.
2. Burning of holes is not permitted.

L. Prior to making field connections to existing structural steel, remove completely all paint from existing steel which will be in contact with new steel and new welds.

M. Tighten and leave in place erection bolts used in welded construction.

N. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1 in 20 with a plane normal to bolt axis.

O. After bolts are tightened, upset threads of non-high strength bolts and anchor bolts to prevent nuts from backing off.

P. After Erection:

1. Grind smooth all sharp surface irregularities resulting from field cutting or welding.
2. Power tool clean welds, bolts, washers and abrasions to shop coat removing all rust and foreign matter.

Q. Expansion Anchor Bolts and Adhesive Anchor Bolts:

1. Minimum embedment as recommended by manufacturer or specified herein, whichever is larger.
2. Notify Owner if required depth of embedment cannot be achieved at a particular bolt location.
3. Follow manufacturer's recommendations for installation and torque.

3.3 FIELD QUALITY CONTROL

A. Testing Agency responsibilities are described in the SOURCE QUALITY CONTROL Article in PART 2 of this Specification Section.

B. Erected Frame Tolerance, unless noted otherwise on the Drawings:

1. Do not exceed cumulative effect of rolling, fabrication and erection tolerance for overall finished dimensions.
2. Erection tolerances are defined relative to member working points and working lines as follows:
   a. Actual centerline of top flange or surface at each end for horizontal members.
   b. Actual center of member at each end for all other members.
   c. Other points may be used, providing they are based on these definitions.
   d. Working line is straight line connecting member working points.
3. Tolerances on position and alignment are as specified in the Code, unless otherwise modified.
   a. Provide "adjustable items" such as lintels, wall supports, curb angles, window mullions and similar members with adjustable connections to supporting structural frame.

4. Certification by steel erector:
    a. Certify the location of erected structural steel is acceptable for plumbness, level and aligned within tolerances specified.
    b. Provide certification upon completion of any part of work.
    c. Provide certification prior to start of work by other trades that may be supported; attach to structural steel work.

3.4 CLEANING AND REPAIR OF SHOP PRIMER PAINT

A. After erection, clean all steel of mud or other foreign materials, and repair any damage.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other Specification Sections.
2. Design of all temporary bracing not indicated on Drawings.
3. Design of systems and components, including but not limited to:
   a. Stairs.
   b. Landings.
   c. Ladders.
   d. Modular framing system.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 01 - General Requirements.
2. Section 05 12 00 - Structural Steel.
3. Section 05 52 05 - Steel Railings.
4. Section 46 34 50 - Pre-Engineered, Fabricated Thermal Hydrolysis Process System.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. American Association of State Highway and Transportation Officials (AASHTO):
   a. HB, Standard Specifications for Highway Bridges.
2. American Institute of Steel Construction (AISC):
   a. 325, Manual of Steel Construction - Allowable Stress Design (ASD).
   b. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
3. American National Standards Institute (ANSI):
   a. A14.3, Ladders - Fixed - Safety Requirements.
4. American Society of Civil Engineers (ASCE):
   a. 7, Minimum Design Loads for Buildings and Other Structures.
5. ASTM International (ASTM):
   a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   b. A36, Standard Specification for Carbon Structural Steel.
   c. A47, Standard Specification for Ferritic Malleable Iron Castings.
   d. A48, Standard Specification for Gray Iron Castings.
   e. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   f. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
   g. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   i. A197, Standard Specification for Cupola Malleable Iron.
   j. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   k. A276, Standard Specification for Stainless Steel Bars and Shapes.
   l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

m. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
o. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
p. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
q. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
r. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
s. A536, Standard Specification for Ductile Iron Castings.
t. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
u. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
v. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
w. A668, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
x. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
y. A786, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
z. A992, Standard Specification for Steel for Structural Shapes.
aa. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
bb. B26, Standard Specification for Aluminum-Alloy Sand Castings.
cc. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
dd. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
ee. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
ff. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
gg. B632, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
hh. F467, Standard Specification for Nonferrous Nuts for General Use.
ii. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
jj. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
kk. F835, Standard Specification for Alloy Steel Socket Button and Flat Countersunk Head Cap Screws.
ll. F879, Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws.
mm. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
nn. F1789, Standard Terminology for F16 Mechanical Fasteners.

6. American Welding Society (AWS):
   a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. D1.1, Structural Welding Code - Steel.
   c. D1.2, Structural Welding Code - Aluminum.
   d. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
7. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP 510, Metal Stairs Manual.

b. AMP 555, Code of Standard Practice for the Architectural Metal Industry (Including Miscellaneous Iron).
c. MBG 531, Metal Bar Grating Manual.

8. NACE International (NACE).
9. Nickel Development Institute (NiDI):
   a. Publication 11 007, Guidelines for the welded fabrication of nickel-containing stainless steels for corrosion resistant services.
10. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
11. Building code:
    a. International Code Council (ICC):
       1) Virginia Building Performance Standards.
       2) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
1. Qualify welding procedures and welding operators in accordance with AWS.
2. Fabricator shall have minimum of 10 years' experience in fabrication of metal items specified.
3. Engineer for Supplier-designed systems and components: Professional structural engineer licensed in the Commonwealth of Virginia.
4. NACE certified inspector shall have minimum of two years' experience performing inspections as indicated.
   a. Have a current Level III coating inspector certification.

1.3 DEFINITIONS

A. Fasteners: As defined in ASTM F1789.

B. Galvanizing: Hot-dip galvanizing per ASTM A123/A123M or ASTM A153/A153M with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

C. Hardware: As defined in ASTM A153/A153M.

D. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Fabrication and/or layout drawings and details:
   a. Submit drawings for all fabrications and assemblies.
      1) Include erection drawings, plans, sections, details and connection details.
   b. Identify materials of construction, shop coatings and third party accessories.
3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Provide manufacturer's standard allowable load tables for the following:
      1) Grating and checkered plate.
      2) Expansion anchor bolts.
      3) Adhesive anchor bolts.
      4) Modular framing systems.

4. Supplier designed systems and components, including but not limited to, stairs, landings and ladders:
    a. Certification that manufactured units meet all design loads specified.
    b. Shop Drawings and engineering design calculations:
        1) Indicate design live loads.
        2) Sealed by a professional structural engineer registered in the Commonwealth of Virginia.
        3) Owner will review for general compliance with Contract Documents.

B. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Certification of welders and welding processes.
    a. Indicate compliance with AWS.
3. NACE inspector qualifications.
4. NACE certification of surface preparation.
5. NACE certification of paint application.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle fabrications to avoid damage.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Headed studs and deformed bar anchors:
    a. Nelson Stud Welding Div., TRW Inc.
    b. Stud Welding Products, Inc.
2. Expansion anchor bolts:
    a. Hilti Inc.
    b. ITW Ramset/Red Head.
    c. Simpson Strong-Tie.
3. Epoxy adhesive anchor bolts:
    a. Hilti Inc.
    b. ITW Ramset/Red Head.
    c. Simpson Strong-Tie.
4. Self-tapping concrete anchors:
    a. ITW Buildex.
    b. Powers Fasteners.
5. Ladders:
    a. Any manufacturer capable of meeting the requirements of this Specification Section.
6. Galvanizing repair paint:
    a. Clearco Products Co., Inc.
    b. ZRC Products.
7. Modular framing system:
    a. Unistrut Building Systems.
    b. B-Line Systems.
    c. Kindorf.
    d. Superstrut.
8. Ladder safety extension post:
    a. Bilco.

2.2 MATERIALS

A. Steel:
   1. Structural:
      a. W-shapes and WT-shapes: ASTM A992, Grade 50.
      b. All other plates and rolled sections: ASTM A36.
   2. Pipe: ASTM A53, Types E or S, Grade B or ASTM A501.
   3. Structural tubing:
      a. ASTM A500, Grade B (46 ksi minimum yield).
   4. Bolts, nuts and washers, high strength:
      a. ASTM A325.
      b. Galvanized, ASTM A153/A153MProvide two (2) washers with all bolts.
   5. Bolts and nuts:
      a. ASTM A307, Grade A.
   6. Steel forgings: ASTM A668.

B. Iron:
   1. Ductile iron: ASTM A536.
   2. Gray cast iron: ASTM A48 (minimum 30,000 psi tensile strength).
   3. Malleable iron: ASTM A47, ASTM A197.

C. Stainless Steel:
   1. Stainless steel in welded applications: Low carbon 'L' type.
   2. Minimum yield strength of 30,000 psi and minimum tensile strength of 75,000 psi.
      a. Bars, shapes: ASTM A276, Type 304.
      b. Tubing and pipe: ASTM A269, ASTM A312 or ASTM A554, Type 304 or 316.
      c. Strip, plate and flat bars: ASTM A666, Type 304 or 316.
      d. Bolts and nuts: ASTM F593, Type 303, 304 or 316.
   3. Minimum yield strength of 25,000 psi and minimum tensile strength of 70,000 psi.
      a. Strip, plate and flat bar for welded connections, ASTM A666, Type 304L or 316L.
   4. Welding electrodes: In accordance with AWS for metal alloy being welded.

D. Washers: Same material and alloy as found in accompanying bolts and nuts.

E. Embedded Anchor Bolts:
   1. Building anchor bolts:
      a. ASTM F1554, Grade 55 with weldability supplement S1 or ASTM A36 for threaded rods galvanized.
      b. ASTM A307, Grade A for headed bolts galvanized.
   2. All other anchor bolts: Type 304 or 316 stainless steel with matching nut and washer.

F. Expansion Anchor Bolts and Adhesive Anchor Bolts:
   1. Stainless steel, Type 304, 314 or 316.
   2. Provide minimum edge distance cover and spacing as recommended by manufacturer, or as indicated on Drawings whichever is larger.
      a. Minimum embedment as recommended by manufacturer or eight (8) diameters of bolt, whichever is larger.
      b. Notify Owner if required depth of embedment cannot be achieved at a particular anchor bolt location.
      c. Follow manufacturer's recommendations for installation and torque.
   3. Submit manufacturer's load test data to verify at least the anchor bolt capacities at the following embedment depths:
      a. Data must be based on actual tests performed in unreinforced mass of concrete of not more than 4000 psi compressive strength.

b. Capacity must be at a concrete temperature of at least 130 DegF.

Anchor Bolt Diameter (IN)	Embedment (IN)	Minimum Ultimate Tension Capacity (KIP)*, **
3/8	3	4.8
1/2	4	8.1
5/8	5	11.4
3/4	6	15.4
7/8	7	20.0
1	8	24.7
1-1/4	10	34.3

* Data must be based on actual tests preformed in unreinforced mass concrete of not more than 4000 psi compressive strength.

** Capacity must be at a concrete temperature of at least 130 DegF.

4. Expansion anchor bolts:
   a. Kwik Bolt by Hilti, Inc.
   b. Trubolt by ITW Ramset/Red Head.
   c. Wedge-All by Simpson Strong-Tie.
5. Adhesive anchor bolts:
   a. HVA Adhesive Anchor System by Hilti.
   b. HIT HY 150 Adhesive Anchor by Hilti.
   c. HSE 2411 Epoxy Adhesive Anchor by Hilti.
   d. EPCON Ceramic 6 Epoxy by ITW Ramset/Red Head.
   e. Acrylic-Tie by Simpson Strong-Tie.
6. Self-tapping concrete anchors:
   a. Tapcon by ITW Buildex.
   b. 410 stainless steel.
   c. 1/4 IN DIA with 5/16 IN hex head.
      1) Minimum embedment as recommended by manufacturer.
   d. #3 Phillips flat head.

G. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.

H. Deformed Bar Anchors: ASTM A496 or ASTM A1064 with a minimum yield strength of 70,000 psi and a minimum tensile strength of 80,000 psi.

I. Iron and Steel Hardware: Galvanized in accordance with ASTM A153/A153M when required to be galvanized.

J. Galvanizing Repair Paint:
   1. High zinc dust content paint for regalvanizing welds and abrasions.
   2. ASTM A780.
   3. Zinc content: Minimum 92 percent in dry film.
   4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."

K. Protect Dissimilar Materials.

2.3 MANUFACTURED UNITS

A. Ladders:
   1. General:
      a. Fully welded type.
         1) All welds to be full penetration welds.
      b. All ladders of a particular material shall have consistent construction and material shapes and sizes unless detailed otherwise on the Drawings.
      c. Design ladder in accordance with OSHA Standards, ANSI A14.3, ASCE 7 and applicable Building Codes.
      d. Ladders shall be designed to support a minimum concentrated live load of 300 LBS at any point to produce the maximum stress in the member being designed.
         1) Apply additional 300 LB loads for each section of ladder exceeding 10 FT.
      e. Maximum allowable stresses per AISC Specification.
      f. Maximum lateral deflection: Side rail span/240 when lateral load of 100 LBS is applied at any location.
   2. Material:
      a. Steel.
      b. Finish:
         1) Mill.
   3. Rails:
      a. Round pipe or rectangular tubing:
         1) Round pipe:
            a) 1-1/2 IN nominal diameter.
            b) Schedule 80.
         2) Rectangular tubing:
            a) Cross-section: 3 by 2 IN maximum.
            b) Thickness: 0.125 IN minimum.
      b. Spacing:
         1) Minimum clear distance between rails to be 18 IN.
         2) Step-through ladder extensions: 24 IN, centerline to centerline.
      c. Provide cap at exposed top and bottom of side rails.
         1) Provide weep holes as necessary to prevent the accumulation of moisture within hollow members.
      d. Extend side rails of step-through ladders a minimum of 42 IN above the landing.
   4. Rungs:
      a. Minimum 1 IN DIA or 1 IN square solid bar.
         1) Integral non-slip finish on all sides.
            a) Non-slip finish: Coarse knurling or extruded serrations.
            b) Shop or field-applied grit tape and cap type non-slip finish is not acceptable.
      b. Rungs shall penetrate inside wall of side rails.
         1) Do not extend rungs beyond the outside face of the side rail.
         2) Provide full-penetration weld all around rung.
      c. Rung spacing:
         1) Uniform, 12 IN.
         2) Top rung shall be level with landing or platform.
            a) Where top of ladder terminates at grating cover, floor access door, roof hatch or similar condition; locate top rung as close as practicable to, but not more than 6 IN below, adjacent walking surface.
         3) Spacing of bottom rung from grade or platform may vary but shall not exceed 14 IN.

5. Brackets:
    a. Angle or bent plate brackets welded to side rails:
        1) 3/8 IN by 2-1/2 IN by length required.
        2) Provide punched holes for 3/4 IN bolts or anchors.
        3) Minimum distance from centerline of rung to wall or any obstruction: 7 IN.
        4) Maximum spacing: 4 FT OC.
    b. For floor supported ladders, provide 3/8 by 2-1/2 by 4 IN rectangular bracket or 3/8 by 6 by 6 IN square plate welded to rails with punched holes for 3/4 IN bolts.
        1) Provide wall brackets on floor supported units if vertical run is over 4 FT.
6. Provide ladder cage where shown on the Drawings.
    a. Cage construction shall meet all requirements of OSHA Standards and this Specification Section:
        1) Hoops: Minimum 1/4 by 2 IN bar at 48 IN OC spacing.
        2) Vertical bars: Minimum 1/4 by 1-1/2 IN bar.
        3) Weld all connections.
        4) Construct cage of same materials as the ladder on which it is mounted.
        5) Mount cage on ladder by welding.
7. Landings:
    a. Construct landing, railing and all supports of same material as the ladder.
    b. Design landing platform and supporting structure for not less than 100 psf plus a concentrated load of 300 LBS with a maximum deflection of 1/300 of span under a superimposed live load of 100 psi.
    c. Grating:
        1) Minimum 1-1/2 IN non-slip grating per this Specification Section.
        2) Attach grating using stainless steel clips and bolts at 24 IN OC maximum spacing.
    d. Structural support: Channel or tubular sections with bracing, plates, angles, etc., to support guardrail and grating and to support landing off the side of the building wall framing.
        1) Weld or bolt all connections using stainless steel bolts, nuts and washers.
    e. Guardrails:
        1) Match ladder side rails.
            a) Space two intermediate rails equally between top rail and top of kickplate.
        2) Provide 4 IN high x 3/8 IN thick toeboard each side of landing.
8. Gates:
    a. Constructed of same material and sizes as the ladder system.
    b. Hinges:
        1) Stainless steel.
        2) Heavy-duty, self-closing.
    c. Gate stop:
        1) Galvanized steel.
        2) Positive self-latching.
9. Ladder safety extension post:
    a. Telescoping tubular galvanized steel section that automatically locks into place when fully extended.
    b. Non-ferrous corrosion-resistant spring and hardware.
    c. Factory assembled with all hardware necessary for mounting to ladder.
    d. Bilco "LadderUp" safety post.

B. Metal Stairs:
1. Fabricated as indicated.
2. Treads: Grating as specified.
    a. Provide integral corrugated non-slip nosing.
3. Risers:
    a. Grating treads: Solid plate attached to trailing edge of tread.

4. Landings:
    a. Grating as specified.
    b. Provide integral corrugated non-slip nosing at edge acting as stair tread/nosing.
5. Fabricate and design stair, platforms and landings, and all connections to support a 100 psf uniform live load or a concentrated load of 1000 LBS, whichever requires the stronger component.
6. Design, fabricate, and install in compliance with NAAMM and applicable codes.
    a. NAAMM AMP 510:
        1) Exterior at site structures and equipment: Industrial Class.
        2) Interior or exterior at buildings: Service Class.
7. Handrails and guardrails: Refer to Specification Section 05 52 05 - Steel Railings.
8. Material:
    a. Steel: ASTM A36, galvanized after fabrication.

C. Steel Grating:
1. NAAMM MBG 531.
2. Bearing bars:
    a. Rectangular 1-1/2 by 3/16 IN unless shown otherwise on Drawings.
    b. Maximum 1-3/16 IN OC spacing.
3. Cross bars:
    a. Welded, swagged or pressure locked to bearing bars.
    b. Maximum 4 IN OC spacing.
4. Top edges of bars: Serrated or grooved.
5. Removable grating sections: Not wider than 3 FT and not more than 100 LBS.
6. Finish:
    a. Galvanized.
    b. Clips and bolts: Galvanized.
    c. Seat angles: Galvanized steel.
7. Ends and perimeter edges: Banded.
8. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
9. Provide joints at openings between individual grating sections.

2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.
1. Grind smooth all rough welds and sharp edges.
    a. Round all corners to approximately 1/32 - 1/16 IN nominal radius.

C. Provide drilled or punched holes with smooth edges.
1. Punch or drill for field connections and for attachment of work by other trades.

D. Weld Permanent Shop Connections:
1. Welds to be continuous fillet type unless indicated otherwise.
2. Full penetration butt weld at bends in stair stringers and ladder side rails.
3. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1/A5.1M.
4. Weld aluminum in accordance with AWS D1.2.
5. Weld stainless steel in accordance with AWS D1.6.
    a. Treat all welded areas in accordance with ASTM A380.
6. Weld stainless steel in accordance with AWS D1.6 and NiDI 11 007.
7. All headed studs to be welded using automatically timed stud welding equipment.
8. Grind smooth welds that will be exposed.

E. Conceal fastenings where practicable.

F. Fabricate work in shop in as large assemblies as is practicable.

G. Tolerances:
   1. Rolling:
      a. ASTM A6.
      b. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Supplier is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC Specification.
   2. Fabrication tolerance:
      a. Member length:
         1) Both ends finished for contact bearing: 1/32 IN.
         2) Framed members:
            a) 30 FT or less: 1/16 IN.
            b) Over 30 FT: 1/8 IN.
      b. Member straightness:
         1) Compression members: 1/1000 of axial length between points laterally supported.
         2) Non-compression members: ASTM A6 tolerance for wide flange shapes.
      c. Specified member camber (except compression members):
         1) 50 FT or less: Minus 0/plus 1/2 IN.
         2) Over 50 FT: Minus 0/plus 1/2 IN (plus 1/8 IN per 10 FT over 50 FT).
         3) Members received from mill with 75 percent of specified camber require no further cambering.
         4) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.
         5) Camber shall be measured in fabrication shop in unstressed condition.
      d. At bolted splices, depth deviation shall be taken up by filler plates.
         1) At welded joints, adjust weld profile to conform to variation in depth.
         2) Slope weld surface per AWS requirements.
      e. Finished members shall be free from twists, bends and open joints.
         1) Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.

H. Fabricate grating, checkered plate, stairs, ladders and accessories using galvanized steel unless shown otherwise on Drawings.
   1. Finish:
      a. Mill, unless noted otherwise.
      b. Coat surfaces in contact with dissimilar materials.

I. Fabricate grating in accordance with NAAMM MBG 531.
   1. Maximum tolerance for difference in depth between grating depth and seat or support angle depth: 1/8 IN.
   2. Distance between edge of grating and face of embedded seat angle or face of wall or other structural member: 1/4 IN.
      a. Tolerance: NAAMM MBG 531.
   3. Removable sections: Not wider than 3 FT and not more than 100 LBS.
   4. Ends and perimeter edges: Banded.
      a. Provide full depth banding unless noted otherwise.
      b. Banding at trenches and sumps to be 1/4 IN less than grating depth to allow for drainage.
   5. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
   6. Provide joints at openings between individual grating sections.
   7. Fabricate grating so that bearing bars and cross bars in adjacent sections are aligned.

J. Fabricate checkered plate and miscellaneous metals in accordance with NAAMM AMP 555.
   1. Workmanship: Class 2 unless noted otherwise.

K. Passivate stainless steel items and stainless steel welds after they have been ground smooth, where indicated on Drawings.
   1. ASTM A380.

2.5 SOURCE QUALITY CONTROL

A. Surface Preparation:
   1. All miscellaneous metal fabrication item surfaces shall be inspected and approved by NACE certified coatings inspector prior to application of shop-applied paint coating.
      a. Inspection shall be performed to determine depth of blast profile and cleanliness of surface.
      b. Fabricator shall reblast and or re-clean surfaces as required until acceptable.

B. Shop Applied Paint Coating Application:
   1. After surface has been accepted in writing by NACE certified coatings inspector, fabricator may proceed with application of paint coatings.
   2. Application of paint coatings shall be observed and certified by NACE certified coatings inspector.

C. Supplier Pays for Field Inspection and Testing:
   1. Owner will employ and pay for services of an independent testing agency to inspect and test structural steel shop and field work for compliance with this Specification Section.
   2. Supplier responsible for testing to qualify shop and field welders and as needed for Supplier's own quality control to ensure compliance with Contract Documents.
   3. Supplier provides sufficient notification and access so inspection and testing can be accomplished.
   4. Supplier pays for retesting of failed tests and for additional testing required when defects are discovered.

D. Supplier Pays for Shop Inspection and Testing:
   1. Employ and pay for the services of a qualified independent testing agency to inspect and test all structural steel work for compliance with Contract Documents.
   2. Independent testing agency shall have a minimum of five years performing similar work and shall be subject to Owner's approval.

E. Responsibilities of Testing Agency:
   1. Inspect shop and field welding in accordance with AWS Code including the following non-destructive testing:
      a. Visually inspect all welds.
      b. In addition to visual inspection, test 50 percent of full penetration welds and 20 percent of fillet welds with liquid dye penetrant.
      c. Test 20 percent of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
   2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
      a. Verify direct tension indicator gaps.
   3. Inspect structural steel which has been erected.
   4. Inspect stud welding in accordance with AWS Code.
   5. Prepare and submit inspection and test reports to Owner.
      a. Assist Owner to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide items to be built into other construction in time to allow their installation.
   1. If such items are not provided in time for installation, cut in and install.

B. Prior to installation, inspect and verify condition of substrate.

C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

3.2 INSTALLATION

A. Set metal work level, true to line, plumb.
   1. Shim and grout as necessary.

B. Supplier is solely responsible for safety.
   1. Construction means and methods and sequencing of work is the prerogative of the Supplier.
   2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing or rigid connections are installed.
   3. Partially complete structural members shall not be loaded without an investigation by the Supplier.
   4. Until all elements of the permanent structure and lateral bracing system are complete, temporary bracing for the partially complete structure will be required.

C. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including construction activities and operation of equipment is the responsibility of the Contractor.
   1. Plumb, align, and set structural steel members to specified tolerances.
   2. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
   3. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
   4. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.
      a. If not obvious from experience or from the Drawings, the Contractor shall confer with the Owner to identify those structural steel elements that must be complete before the temporary bracing system is removed.
   5. Remove and dispose of all temporary work and facilities off-site.

D. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
   1. Report defects in work-in-place which may influence satisfactory completion of the work.
   2. Absence of such notification will be construed as acceptance of work-in-place.

E. Field Measurement:
   1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
   2. Supplier is responsible for the accurate fit of the work.

F. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.
   1. Use surveyor's level.
   2. Notify Owner of any errors or deviations found by such checking.

G. Framing member location tolerances after erection shall not exceed the frame tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

H. Erect plumb and level; introduce temporary bracing required to support erection loads.

I. Use light drifting necessary to draw holes together.
   1. Drifting to match unfair holes is not allowed.

J. Welding:
   1. Conform to AWS D1.1 and requirements of the FABRICATION Article in PART 2 of this Specification Section.
   2. When joining two (2) sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.

K. Shore existing members when unbolting of common connections is required.
   1. Use new bolts for rebolting connections.

L. Clean stored material of all foreign matter accumulated during erection period.

M. Bolt Field Connections: Where practicable, conceal fastenings.

N. Field Welding:
   1. Follow AWS procedures.
   2. Grind welds smooth where field welding is required.

O. Field cutting grating or checkered plate to correct fabrication errors is not acceptable.
   1. Replace entire section.

P. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.

Q. Unless noted or specified otherwise:
   1. Connect steel members to steel members with 3/4 IN DIA ASTM A325 high strength bolts.
      a. Provide dissimilar metals protection.
   2. Connect steel members to concrete and masonry using stainless steel expansion anchor bolts or adhesive anchor bolts unless shown otherwise.
      a. Provide dissimilar materials protection.
   3. Provide washers for all bolted connections.
   4. Where exposed, bolts shall extend a maximum of 3/4 IN and a minimum of 1/2 IN above the top nut.
      a. If bolts are cut off to required maximum height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nuts.

R. Install and tighten ASTM A325 high-strength bolts in accordance with the AISC 325, Allowable Stress Design (ASD).
   1. Provide hardened washers for all ASTM A325 bolts.
      a. Provide the hardened washer under the element (nut or bolt head) turned in tightening.

S. After bolts are tightened, upset threads of ASTM A307 unfinished bolts or anchor bolts to prevent nuts from backing off.

T. Secure metal to wood with lag screws of adequate size with appropriate washers.

U. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing.
   1. Provide full penetration welded splices where continuity is required.

V. Provide each fabricated item complete with attachment devices as indicated or required to install.

W. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.

X. Set beam and column base plates accurately on nonshrink grout as indicated on Drawings.
   1. See Specification Section 05 12 00 - Structural Steel for non-shrink grout.
   2. Set and anchor each base plate to proper line and elevation.
      a. Use metal wedges, shims, or setting nuts for leveling and plumbing columns and beams.
         1) Wedges, shims and setting nuts to be of same metal as base plate they support.
         2) Tighten nuts on anchor bolts.
      b. Fill space between bearing surface and bottom of base plate with nonshrink grout.
         1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
      c. Do not remove wedges or shims.
         1) Where they protrude, cut off flush with edge of base plate.
      d. Fill sleeves around anchor bolts solid with non-shrink grout.

Y. Tie anchor bolts in position to embedded reinforcing steel using wire.
   1. Tack welding prohibited.
      a. Coat bolt threads and nuts with heavy coat of clean grease.
   2. Anchor bolt location tolerance:
      a. 1/16 IN.
      b. Provide steel templates for all column anchor bolts.

Z. Install bollards in concrete as detailed.
   1. 48 IN projection above ground.
   2. 48 IN embedment in concrete, unless detailed otherwise on Drawings.
   3. Fill pipe with concrete and round off at top.

AA. Accurately locate and place frames for openings before casting into floor slab so top of plate is flush with surface of finished floor.
   1. Keep screw holes clean and ready to receive screws.

BB. Attach grating to end and intermediate supports with grating saddle clips and bolts.
   1. Maximum spacing: 2 FT OC with minimum of two (2) per side.
   2. Attach individual units of aluminum grating together with clips at 2 FT OC maximum with a minimum of two (2) clips per side.

CC. Repair damaged galvanized surfaces in accordance with ASTM A780.
   1. Prepare damaged surfaces by abrasive blasting or power sanding.
   2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

DD. Anchor ladder to concrete structure with minimum 3/4 IN stainless steel anchor bolts with minimum 6 IN embedment.

EE. Install ladder safety extension post in accordance with manufacturer's instructions.
   1. Mount device opposite the climbing side.
   2. Provide ladder safety extension device for all ladders unless noted otherwise.

FF. Mount ladder fall protection system with rail offset from ladder side rail approximately 3 IN.

GG. Install factory pre-fabricated stairs in location indicated in the Contract Documents.

3.3 FIELD QUALITY CONTROL

A. Tolerances shall meet structural requirements of Specification Section 05 12 00 - Structural Steel for erecting items of structural nature.

B. Tolerances (unless otherwise noted on the Drawings):
   1. Frame placement, after assembly and before welding or tightening.
      a. Deviation from plumb, level and alignment: 1 in 500, maximum.

b. Displacement of centerlines of columns: 1/2 IN maximum, each side of centerline location shown on Drawings.

3.4 CLEANING

A. After fabrication, erection, installation or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.

B. All stainless steel products in addition to Paragraph A. above:
   1. Remove all heat tint, rusting, discoloration by passivation, ASTM A380, or other acceptable means as listed in NiDI 11 007 as approved by the Owner.

END OF SECTION

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SECTION 05 52 05
STEEL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Steel handrail, stair rail and guardrail.
   2. Steel guardrail gates.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 05 50 00 - Metal Fabrications.
   3. Section 46 34 50 - Pre-Engineered, Fabricated Thermal Hydrolysis Process System.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. U.S. Department of Justice, Architectural and Transportation Barriers Compliance Board (Access Board):
      a. Americans with Disabilities Act (ADA):
         1) Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      d. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      e. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
      f. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   3. American Welding Society (AWS):
      a. D1.1, Structural Welding Code - Steel.
   4. National Association of Architectural Metal Manufacturers (NAAMM):
      a. AMP 521, Pipe Railing Systems Manual.
   5. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
   6. Building code:
      a. Virginia Building Performance Standards.
      b. International Code Council (ICC):
         1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

B. Qualify welding procedures and welding operators in accordance with AWS.

1.3 DEFINITIONS

A. Hardware: As defined in ASTM A153/A153M.

B. Galvanizing: Hot-dip galvanizing per ASTM A123/A123M or ASTM A153/A153M with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

C. Guardrail: A system of building components located near the open sides of elevated walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to the lower level.

D. Handrail: A railing provided for grasping with the hand for support.

E. Railing: A generic term referring to guardrail, handrail and/or stair rails.

F. Stair Rail: A guardrail, installed at the open side of stairways with either a handrail mounted to the inside face of the guardrail, or where allowed by applicable codes, with the top rail mounted at handrail height and serving the function of a handrail.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings.
      a. Plan showing profile, location, section and details of each railing, and type and details of anchorage system.
      b. Location and type of expansion joints.
      c. Materials of construction including shop-applied coatings.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Certification of welders and welding procedures indicating compliance with AWS.
   3. Certification that railings have been designed and fabricated to meet the loading requirements specified.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver and handle railings to preclude damage.

B. Store railings on skids, keep free of dirt and other foreign matter which will damage railings or finish and protect from corrosion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Welded railing systems:
      a. Any manufacturer meeting this Specification Section.
   2. Galvanizing repair paint:
      a. ZRC Products.

2.2 MATERIALS

A. Pipe: ASTM A53, Types E or S, Grade B, or ASTM A501.

B. Steel Sheet, Bar (Pickets) and Plate: ASTM A36.

C. Galvanizing Repair Paint:
   1. High zinc dust content paint for regalvanizing welds and abrasions.
   2. Dried film shall contain not less than 95 percent zinc dust by weight.
   3. ZRC Products "ZRC."

D. Expansion and Adhesive Anchors: See Specification Section 05 50 00 - Metal Fabrications .

E. Welding Electrodes: AWS D1.1, E70 Series.

2.3 FABRICATION

A. General:
   1. Verify field conditions and dimensions prior to fabrication.
   2. For fabrication of items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
      a. Remove blemishes by grinding and buffing or by welding and grinding, prior to cleaning, treating and application of surface finishes.
   3. Form exposed work with smooth, short radius bends, accurate angles and straight edges.
      a. Ease exposed edges to a radius of approximately 1/32 IN.
      b. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
   4. Form exposed connections with flush, smooth, hairline joints, using galvanized steel splice locks to splice sections together or by welding.
   5. Provide for anchorage of type indicated on the Drawings or as required by field conditions.
      a. Drill or punch holes with smooth edges.
   6. Design railing and anchorage system in accordance with NAAMM AMP 521 to withstand loading as required by Building Code.
   7. Design railings in accordance with accessibility requirements per the Building Code and ADAAG.

B. Custom fabricate pipe railings to dimensions and profiles indicated.
   1. Guardrails:
      a. 1-1/2 IN nominal diameter pipe.
      b. Top rails and intermediate rails: Schedule 40.
      c. Vertical posts: Schedule 80.
   2. Handrails mounted to walls or guardrail vertical posts: 1-1/4 IN nominal diameter Schedule 40 pipe.
   3. Space two intermediate rails equally spaced between the top rail and kickplate to requirements of the Building Code or OSHA Standards, whichever requires the more restrictive design.
   4. Space vertical posts as required by loading requirements but not more than 4 FT OC.
      a. Avoid locating vertical posts at changes in direction of railing.
      b. Hold vertical post back from corner and provide radiused corners.
   5. Space handrail brackets as required by loading requirements but not more than 4 FT OC.
   6. Base plate for vertical guardrail posts mounted to top of concrete surface:
      a. 3/8 x 6 x 6 IN square plate welded to the vertical post.
      b. Predrilled to accept four (4) anchors.
   7. Base plate for vertical guardrail post mounted to metal structure:
      a. 3/8 x 2-1/2 x 8 IN plate welded to the vertical post.
      b. Predrilled to accept two (2) fasteners.
   8. Mounting bracket for vertical guardrail post mounted to vertical concrete surface or web of metal structural member:
      a. Pair of 3/8 IN angles or bent plates welded to vertical posts.
      b. Predrilled to accept two (2) fasteners each.

c. Provide 1/4 x 4 IN high toe boards at elevated walkways and platforms, where indicated on the Drawings or required by OSHA Standards.
    1) Clearance between bottom of toe board and walking surface shall not exceed 1/4 IN.
d. Guardrail gates:
    1) Constructed of same material and sizes as the guardrail system.
    2) Width of gate as shown on Drawings.
    3) Hinges:
        a) Self-closing.
            (1) Stainless steel torsion spring.
        b) Similar to Wagner, Model "IR100."
    4) Gate latch and stop:
        a) Spring-loaded pin latch.
            (1) Stainless steel spring.
        b) Similar to Wagner, Model "IR101."

C. Welded Railing Fabrication:
1. All welding to be continuous in accordance with AWS D1.1.
    a. All welded railing joints shall have full penetration welds.
2. All exposed welds to be ground and buffed smooth and flush to match and blend with adjoining surfaces.
    a. NAAMM AMP 521, Type 2.
3. No ragged edges, surface defects, or undercutting of adjoining surfaces will be accepted.
4. Fit exposed ends of guardrails and handrails with solid terminations.
    a. Return ends of handrails to wall but do not attach to wall.
5. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly of units at project site.

D. Install weeps to drain moisture from hollow sections of railing at exterior locations and in high humidity areas.
1. Drill 1/4 IN weep hole in railings closed at bottom:
    a. 1 IN above walkway surface at bottom of posts.
        1) 1 IN above solid rod at removable railing sections.
    b. At low point of intermediate rails.
    c. Drill hole prior to galvanizing.
    d. Do not drill weep holes:
        1) In bottom of base plate.

E. Expansion Joints:
1. Joints to be designed to allow expansion and contraction of railing and still meet design loads required.
    a. Top rail splices and expansion joints shall be located within 8 IN of post or other support.
    b. Where railings span building expansion joints; provide a railing expansion joint in the span crossing the building expansion joint.
2. Provide expansion joints in any continuous run exceeding 20 FT in length.
    a. Space expansion joints at not more than 40 FT on center.
3. Provide minimum 0.10 IN of expansion joint for each 20 FT length of top rail for each 25 DegF differential between installation temperature and maximum design temperature.
    a. Maximum expansion joint width at time of installation shall not exceed 3/8 IN.
        1) Provide additional expansion joints as required to limit expansion joint width.
4. Provide slip-joint with internal sleeve.
    a. Extend slip joint min 2 IN beyond joint at maximum design width.
    b. Fasten internal sleeve securely to one side
        1) Provide allen-head set screw located in bottom of rail.
        2) Rivets or exposed screw heads are not acceptable.

F. Finish: Galvanized after fabrication.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to installation, inspect and verify condition of substrate.

B. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

3.2 INSTALLATION

A. Install handrails and guardrails to meet loading requirements of the Building Code.

B. Install products in accordance with NAAMM AMP 521 and manufacturer's instructions.

C. Set work accurately in location, alignment and elevation; plumb, level, and true.
   1. Measure from established lines and items which are to be built into concrete, masonry or similar construction.

D. Align railings prior to securing in place to assure proper matching at butting and expansion joints and correct alignment throughout their length.
   1. Provide shims as required.

E. Install proper sized expansion joints based on temperature at time of installation and differential coefficient of expansion of materials in all railings as recommended by manufacturer.
   1. Lubricate expansion joint splice bar for smooth movement of railing sections.

F. Provide removable railing sections where indicated on Drawings.

G. Attach handrails to walls or guardrails with brackets designed for condition.
   1. Provide brackets which provide a minimum 1-1/2 IN clearance between handrail and nearest obstruction.
      a. Handrails shall not project more than 4-1/2 IN into required stairway width.
   2. Anchor handrail brackets to concrete or masonry walls with 1/2 IN stainless steel adhesive anchors and stainless steel hex head bolts.

H. Anchor railings to concrete with minimum 1/2 IN stainless steel adhesive anchors with stainless steel bolts, nuts and washers unless noted otherwise in the Contract documents.
   1. Where exposed, bolts shall extend minimum 1/2 IN and maximum 3/4 IN above the top nut.
      a. If bolts are cut off to required height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nut.
      b. Bevel the top of the bolt after cutting to provide a smooth surface.

I. Anchor railings to metal structure with minimum 3/4 IN stainless steel bolts, nuts and washers.

J. Install toeboards to fit tight to the walking surface.
   1. Attach to railing vertical post with manufacturer's standard mounting clamp:
      a. Adjustable.
      b. Designed to engage in extruded slot on back of toeboard.
   2. Provide splice bars, corner splices and brackets:
      a. Manufacturer's standard items as required for a complete installation.
   3. Notch toeboards at base plates or other obstructions.
   4. Bottom of toeboard shall not exceed 1/4 IN above walking surface.

K. Repair damaged galvanized surfaces in accordance with ASTM A780.
   1. Properly prepare surface in accordance with galvanizing repair paint manufacturer's recommendations.
   2. Apply minimum 6 mils DFT of galvanizing repair paint in accordance with manufacturer's recommendations.

L. Provide railings as required for stair construction identified in Specification Section 05 50 00 - Metal Fabrications.

M. Install guardrail gate plumb and level in location shown on Drawings.
   1. Center gate in opening.
   2. Top of gate to match top of guardrail.
   3. Fasten hinges to gate and jamb post:
      a. Minimum three (3) 1/4 IN stainless steel countersunk machine screws per leaf.
      b. Drill and tap into railing and gate vertical posts.
   4. Provide not less than two (2) hinges per gate.
   5. Install gate latch and stop on strike side of opening.
      a. Fasten to gate with 1/4 IN stainless steel countersunk machine screws.
      b. Drill and tap into gate vertical post.
      c. Drill hole in railing vertical post to receive latch pin.
   6. Adjust to provide smooth operation:
      a. Self-closing and self-latching.

END OF SECTION

SECTION 09 96 00
HIGH PERFORMANCE INDUSTRIAL COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. High performance industrial coatings (HPIC).
   2. Any other coating, thinner, accelerator, inhibitor, etc., specified or required as part of a complete System specified in this Specification Section.
   3. Minimum surface preparation requirements.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 61 03 - Equipment: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D3359, Standard Test Methods for Measuring Adhesion by Tape Test.
      b. D4414, Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
      c. D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
      d. D6677, Standard Test Method for Evaluating Adhesion by Knife.
      e. D7091, Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals.
   2. The Society for Protective Coatings (SSPC):
      a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
      b. SP 1, Solvent Cleaning.
      c. SP 16, Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
   3. The Society for Protective Coatings/NACE International (SSPC/NACE):
      a. SP 5/NACE No. 1, White Metal Blast Cleaning
      b. SP 6/NACE No. 3, Commercial Blast Cleaning.
      c. SP 7/NACE No. 4, Brush-off Blast Cleaning.
      d. SP 10/NACE No. 2, Near-White Blast Cleaning.
      e. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
   1. Coating manufacturer's authorized representative shall provide written statement attesting that applicator has been instructed on proper preparation, mixing and application procedures for coatings specified.
   2. Applicators shall have minimum of 10 years' experience in application of similar products on similar project.
      a. Provide references for minimum of three (3) different projects completed in last five years with similar scope of work.
      b. Include name and address of project, size of project in value (painting) and contact person.

C. Miscellaneous:
   1. Furnish coating through one (1) manufacturer unless noted otherwise.

D. Deviation from specified mil thickness or product type is not allowed without written authorization of Owner.

E. Material shall not be thinned unless approved, in writing, by coating manufacturer's authorized representative.

1.3 DEFINITIONS

A. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified or in Specification Section 01 61 03.

B. Corrosive Environment:
   1. Immersion in or subject to:
      a. Condensation, spillage or splash of a corrosive material such as water, wastewater or chemical solution.
      b. For purposes of this Specification Section, corrosive environments include:
         1) Exterior areas not otherwise identified as highly corrosive.

C. Holiday:
   1. A void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating.
   2. May also be identified as a discontinuity or pinhole.

D. Exposed Exterior Surface:
   1. Exterior surface which is exposed to view.
   2. Exterior surface which is exposed to weather but not necessarily exposed to view.

E. Immersion Service:
   1. Any surface immersed in water or some other liquid.

F. HPIC: High performance industrial coatings.
   1. Epoxies, urethanes, vinyl ester, waterborne vinyl acrylic emulsions, acrylates, silicones, alkyds, acrylic emulsions and any other coating listed as a HPIC.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Applicator experience qualifications.
      a. No submittal information will be reviewed until Owner has received and approved applicator qualifications.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's application instructions.
      c. Manufacturer's surface preparation instructions.
      d. If products being used are manufactured by Company other than listed in the MATERIALS Article of this Specification Section, provide complete individual data sheet comparison of proposed products with specified products including application procedure, coverage rates and verification that product is designed for intended use.
      e. Contractor's written plan of action for containing airborne particles created by blasting operation and location of disposal of spent contaminated blasting media.
      f. Coating manufacturer's recommendation on abrasive blasting.
      g. Manufacturer's recommendation for universal barrier coat.
      h. Manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.
   4. Manufacturer's statement regarding applicator instruction on product use.

5. Certification that High Performance Coating Systems proposed for use have been reviewed and approved by Senior Corrosion Specification Specialist employed by the coating manufacturer.

B. Samples:
   1. Manufacturer's full line of colors for Owner's preliminary color selection.
   2. After preliminary color selection by Owner provide two (2) 3 x 5 IN samples of each final color selected.

C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Approval of application equipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. High Performance Industrial Coatings:
      a. Carboline Company.
      b. M. A. Bruder & Sons, Inc. (M.A.B. Paints).
      c. Tnemec Company, Inc.
      d. PPG Industries Inc. (Industrial Coatings).
      e. International Protective Coatings.
      f. The Sherwin-Williams Company.
      g. Devoe Coatings (ICI North America).
      h. Madison Chemical Industries Inc.
      i. Ameron International Performance Coatings.

2.2 COLOR AND LIFE OF FILM

A. Use colors defined by Painting Schedule or Paint Type.

B. Each Coat: Different discernible color or tint.

C. Colors of Surfaces Finished: Remain free from serious variations and fading for at least one year.
   1. End of Guarantee Period: No evidence of blisters, peeling, running, scaling, streaks, or stain.
   2. Washability: Washing with water and alkali free soap will remove surface dirt without deteriorating paint.

2.3 PAINT SYSTEMS

A. Descriptions: Paint systems and materials including requirements for types of coating, prime, intermediate and topcoat and coating thickness are given under Coating Systems.

B. Surface Preparation: Described with paint system, under Surface Preparation, Coating Systems.

C. Changes: Submit changes to coating system schedule for Engineer’s approval with written guarantee from coating manufacturer that system will perform in specified environment.

2.4 MATERIALS

A. General:
   1. High Performance Industrial Coatings: Products listed are manufactured by Tnemec.
   2. Products of other manufacturers will be considered for use provided that the product:
      a. Is of the same generic resin.
      b. Requires comparable surface preparation.
      c. Has comparable application requirements.

d. Meets the same VOC levels or better.
e. Provides the same finish and color options.
f. Will withstand the atmospheric or immersion conditions of the location where it is to be applied.

3. Where manufacturer's product data sheet indicates a minimum mil thickness per coat that is greater than specified herein, mil thickness for entire coating system shall be increased proportionately.

B. For unspecified materials such as thinner, provide manufacturer's recommended products.

C. High Performance Industrial Coatings:

Generic Description	Product
Polyamidoamine Epoxy	Series L69 Hi-Build Epoxoline II
Zinc-Rich Urethane	Series 94-H_20 Hydro-Zinc
Polyfunctional Hybrid Urethane (Gloss)	Series 740 UVX

2.5 COATING SYSTEMS:

Environment	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Ferrous Metals (Structural & Miscellaneous Metals)				
Exterior atmospheric *Coastal Areas*	SSPC SP-10/ NACE No. 2	2.5 to 3.5 mil Series 94-H_2O	4.0 to 6.0 mil Series L69	2.5 to 3.5 mil Series 740

PART 3 - EXECUTION

3.1 ITEMS TO BE COATED

A. Exterior Surfaces, including but not limited to:
1. Pumps.
2. Valves.

3.2 ITEMS NOT TO BE PAINTED

A. Stainless Steel Surfaces.

3.3 PREPARATION

A. General:
1. Painting Systems: Primer, intermediate, and finish coats produced by single manufacturer.
a. Thinners and Other Additives: Recommended by paint manufacturer for each particular system.
2. Prepare surfaces to be painted in accordance with coating manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.
a. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by the Owner.
3. Inspect metal surfaces with welds for weld flux, weld splatter, laminations, and other imperfections, and remove before surface preparation and painting.
4. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of coating to surface.

5. Adhere to manufacturer's recoat time surface preparation requirements.
    a. Surfaces that have exceeded coating manufacturer's published recoat time and/or have exhibited surface chalking shall be prepared prior to additional coating in accordance with manufacturer's published recommendations.
        1) Minimum SSPC SP 7/NACE No. 4 unless otherwise approved by Owner.

B. Protection:
1. Surfaces during surface preparation and painting processes with drop cloths and protective covers.
2. Working parts of mechanical and electrical equipment.
3. Newly painted surfaces from contamination and overspray.
4. Protect surrounding surfaces not to be coated.
5. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.
6. Protect code labels, equipment identification or rating plates and similar labels, tagging and identification.

C. Prepare and paint before assembly all surfaces which are inaccessible after assembly.

D. Ferrous Metal:
1. Complete fabrication, welding or burning before beginning surface preparation.
    a. Chip or grind off flux, spatter, slag or other laminations left from welding.
    b. Remove mill scale.
    c. Grind smooth rough welds and other sharp projections.
2. Solvent clean in accordance with SSPC SP 1.
3. Restore surface of field welds and adjacent areas to original surface preparation.

E. Paint Mixing:
1. Mix paint by mechanical means.
    a. Use paint directly from original containers without additions or thinning except tinting of colors with Engineer’s approval, and for meeting manufacturer’s thinning requirements for spray application without either exceeding viscosity limits (as measured by Ford or Zahn cup) or maximum thinning percentages as measured volumetrically.
2. Do not leave paint in spray pots or painter’s bucket overnight.
    a. Discard unused paint before next day.
3. Do not use any coating beyond its shelf life.
4. Prepare multiple component coatings using entire contents of each component as packaged by paint manufacturer.
    a. Do not mix partial kits or utilize any mixed multiple component coating which has exceeded its pot life regardless of how it was stored, sealed, or thinned.
    b. Provide small quantity kits for touch up and for small areas.
    c. Do not intermix additional components for reason of color or otherwise, even within same generic type of coating.
5. Use only specific thinner listed in manufacturer’s recommended listing for specific coating system.
    a. Generic Thinners: Not for coatings except for clean-up and paint removal.

3.4 APPLICATION

A. General:
1. Thin, mix and apply coatings by brush, roller, or spray in accordance with manufacturer's installation instructions.
    a. Use good quality brushes and accessories appropriate for system applied.
    b. Use flat brushes 4 1/2 IN or less wide.
    c. Application equipment must be inspected and approved in writing by coating manufacturer.

2. Temperature and weather conditions:
    a. Do not paint surfaces when surface temperature is below 50 DegF unless product has been formulated specifically for low temperature application and application is approved in writing by Owner and paint manufacturer's authorized representative.
    b. Avoid painting surfaces exposed to hot sun.
    c. Do not paint on damp surfaces.
3. Apply materials under adequate illumination.
4. Provide complete coverage to mil thickness specified.
    a. Thickness specified is dry mil thickness.
5. Evenly spread to provide full, smooth coverage.
    a. All paint systems are "to cover."
        1) In situations of discrepancy between manufacturer's square footage coverage rates and mil thickness, mil thickness requirements govern.
    b. When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.
    c. Finished paint system shall be uniform and without voids, bugholes, holidays, laps, brush marks, roller marks, runs, sags or other imperfections.
6. Work each application of material into corners, crevices, joints, and other difficult to work areas.
7. Avoid degradation and contamination of blasted surfaces and avoid inter-coat contamination.
    a. Clean contaminated surfaces before applying next coat.
8. Smooth out runs or sags immediately, or remove and recoat entire surface.
9. Allow preceding coats to dry before recoating.
    a. Recoat within time limits specified by coating manufacturer.
    b. If recoat time limits have expired re-prepare surface in accordance with coating manufacturer's printed recommendations.
10. Coat all aluminum in contact with dissimilar materials.
11. When coating rough surfaces which cannot be backrolled sufficiently, hand brush coating to work into all recesses.
12. Backroll surfaces if paint coatings are spray applied.

B. Prime Coat Application:
1. Prime coat shall be applied in the factory.
2. Prime all surfaces indicated to be painted.
    a. Apply prime coat in accordance with coating manufacturer's written instructions and as written in this Specification Section.
3. Prime ferrous metals embedded in concrete to minimum of 1 IN below exposed surfaces.
4. Apply zinc-rich primers while under continuous agitation.
5. Brush or spray bolts, welds, edges and difficult access areas with primer prior to primer application over entire surface.
6. Touch up damaged primer coats prior to applying finish coats.
    a. Restore primed surface equal to surface before damage.

C. Finish Coat Application:
1. Finish coat shall be applied in the factory.
2. Apply finish coats in accordance with coating manufacturer's written instructions and in accordance with this Specification Section; manufacturer instructions take precedent over these Specifications.
3. Touch up damaged finish coats using same application method and same material specified for finish coat.
    a. Prepare damaged area in accordance with the PREPARATION Article of this Specification Section.

3.5 FIELD QUALITY CONTROL

A. Application Deficiencies:
   1. Surfaces showing runs, laps, brush marks, telegraphing of surface imperfections or other defects will not be accepted.
   2. Surfaces showing evidence of fading, chalking, blistering, delamination or other defects due to improper surface preparation, environmental controls or application will not be accepted.
      a. Epoxy surfaces showing evidence of chalking or amine blush shall be prepared and recoated as follows:
         1) Solvent clean surfaces in accordance with SSPC SP1 and abrasive blast in accordance with SSPC SP7/NACE No. 4.
         2) Recoat with intermediate and finish coats in accordance with coating system specified herein.

B. Provide protection for painted surfaces.
   1. Surfaces showing soiling, staining, streaking, chipping, scratches, or other defects will not be accepted.

C. Measure wet coating with wet film thickness gages in accordance with ASTM D4414.

D. Measure coating dry film thickness in accordance with SSPC PA 2.

E. Measure surface temperature of items to be painted with surface temperature gage specifically designed for such.

F. Measure substrate humidity with humidity gage specifically designed for such.

3.6 CLEANING

A. Clean paint spattered surfaces.
   1. Use care not to damage finished surfaces.

B. Upon completion of painting, replace hardware, accessories, plates, fixtures, and similar items.

C. Remove surplus materials, scaffolding, and debris.

END OF SECTION

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SECTION 10 14 00
IDENTIFICATION DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Tag, tape and stenciling systems for equipment, piping, valves, pumps, ductwork and similar items, and hazard and safety signs.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 46 34 50 - Pre-Engineered, Fabricated Thermal Hydrolysis Process System.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. A13.1, Scheme for the Identification of Piping Systems.
   2. The International Society of Automation (ISA).
   3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. Z535.1, Safety Color Code.
      b. Z535.2, Environmental and Facility Safety Signs.
      c. Z535.3, Criteria for Safety Symbols.
      d. Z535.4, Product Safety Signs and Labels.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Catalog information for all identification systems.
      b. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. W.H. Brady Co.
   2. Panduit.
   3. Seton.
   4. National Band and Tag Co.
   5. Carlton Industries, Inc.

6. Or approved equal.

2.2 MANUFACTURED UNITS

A. Type A1 - Round Metal Tags:
   1. Materials:
      a. Aluminum or stainless steel.
      b. Stainless steel shall be used in corrosive environments.
   2. Size:
      a. Diameter: 1-1/2 IN minimum.
      b. Thickness: 0.035 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

B. Type A2 - Rectangle Metal Tags:
   1. Materials: Stainless steel.
   2. Size:
      a. 3-1/2 IN x 1-1/2 IN minimum.
      b. Thickness: 0.036 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

C. Type A3 - Metal Tape Tags:
   1. Materials: Aluminum or stainless steel.
   2. Size:
      a. Width 1/2 IN minimum.
      b. Length as required by text.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Embossed.
   4. Color: Natural.

D. Type B1- Square Nonmetallic Tags:
   1. Materials: Fiberglass reinforced plastic.
   2. Size:
      a. Surface: 2 x 2 IN minimum.
      b. Thickness: 100 mils.
   3. Fabrication:
      a. 3/16 IN mounting hole with metal eyelet.
      b. Legend: Preprinted and permanently embedded and fade resistant.
   4. Color:
      a. Background: Manufacturer standard or as specified.
      b. Lettering: Black.

E. Type B2 - Nonmetallic Signs:
   1. Materials: Fiberglass reinforced or durable plastic.
   2. Size:
      a. Surface: As required by text.
      b. Thickness: 60 mils minimum.
   3. Fabrication:
      a. Rounded corners.
      b. Drilled holes in corners with grommets.

c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.

4. Color:
   a. Background: Manufacturer standard or as specified.
   b. Lettering: Black.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

F. Type C - Laminated Name Plates:
1. Materials: Phenolic or DR (high impact) acrylic.
2. Size:
   a. Surface: As required by text.
   b. Thickness: 1/16 IN.
3. Fabrication:
   a. Outdoor rated and UV resistant when installed outdoors.
   b. Two (2) layers laminated.
   c. Legend: Engraved through top lamination into bottom lamination.
   d. Two (2) drilled side holes, for screw mounting.
4. Color: Black top surface, white core, unless otherwise indicated.

G. Type D - Self-Adhesive Tape Tags and Signs:
1. Materials: Vinyl tape or vinyl cloth.
2. Size:
   a. Surface: As required by text.
   b. Thickness: 5 mils minimum.
3. Fabrication:
   a. Indoor/Outdoor grade.
   b. Weather and UV resistant inks.
   c. Permanent adhesive.
   d. Legend: Preprinted.
   e. Wire markers to be self-laminating.
4. Color: White with black lettering or as specified.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

H. Type E - Heat Shrinkable Tape Tags:
1. Materials: Polyolefin.
2. Size: As required by text.
3. Fabrication:
   a. Legend: Preprinted.
4. Color: White background, black printing.

I. Type G - Stenciling System:
1. Materials:
   a. Exterior type stenciling enamel.
   b. Either brushing grade or pressurized spray can form and grade.
2. Size: As required.
3. Fabrication:
   a. Legend: As required.
4. Color: Black or white for best contrast.

J. Type H – Plastic Laminate Colored Paper Labels:
1. Materials: Color paper, machine printed between two sheets of vinylite plastic.
2. Size: As required by text.
   a. Minimum one IN high white letters on a black background for raceways 2-1/2 IN and smaller diameter and two IN high letters for raceways larger than 2-1/2 IN diameter.

3. Fabrication:
    a. Legend:
        1) System voltage and equipment served or type of service.
        2) Preprinted.

2.3 ACCESSORIES

A. Fasteners:
    1. Bead chain: #6 brass, aluminum or stainless steel.
    2. Plastic strap: Nylon, urethane or polypropylene.
    3. Screws: Self-tapping, stainless steel.
    4. Adhesive, solvent activated.

2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install identification devices at specified locations.

B. All identification devices to be printed by mechanical process, hand printing is not acceptable.

C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.

D. Attach tags with 1/8 IN round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.
    1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.

E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.
    1. Several items of equipment mounted in housing to be individually tagged inside the compartment.

3.2 SCHEDULES

A. Process Systems:
    1. General:
        a. Use preprinted self-adhesive labels for pipe legends on horizontal and vertical centerline.
            1) Place lettering below horizontal centerline where pipelines are so close together or where located above normal line of vision.
        b. Locate labels and bands:
            1) At the suction and discharge of pumps.
            2) At intersections, changes in direction (route) or obstructions and at regular intervals along pipe runs (not to exceed 20 FT).
            3) Both sides of valves, risers, “T” intersections, machinery or equipment.
            4) At valves, risers, "T" joints, machinery or equipment.
            5) If flow is in both directions use double headed arrow markers.
            6) At junction points and point of distribution.
        c. Use self-adhesive arrows, same size as letters indicating direction of flow pointing away from legend.

d. The Piping Color Identification Code Schedule should be used to identify all piping. The identification for equipment and piping should include both the proper color and the proper markings.
e. Self-adhesive markings should be black or white in color to contrast with the pipe or pipe jacketing background color.
f. Stenciled markings shall be all capital letters. Markings for equipment should be 2-1/2 IN in size. Markings for pipes should be sized as follows:

No.	Outside Diameter of Pipe Covering in Inches	Height of Letters Inches	Width of Color Band in Inches
1	3/4 to 1 1/4	1/2	4
2	1 1/2 to 2 1/2	3/4	6
3	3 to 6	1 1/4	8
4	7 to 10	2 1/2	12
5	Greater than 10	3 1/2	12

g. If piping is stainless steel or has insulation and jacketing, then piping must be distinctly marked with color-coded bands around the pipe and labeled per the Equipment and Piping Color Identification Code Schedule. All piping shall be frequently marked with color-coded bands and labels.
h. A clear ultraviolet resistant tape shall be applied around all pipe abbreviations, flow arrows, and color coded bands for all outdoor piping.
i. Apply all markings and tape in uniform manner parallel to piping.
j. Piping indicated with color-coded bands in addition to paint are indicated in the Piping Color Identification Code Schedule.

2. Piping Color Identification Code Schedule:

Symbol	Service	Pipe Color	Band Color[1]
UW	Utility Water	Dark Green	Dark Green
THS	Thermally Hydrolyzed Solids	Dark Brown	Dark Brown
PG	Process Gas	Red	Red
PW	Potable Water	Light Blue	Light Blue
TS	Thickened Solids	Dark Brown	Dark Brown
MPS	Medium Pressure Steam	Orange	Orange and Dark Blue

[1]For stainless steel piping and/or piping that has insulation and jacketing.

3. Valves:
   a. Tag type:
      1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
      2) Indoor noncorrosive:
         a) Type A1 - Round Metal Tags.
         b) Type B1 - Square Nonmetallic Tags.
      3) Indoor corrosive:
         a) Stainless steel Type A1 - Round Metal Tags.
         b) Type B1 - Square Nonmetallic Tags.
   b. Fastener:
      1) Type A1: Chain of the same material.
      2) Type B1: Stainless steel chain.
   c. Color: Per ASME A13.1 corresponding to the piping system.

d. Legend:
    1) Letter height: 1/4 IN minimum.
    2) Valve designation as indicated on the Drawings (e.g., “V-xxx”).

4. Process equipment (e.g., pumps, pump motors, air compressors, etc.):
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Tags and Signs.
        3) Type G - Stenciling System.
    b. Fastener:
        1) Self.
        2) Screws.
        3) Adhesive.
    c. Legend:
        1) Letter height: 1/2 IN minimum.
        2) Equipment designation as indicated on the Drawings (e.g., “Primary Sludge Pump P-xxx”).
5. Piping systems:
    a. Tag type:
        1) Outdoor locations: Type G - Stenciling System.
        2) Indoor locations:
            a) Type D - Self-Adhesive Tape Tags and Signs.
            b) Type G - Stenciling System.
    b. Fastener: Self.
    c. Color: Per ASME A13.1.
    d. Legend:
        1) Letter height: Manufacturers standard for the pipe diameter.
        2) Mark piping in accordance with ASME A13.1.
        3) Use piping designation as indicated on the Drawings.
        4) Arrow: Single arrow.
6. Process tanks (over 1000 GAL) and basins, (e.g., reactors, Pulper, chemical storage, clarifiers, trickling filters, digesters, etc.):
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type G - Stenciling System.
    b. Fastener:
        1) Screw.
        2) Self.
    c. Location as directed by Owner.
    d. Legend:
        1) Letter height: 4 IN minimum.
        2) Equipment designation as indicated on the Drawings (e.g., “Clarifier CL-xxx”).
7. Tanks (less than 1000 GAL) (e.g., break tanks, chemical tanks, hydro-pneumatic tanks, air receivers, etc.):
    a. Tag type:
        1) Type D - Self-Adhesive Tape Tags and Signs.
        2) Type G - Stenciling System.
    b. Fastener: Self.
    c. Legend:
        1) Letter height: 2 IN minimum.
        2) Equipment designation as indicated on the Drawings (e.g., “Polymer Storage Tank Txxx”)
8. Equipment that starts automatically:
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Tags and Signs.

b. Fastener:
    1) Type B2 - Screw or adhesive.
    2) Type D - Self.
c. Size: 5 IN x 7 IN.
d. Legend:
    1) OSHA Warning Sign.
    2) Description of Warning: "THIS MACHINE STARTS AUTOMATICALLY".

B. Instrumentation Systems:
1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.):
    a. Tag type:
        1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
        2) Indoor noncorrosive:
            a) Type A1 - Round Metal Tags.
            b) Type B1 - Square Nonmetallic Tags.
        3) Indoor corrosive:
            a) Stainless steel Type A1 - Round Metal Tags.
            b) Type B1 - Square Nonmetallic Tags.
    b. Fastener:
        1) Type A1: Chain of the same material.
        2) Type B1: Stainless steel chain.
    c. Legend:
        1) Letter height: 1/4 IN minimum.
        2) Equipment ISA designation as indicated on the Drawings (e.g., "FIT-xxx").
2. Enclosure for instrumentation and control equipment, (e.g., PLC control panels, etc.):
    a. Tag type: Type C - Phenolic Name Plates.
    b. Fastener: Screws.
    c. Legend:
        1) Letter height: 1/2 IN minimum.
        2) Equipment name (e.g., "PLC CONTROL PANEL PCP-xxx").
3. Components inside equipment enclosure, (e.g., PLC's, control relays, contactors, and timers):
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Legend:
        1) Letter height: 3/16 IN minimum.
        2) Description or function of component (e.g., "PLC-xxx" or "CR-xxx").
4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.):
    a. Tag type: Type C - Phenolic Name Plates.
    b. Fastener: Screws.
    c. Legend:
        1) Letter height: 1/4 IN minimum.
        2) Component ISA tag number as indicated on the Drawings (e.g., "HS-xxx").

C. Electrical Systems:
1. Safety switches, separately mounted circuit breakers and motor starters, VFD's, etc.:
    a. Tag type: Type C - Phenolic Name Plates.
    b. Fastener: Screws.
    c. Legend:
        1) Letter height: 1/4 IN minimum.
        2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").
2. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.), pullboxes:
    a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.
c. Legend:
    1) Letter height: 1/2 IN minimum.
    2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").

3. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.):
    a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
    b. Fastener: Self.
    c. Legend:
        1) Letter height: 3/16 IN minimum.
        2) Description or function of component (e.g., "M-xxx", "CR-xxx" or "TR-xxx").
4. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
    a. Tag type: Type C - Phenolic Name Plates.
    b. Fastener: Screws.
    c. Legend:
        1) Letter height: 1/4 IN minimum.
        2) Component tag number as indicated on the Drawings or as defined by Contractor (e.g., "HS-xxx").
5. Conductors in control panels and in pull or junction boxes where multiple circuits exist.
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Tag conductor at both ends.
    d. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.
6. Conductors in cable trays.
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Tag all conductors at the same location in the tray at 50FT maximum intervals.
    d. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Circuit number or wire number as scheduled on the Drawings.
7. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:
    a. Tag type: Type D - Self-Adhesive Tape Signs.
    b. Fastener: Self.
    c. Legend: Per NFPA 70.
8. Control cable trays:
    a. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
    b. Fastener: Self.
    c. Size: 1-3/4 IN x 2-1/2 IN.
    d. Location: Every 50 FT maximum.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger, (e.g., "LESS THAN 50 VOLTS, CLASS 2 OR 3" or "ANALOG INSTRUMENTATION" or "DIGITAL COMMUNICATION").
9. Exposed conduits, indoor and outdoor.
    a. Tag type: Type H – Plastic Laminate Colored Paper Labels.
    b. Fastener:
        1) Nylon or plastic straps, self-fastening.
        2) Installed in accordance with manufacturer's instructions.

c. Legend:
    1) Letter height:
        a) One IN high for conduits up to and including 2-1/2 IN.
        b) 2 IN high for conduits 3 IN and larger.
    2) Show system voltage and equipment served or type of service.
        a) Submit label schedules for review.
    3) Thermal printing.
    4) Locate at each end within 12 IN of point of termination.

10. Labels shall be continuous one piece.
11. Equipment where more than one (1) voltage source is present:
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Signs.
    b. Fastener:
        1) Screw or adhesive.
        2) Self.
    c. Size: 1-3/4 IN x 2-1/2 IN.
    d. Location: Exterior face of enclosure or cubical.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger: "MULTIPLE VOLTAGE SOURCES".

3.3 STRUCTURAL DESIGN LOAD RATINGS:

A. Provide 225 Hazard and Safety Signs: Floors, platforms, roofs, etc.
    1. Type B2.
    2. Inscription: "XXX PSF Maximum Design Load".
    3. Location: Within each structure/room/roof with additional signs on platform within a structure/room. Mount on at least two walls in each structure/room and on handrail for platforms.

END OF SECTION

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SECTION 26 05 00
ELECTRICAL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for electrical systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 61 03 - Equipment - Basic Requirements.
   3. Section 05 50 00 - Metal Fabrications.
   4. Section 10 14 00 - Identification Devices.
   5. Division 26 - Electrical.
   6. Division 40 - Control Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   2. American Iron and Steel Construction (AISC).
   3. American National Standards Institute (ANSI).
   4. ETL Testing Laboratories (ETL).
   5. ASTM International (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel.
      b. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   6. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C2, National Electrical Safety Code (NESC).
   7. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   8. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   9. Underwriters Laboratories, Inc. (UL).

B. Products to be listed by a Nationally Recognized Testing Laboratory (NRTL) in accordance with applicable product standards.
   1. Applicable product standards including, but not limited to, ANSI, FM, IEEE, NEMA and UL.
   2. NRTL includes, but is not limited to, CSA Group Testing and Certification (CS), FM Approvals LLC (FM), Intertek Testing Services NA, Inc. (ETL), and Underwriters Laboratories, Inc. (UL).

1.3 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.
   1. Outdoor corrosive area: All exterior locations shall be considered to be corrosive.
   2. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00.
   2. See individual specification sections for submittal requirements for products defined as equipment.
   3. See Specification Section 01 61 03 and individual specification sections for submittal requirements for products defined as equipment.
   4. General requirements:
      a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
      b. Include data sheets that include manufacturer's name and product model number.
         1) Clearly identify all optional accessories.
      c. Acknowledgement that products are UL or ETL listed or are constructed utilizing UL or ETL recognized components.
      d. Manufacturer's delivery, storage, handling and installation instructions.
      e. Product installation details.
      f. See individual specification sections for any additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content process of Operation and Maintenance Manuals.

C. When a specification section includes products specified in another specification section, each specification section shall have the required Shop Drawing transmittal form per Specification Section 01 33 00 and all specification sections shall be submitted simultaneously.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 01 65 00.

B. Protect nameplates on electrical equipment to prevent defacing.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide all components of a similar type by one (1) manufacturer.

2.2 MATERIALS

A. Field touch-up of galvanized surfaces.
   1. Zinc-rich primer.
      a. One (1) coat, 3.0 mils, ZRC by ZRC Products.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and wire all equipment, including prepurchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.

B. Install equipment in accordance with the requirements of:
   1. NFPA 70.
   2. The manufacturer's instructions.

C. Install equipment plumb, square and true with construction features and securely fastened.

D. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment. Provide adequate room for Owner's conduit to enter bottom of termination cabinets. See Specification Section 6 05 33 – Raceways and Boxes for additional requirements.

E. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operating and maintenance requirements of other equipment.

F. Maintain access to electrical equipment and devices in accordance with NFPA 70.

G. Device Mounting Schedule:
   1. Mounting heights are as indicated below:
      a. Safety switch (to center of operating handle): 54 IN.
      b. Pushbutton or selector switch control station (to center): 48 IN.

H. Avoid interference of electrical equipment operation and maintenance with structural members, THP train features and equipment of other trades.

I. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
   1. See Specification Section 5 50 00 – Metal Fabrications.
   2. Do not cut, or weld to, building structural members.
   3. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

J. Provide corrosion resistant spacers to maintain 1/4 IN separation between metallic equipment and/or metallic equipment supports and mounting.

K. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

L. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of moisture, rodents and insects.

M. Identify electrical equipment and components in accordance with Specification Section 10 14 00 – Identification Devices.

3.2 FIELD QUALITY CONTROL

A. Replace equipment and systems found inoperative or defective and re-test.

B. The protective coating integrity of support structures and equipment enclosures shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.
   2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
   3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
   4. Repair surfaces which will be inaccessible after installation prior to installation.

C. Replace nameplates damaged during installation.

3.3 DEMONSTRATION

A. Demonstrate equipment in accordance with Specification Section 01 75 00 – Facility and System Start-up.

END OF SECTION

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SECTION 26 05 19
WIRE AND CABLE - 600 VOLT AND BELOW

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Building wire.
      b. Power cable.
      c. Control cable.
      d. Instrumentation cable.
      e. Wire connectors.
      f. Insulating tape.
      g. Pulling lubricant.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 26 05 00 - Electrical - Basic Requirements.
   3. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 1202, Standard for Flame-Propagation Testing of Wire and Cable.
   2. Insulated Cable Engineers Association (ICEA):
      a. S-58-679, Standard for Control Cable Conductor Identification.
   3. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Industrial Control and Systems: Terminal Blocks.
   4. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 57/S-73-532, Standard for Control Cables.
      b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   6. Underwriters Laboratories, Inc. (UL):
      a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
      b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
      c. 467, Standard for Safety Grounding and Bonding Equipment.
      d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
      e. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
      f. 2250, Standard for Safety Instrumentation Tray Cable.

1.3 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:
   1. Multiple conductor, insulated, twisted, with outer sheath.

2. The following are specific types of instrumentation cables:
    a. Analog signal cable:
        1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 Vdc) signals, using No. 18 AWG conductors (seven strands minimum).
        2) Commonly used types are defined in the following:
            a) TSP: Twisted shielded pair.
            b) TST: Twisted shielded triad.

C. Power Cable: Multi-conductor, insulated, with outer sheath.

D. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
    a. Provide submittal data for all products specified in PART 2 of this Specification Section including, but not limited to:
        1) Wire and cable including overall cable diameter.
        2) Cable termination fittings.
        3) Wire connectors.
    b. See Specification Section 26 05 00 - Electrical - Basic Requirements for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Power and control cable:
    a. Aetna Insulated Wire.
    b. Alphawire.
    c. Cerrowire.
    d. Encore Wire Corporation.
    e. General Cable.
    f. Okonite Company.
    g. RoHS.
    h. Southwire Company.
2. Instrumentation cable:
    a. Analog cable:
        1) Alphawire.
        2) Belden Inc.
        3) General Cable.
        4) Southwire.
3. Wire connectors:
    a. Burndy Corporation.
    b. Buchanan.
    c. Ideal.
    d. Ilsco.
    e. 3M Co.
    f. Teledyne Penn Union.
    g. Thomas and Betts.
    h. Phoenix Contact.

4. Insulating and color coding tape:
    a. 3M Co.
    b. Plymouth Bishop Tapes.
    c. Red Seal Electric Co.

2.2 MANUFACTURED UNITS

A. Type G Power Cable:
1. Standards:
    a. Conductors conform to ASTM B-3 and B-8.
    b. Insulation conforms to UL 44, and approved as Type XHHW-2.
    c. UL 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
    d. IEEE-1202, Standard for Flame-Propagation Testing of Wire and Cable.
    e. Cables are suitable for sunlight resistant applications.
    f. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy Power Cable.
2. Three or four conductor power cables rated 600V, 90C in dry or wet locations:
    a. One conductor used as grounding conductor.
3. Conform to NFPA 70 Type TC.
4. Sunlight resistant.
5. Permitted to be installed in conduit.
6. Stranded cooper conductors, XLP insulated, Method 4 phase -identified, insulated conductors cabled with a stranded copper grounding conductor, cable tape, overall LSZH jacket.

B. Control Cable:
1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
    a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
5. Individual conductor color coding:
    a. ICEA S-58-679, Method 1, Table E-2.
    b. See PART 3 of this Specification Section for additional requirements.
6. Conform to NFPA 70 Type TC.

C. Instrumentation Cable:
1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
2. Analog cable:
    a. Tinned copper conductors.
    b. 300 V PVC insulation with PVC jacket.
    c. Twisted with 100 percent foil shield coverage with drain wire.
    d. Six (6) twists per foot minimum.
    e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
3. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.

D. Wire Connectors:
   1. Compression and mechanical screw type:
      a. 600 V rated.
      b. Ground conductors: Conform to UL 467.
      c. Phase and neutral conductors: Conform to UL 486A.
   2. Terminal block type:
      a. High density, screw-post barrier-type with white center marker strip.
      b. 600 V and ampere rating as required, for power circuits.
      c. 600 V, 20 ampere rated for control circuits.
      d. 600 V, 15 ampere rated for instrumentation circuits.
      e. Conform to NEMA ICS 4 and UL 486A.

E. Insulating and Color Coding Tape:
   1. Pressure sensitive vinyl.
   2. Premium grade.
   3. Heat, cold, moisture, and sunlight resistant.
   4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
   5. For cold weather or outdoor location, tape must also be all-weather.
   6. Color:
      a. Insulating tape: Black.
      b. Color coding tape: Fade-resistant color as specified herein.
   7. Comply with UL 510.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Drawings are based on copper conductors, if aluminum is used, the conductor shall be resized to meet the required conductor ampacities.
   1. Permitted Usage of Insulation Types:
      a. Type XHHW-2:
         1) Wire for process feeders or branch circuits will be XHHW-2.
      b. Type THHN/THWN-2:
         1) Lighting and receptacle circuits and #14 AWG class 1 control circuits.

B. Install all cables on the THP train in cable tray. Support cables in accordance with NFPA 70:
   1. Where cables leave the cable tray install cables in aluminum conduit and FLEX-LT at point of termination. See Specification Section 26 05 33 – Raceways and Boxes for additional requirements when cables are exposed outside of the cable tray system.
      a. Cables shall be fully protected and in compliance with NFPA 70.

C. Conductor Size Limitations:
   1. Feeder and branch power conductors shall not be smaller than No. 12 AWG.
   2. Control conductors shall not be smaller than No. 14 AWG.
   3. Instrumentation conductors shall not be smaller than No. 16 AWG.

D. Color Code All Wiring as Follows:
   1. Power cables ICEA S-58-679, Method 4 with:
      a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
      b. Ground conductor: Bare.
   2. Control cables ICEA S-58-679, Method 1, Table E-2:
      a. When a bare ground is not provided, one (1) of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.

b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

3. Instrumentation cables:
   a. TSP: The conductors are colored black, white and numbered.
   b. TST: The conductors are colored black, white, red and numbered.

E. Feeder, branch, control and instrumentation circuits shall not be combined in a cable tray, junction or pull box, except as permitted in the following:
   1. Where field conditions dictate and written permission is obtained from the Owner.
   2. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
      a. The combinations shall comply with the following:
         1) 12 Vdc, 24 Vdc and 48 Vdc may be combined.
         2) AC control circuits shall be isolated from all DC circuits.
   3. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
      a. The combinations shall comply with the following:
         1) Analog signal circuits may be combined.
         2) Digital signal circuits may be combined but isolated from analog signal circuits.

F. Ground the drain wire of shielded instrumentation cables at one (1) end only.
   1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).
   2. Provide terminal blocks for drain wires in termination boxes.

G. Terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
   1. Splicing is not permitted between the THP train-mounted terminal boxes and equipment without exception.
   2. Splicing at motor terminal boxes:
      a. Insulated mechanical screw type connectors.
   3. Control circuits:
      a. Junction and pull boxes: Terminal block type connector.
   4. Instrumentation circuits.
      a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
      b. Terminal junction boxes: Terminal block type connector.
         1) Terminate shield drain wires on a separate terminal.
   5. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

H. Insulating Tape Usage:
   1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
   2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
   3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

I. Color Coding Tape Usage: For color coding of conductors.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing:
   1. See Specification Section 26 08 13 - Acceptance Testing.

END OF SECTION

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SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for grounding and bonding system(s).

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Division 26 - Electrical.
      a. Section 26 05 00 - Electrical: Basic Requirements.
      b. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
      c. Section 26 05 33 - Raceways and Boxes.
      d. Section 26 05 36 - Cable Tray
      e. Section 16080 - Acceptance Testing.
      f. Section 26 28 16 - Safety Switches

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL):
      a. 467, Grounding and Bonding Equipment.

B. Assure ground continuity is continuous throughout the entire Project.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Grounding clamps, terminals and connectors.
         2) Exothermic welding system.
      b. See Specification Section 26 05 00 - Electrical - Basic Requirements for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ground rods and bars and grounding clamps, connectors and terminals:
      a. Erico Products, Inc.

b. Harger Lightning & Grounding.
c. Heary Brothers.
d. Hubbell - Burndy.
e. Robbins Lightning Protection.
f. Thomas & Betts - Blackburn.
g. Thompson Lightning Protection.

2. Exothermic weld connections:
a. Erico Products Inc., Cadweld.
b. Harger Lightning & Grounding - Ultraweld.
c. Hubbell - Burndy (Thermoweld).
d. Thomas & Betts - Furseweld.

2.2 COMPONENTS

A. Wire and Cable:
1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
2. Insulated conductors: Color coded green, per Specification Section 26 05 19 - Wire and Cable - 600 Volt and Below.

B. Conduit: As specified in Specification Section 26 05 19 - Wire and Cable - 600 Volt and Below.

C. Grounding Clamps, Connectors and Terminals:
1. Mechanical type:
a. Standards: UL 467.
b. High copper alloy content.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install products in accordance with manufacturer's instructions.
2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250.
3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections.
4. Do not splice grounding conductors except at termination boxes.
5. Install ground rods and grounding conductors in undisturbed, firm soil.
a. Provide excavation required for installation of ground rods and ground conductors.
b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
c. Unless otherwise specified, connect conductors to ground rods with compressor type connectors or exothermic weld.
d. Provide sufficient slack in grounding conductor to prevent conductor breakage during backfill or due to ground movement.
e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
6. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Raceway Bonding/Grounding:
1. All metallic cable tray shall be installed so that it is electrically continuous.
2. All metallic conduit shall be installed so that it is electrically continuous.
3. All conduits or multi-conductor cable to contain a grounding conductor with insulation identical to the phase conductors.
4. NFPA 70 required grounding bushings shall be of the insulating type.
5. Provide double locknuts at all panels.
6. Bond all conduit, at entrance and exit of equipment, to the equipment ground bus or lug.

7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

C. Equipment Grounding:
   1. All utilization equipment shall be grounded with an equipment ground conductor.

D. Cable Tray Grounding:
   1. Make metal cable tray electrically continuous by one of the following methods:
      a. Tray sections and fittings suitable for grounding purposes.
      b. Provide bonding jumpers at discontinuous joints.
      c. Lay a grounding conductor within the tray for bonding of each individual tray section.
         1) Provide a minimum of one ground lug per tray section.
         2) Grounding conductor: Insulated #4 AWG minimum with green marking tape every 10 FT. Sized in accordance with the largest conductors run within the tray.
         3) Securely tie the grounding conductor to cable tray every 10 FT. Bond the grounding conductor to the cable tray run a minimum of every 50 FT with a UL listed connector.
   2. Bond the tray or tray grounding conductor to every electrical equipment ground bus where conductors terminate.
   3. Bond all conduits to the tray that extend the conductors to field equipment.

3.2 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Owner.

B. Acceptance testing:
   1. See Specification Section 26 08 13 – Acceptance Testing.

END OF SECTION

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SECTION 26 05 33
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Conduits.
      b. Conduit fittings.
      c. Conduit supports.
      d. Wireways.
      e. Pull and junction boxes.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 26 05 00 - Electrical - Basic Requirements.
   3. Section 26 05 19 - Wire and Cable - 600 Volt and Below.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   2. American Iron and Steel Institute (AISI).
   3. ASTM International (ASTM):
      a. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit (IMC).
   5. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C80.1, Electric Rigid Steel Conduit (ERSC).
      b. C80.5, Electrical Aluminum Rigid Conduit.
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Flexible Metal Conduit.
      b. 6, Standard for Electrical Rigid Metal Conduit - Steel.
      c. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      d. 360, Standard for Liquid-Tight Flexible Steel Conduit.
      e. 467, Grounding and Bonding Equipment.
      f. 514A, Metallic Outlet Boxes.
      g. 514B, Conduit, Tubing, and Cable Fittings.
      h. 651, Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
      i. 797, Electrical Metallic Tubing - Steel.
      j. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
      k. 1203, Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   3. Fabrication and/or layout drawings:
      a. Proposed routing of raceways with circuit numbers identified for each raceway.
      b. Identify dimensional size of pull and terminal junction boxes to be used.
      c. Wire terminals.
      d. Terminal junction box connection diagrams identifying cable and circuit numbers for circuits by Contractor and cabling provided by Supplier.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00 – Electrical – Basic Requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Rigid metallic conduits:
      a. Allied Tube and Conduit Corporation.
      b. Triangle PWC Inc.
      c. Western Tube and Conduit Corporation.
      d. Wheatland Tube Company.
      e. LTV Steel Company.
      f. EASCO Aluminum.
      g. Indalex.
      h. VAW of American, Inc.
   2. Flexible conduit:
      a. AFC Cable Systems.
      b. Anamet, Inc.
      c. Electri-Flex.
      d. Flexible Metal Hose Company.
      e. International Metal Hose Company.
      f. Triangle PWC Inc.
      g. LTV Steel Company.
   3. Conduit fittings and accessories:
      a. Appleton.
      b. Carlon.
      c. Cantex.
      d. Crouse-Hinds.
      e. Killark.
      f. Osburn Associates.
      g. OZ Gedney Company.
      h. RACO.
      i. Steel City.
      j. Thomas and Betts.
   4. Support systems:
      a. Unistrut Building Systems.

b. B-Line Systems Inc.
c. Kindorf.
d. Minerallac Fastening Systems.
e. Caddy.

5. Pull and terminal junction boxes:
   a. Appleton Electric Co.
   b. Crouse-Hinds.
   c. Killark.
   d. O-Z/Gedney.
   e. Steel City.
   f. Raco.
   g. Bell.
   h. Hoffman Engineering Co.
   i. Wiegmann.
   j. B-Line Circle AW.
   k. Adalet.
   l. Rittal.

2.2 RIGID METALLIC CONDUITS

A. PVC-Coated Rigid Steel Conduit (PVC-RGS):
   1. Nominal 40 mil Polyvinyl Chloride Exterior Coating:
      a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
      b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.
      c. Color shall be gray.
   2. Nominal 2 mil, minimum, urethane interior coating.
   3. Urethane coating on threads.
   4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
   5. Female Ends:
      a. Have a plastic sleeve extending a minimum of 1 pipe diameter or 2 IN, whichever is less beyond the opening.
      b. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
   6. Standards: NEMA/ANSI C80.1, UL 6, NEMA RN 1.

B. Rigid Aluminum Conduit (RAC):
   1. AA Type 6063 aluminum alloy, T-1 temper.
   2. Maximum copper content of 0.10 percent.
   3. Extruded, seamless.
   4. Standards: NEMA/ANSI C80.5, UL 6.

C. RIGID NONMETALLIC CONDUIT
   1. Schedules 40 (PVC-40) and 80 (PVC-80):
   2. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
   3. Rated for direct sunlight exposure.
   4. Fire retardant and low smoke emission.
   5. Shall be suitable for use with 90 DegC wire and shall be marked "maximum 90 DegC".
   6. Standards: NEMA TC 2, UL 651.

2.3 FLEXIBLE CONDUIT

A. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
   1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.

2. Extruded PVC outer jacket positively locked to the steel core.
3. Liquid and vaportight.
4. Standard: UL 360.

2.4 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RAC:
   1. General:
      a. In hazardous locations listed for use in Class I, Groups C and D locations.
   2. Locknuts:
      a. Threaded cast copper free aluminum or malleable iron.
      b. Gasketed or non-gasketed.
      c. Grounding or non-grounding type.
   3. Bushings:
      a. Threaded, insulated cast copper free aluminum or malleable iron.
      b. Grounding or non-grounding type.
   4. Hubs: Threaded, insulated and gasketed cast copper free aluminum for raintight connection.
   5. Couplings:
      a. Threaded straight type: Same material and finish as the conduit with which they are used on.
   6. Unions: Cast copper free aluminum.
   7. Conduit bodies (ells and tees):
      a. Body: Cast copper free aluminum with threaded hubs.
      b. Standard and mogul size.
      c. Cover:
         1) Clip-on type with 316 stainless steel screws.
         2) Gasketed or non-gasketed cast copper free aluminum.
   8. Conduit bodies (round):
      a. Body: Cast copper free aluminum with threaded hubs.
      b. Cover: Threaded screw on type, gasketed, cast copper free aluminum.
   9. Sealing fittings:
      a. Body: Cast copper free aluminum with threaded hubs.
      b. Standard and mogul size.
      c. With or without drain and breather.
      d. Fiber and sealing compound: UL listed for use with the sealing fitting.
   10. Expansion couplings:
      a. 2 IN nominal straight-line conduit movement in either direction.
      b. Cast copper free aluminum.
      c. Gasketed for wet locations.
      d. Internally or externally grounded.
   11. Expansion/deflection couplings:
      a. 3/4 IN nominal straight-line conduit movement in either direction.
      b. 30-degree nominal deflection from the normal in all directions.
      c. Metallic hubs, neoprene outer jacket and 316 stainless steel jacket clamps.
      d. Internally or externally grounded.
      e. Watertight, raintight and concrete tight.
      f. Cast copper free aluminum.

B. Standards: UL 467, UL 514B, UL 886.
   1. Expansion couplings:
      a. 2 IN nominal straight-line conduit movement in either direction.
      b. Galvanized steel with insulated bushing.
      c. Gasketed for wet locations.
      d. Internally or externally grounded.
   2. Expansion/deflection couplings:
      a. 3/4 IN nominal straight-line conduit movement in either direction.

b. 30-degree nominal deflection from the normal in all directions.
c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
d. Internally or externally grounded.
e. Watertight, raintight and concrete tight.

3. Standards: UL 467, UL 514B, UL 886.

C. Fittings for Use with PVC-RGS:
1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RAC" and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."

D. Fittings for Use with FLEX-LT:
1. Provide stainless steel fittings.
2. Connector:
a. Straight or angle type.
b. Stainless steel construction or PVC coated construction, insulated and gasketed.
c. Composed of locknut, grounding ferrule and gland compression nut.
3. Standards: UL 467, UL 514B.

2.5 ALL RACEWAY AND FITTINGS

A. Mark Products:
1. Identify the nominal trade size on the product.
2. Stamp with the name or trademark of the manufacturer.

2.6 PULL AND TERMINAL JUNCTION BOXES

A. NEMA 4X Rated (metallic):
1. Body and cover: 14 GA Type 316 stainless steel.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Continuous hinged door, stainless steel hardware, with quick-release latches.
6. Door with oil-resistant gasket.
7. Boxes shall be sized for termination of conduits emerging from below the equipment concrete pad. Boxes shall accommodate spare conduits as well as those required in the Supplier design.

B. Miscellaneous Accessories:
1. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
2. Split covers when heavier than 25 LBS.
3. Weldnuts for mounting optional panels and terminal kits.
4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

C. Terminal Junction Boxes – Termination Requirements:
1. Wiring to circuits external to the boxes shall be connected to interposing terminal blocks.
2. Terminal blocks rigidly mounted on DIN rail mounting channels.
3. Terminal strips located to provide adequate space for entrance and termination of the field conductors.
4. Terminal block markings:
a. Marking shall be the same as associated wire marking.
b. Legible, machine-printed markings.
c. Markings as identified in the shop drawings.
5. Terminal block mechanical characteristics, and electrical characteristics shall be in accordance with NEMA ICS 4.
6. Terminal blocks with continuous marking strips.
a. Each terminal block shall be identified with machine printed labels.

7. Terminals shall facilitate wire sizes as follows:
   a. 120 Vac control applications: Conductor size 12 AWG maximum.
   b. Instrumentation applications: Conductor size 16 AWG maximum.
8. Analog signal cable shield drain conductors shall be individually terminated.
9. Install minimum of 20 percent spare terminals.
10. When control circuits require more than one field conductor connected to a single wiring point, a sufficient number of terminal points shall be connected internally to allow termination of only one field conductor per terminal block.
11. DIN rail mounting channels shall be installed along full length of the terminal strip areas to facilitate future expansion.

D. Standards: NEMA 250, UL 50.

2.7 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:
   1. Material requirements.
      a. Stainless steel: AISI Type 316.

B. Single Conduit and Outlet Box Support Fasteners:
   1. Material requirements:
      a. Stainless steel: AISI Type 316.

PART 3 - EXECUTION

3.1 RACEWAY INSTALLATION - GENERAL

A. Exposed conduit in hazardous or corrosive spaces will be PVC-coated rigid steel (PVC-RGS) conduit.

B. Exposed conduit in dry or wet spaces will be rigid galvanized steel (RGS) or aluminum.

C. Buried conduit will be PVC-RGS or, in a concrete-encased ductbank, Schedule 40 PVC.

D. Provide PVC-RGS when exposed cable is less than 6 IN when cable would be subject to damage or the exposed cable would become a safety or tripping hazard. Final determination made by Owner/Engineer.

E. Shall be in accordance with the requirements of:
   1. NFPA 70.
   2. Manufacturer instructions.

F. Size of Raceways:
   1. Unless specifically indicated otherwise, the minimum raceway size shall be:
      a. Conduit: 3/4 IN.

G. Field Bending and Cutting of Conduits:
   1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
   2. Do not reduce the internal diameter of the conduit when making conduit bends.
   3. Debur interior and exterior after cutting.

H. Where aluminum conduit and fittings are used with steel boxes and fitting, provide an anti-corrosive compound to the male threads of the conduit and fittings.

I. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.
   1. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.

J. Remove moisture and debris from conduit before wire is pulled into place.
   1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
   2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
   3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

K. Conduit entering outdoor equipment shall enter the bottom or side of the equipment.

3.2 RACEWAY ROUTING

A. Cable tray is permitted as specified in Specification Section 26 05 36 – Cable Tray. Where multi-conductor cable will be exposed outside of the tray, install cable in aluminum conduit and/or FLEX-LT as permitted by NFPA 70.

B. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
   1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
   2. Run in straight lines parallel to or at right angles to module steel structure lines.
   3. Do not route conduits:
      a. Through areas of high ambient temperature or radiant heat.
   4. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 degrees of bends in the conduit run or in long straight runs to limit pulling tensions.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:
   1. Between instrumentation and 600 V and less AC power or control: 6 IN.
   2. Between process, gas, air and water pipes: 6 IN.

D. Conduits shall be installed to eliminate moisture pockets.
   1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Above grade/concrete slab conduits entering outdoor control panels, instrumentation shall enter the enclosures from the side or bottom of the enclosure to avoid condensation dripping onto equipment. Where conduits are routed from above, prior to entering the enclosure provide conduit drains.

F. Conduit joints shall be watertight.

3.3 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Area Designations:
   1. Dry/wet spaces:
      a. RGS.
   2. Buried:
      a. PVC-RGS.
      b. Schedule 40 PVC when encased in a concrete ductbank.
   3. Corrosive areas:
      a. PVC-RGS.
   4. Highly Corrosive areas:
      a. PVC-RGS.
   5. NFPA 70 hazardous areas:
      a. PVC-RGS.

B. FLEX-LT conduits shall be installed as the final conduit connection to motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.
   1. The maximum length shall not exceed:
      a. 3 FT to motors.
      b. 2 FT to all other equipment.

3.4 CONDUIT FITTINGS AND ACCESSORIES

A. Terminate Conduits:
   1. In NEMA 4X rated enclosures:
      a. Watertight, insulated and gasketed hub and locknut.
   2. At cable tray:
      a. Provide insulated bushing.

3.5 CONDUIT SUPPORT

A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
   1. Outdoor areas:
      a. Stainless steel system consisting of: stainless steel channels and fittings, nuts and hardware and conduit clamps.

B. Permitted single conduit support fasteners per area designations and conduit types:
   1. Outdoor areas:
      a. Material: Stainless steel.
      b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
   2. Conduit type shall be compatible with the support fastener material.
      a. Stainless steel system.

3.6 PULL AND JUNCTION BOX INSTALLATION

A. General:
   1. Install products in accordance with manufacturer's instructions.
   2. Size boxes in accordance with NFPA 70 to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

B. Pull and Terminal Junction Boxes:
   1. Install pull or terminal junction boxes to facilitate the Supplier’s equipment and in spaces where underground conduit has clear access to the boxes from the bottom. Reaching over conduit to access boxes is not permitted.
      a. Boxes shall have a minimum of 3 FT clear space from the front of the box to any object from the floor to 6 FT-6IN above the floor. Provide of minimum of 30 IN side-to-side access space.
      b. Make covers of boxes accessible.
   2. Permitted uses of NEMA 4X stainless steel metallic enclosure:
      a. Pull or terminal junction box surface mounted in outdoor areas.

END OF SECTION

SECTION 26 05 36
CABLE TRAY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cable tray and associated fittings and supports.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 10 14 00 - Identification Devices.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 05 26 - Grounding.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
      c. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   2. National Electrical Manufacturers Association (NEMA):
      a. VE-1, Metal Cable Tray Systems.
      b. VE-2, Metal Cable Tray Installation Guidelines.
   3. Underwriters Laboratories, Inc. (UL).
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

1.3 DEFINITIONS

A. Types of Cable Tray:
   1. Ventilated trough: A prefabricated metal structure consisting of two (2) longitudinal side rails and a ventilated bottom with clear openings no greater than 4 IN.
   2. Solid-bottom: A prefabricated metal structure consisting of two (2) longitudinal side rails and a bottom with no openings within the cable-bearing surface.

1.4 SYSTEM DESCRIPTION

A. The Supplier shall select the preferred cable tray.

B. Miscellaneous:
   1. The cable tray shall be sized in accordance with the NFPA 70 and the requirements of this Specification Section.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.

b. See Specification Section 26 05 00 - Electrical - Basic Requirements for additional requirements.

3. Fabrication and/or layout drawings:
   a. Routing, size and fittings.

B. Informational Submittals:
1. Cable tray fill calculations.
2. Cable schedule of cables in cable trays and cable routing plans.

1.6 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00 - Electrical - Basic Requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Metallic and nonmetallic cable tray systems:
   a. Eaton B-Line.
   b. T.J. Cope.
   c. Husky/Burndy.
   d. Thomas & Betts.
   e. P-W Ind.

2.2 COMPONENTS

A. Ventilated Trough Tray:
1. Material:
   a. Steel:
      1) Side channels and transverse elements: Hot rolled ASTM A1011 carbon steel galvanized per ASTM A123/A123M.
   b. Aluminum:
      1) Side channels: Heat treatable alloy Type 6063-T6.
      2) Transverse elements: Heat-treated alloy Type 6063-T6 (solid channel) or Type 6063-NHT (tubular).
2. Fabrication:
   a. Standard: NEMA VE-1.
   b. Side rails:
      1) I-beam or channel.
      2) Flange in or out (full width top opening).
   c. Transverse elements: One-piece, corrugated, ventilated bottom.
   d. Maximum open spacing between elements is 4 IN as measured in a direction parallel to the side rails.
   e. Metallic trays shall be UL classified per NFPA 70 as an equipment grounding conductor.

B. Solid-Bottom Tray:
1. Material:
   a. Steel:
      1) Side channels and transverse elements: Hot rolled ASTM A1011 carbon steel galvanized per ASTM A123/A123M.
2. Fabrication:
   a. Standard: NEMA VE-1.
   b. Side rails:
      1) I-beam or channel.
      2) Flange in or out (full width top opening).

c. Transverse elements: One-piece, corrugated, solid bottom.
d. Metallic trays shall be UL classified per NFPA 70 as an equipment grounding conductor.

C. Fittings:
1. Radius of bends: As required for cable layout in tray.
2. Degrees of arc for elbows: As required for cable tray layout.

2.3 ACCESSORIES

A. Accessories including but not limited to, splice plates, barrier strips, drop outs, box connector, end plate and conduit clamps to be the same material as the tray or other compatible material.

B. Covers and Associated Accessories:
1. Material: Same base material as tray.
2. Types: Solid flanged (flat), ventilated flanged (flat), peak flanged.

C. Cable Tray Ground Clamps:
1. Malleable iron or tin-plated extruded aluminum with zinc-plated steel screws.
2. Serrated edges to bite into and bond to the cable tray system.

D. Support system:
1. Material: See Specification Section 26 05 00 - Electrical - Basic Requirements for material specifications.
2. See PART 3 of this Specification Section for material type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with NEMA VE-2 and as recommended by the manufacturer's instructions.

B. Install cable tray, fittings and accessories, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.

C. Cable Tray Supports:
1. Provide supports at required locations to provide the loading capacity per the Supplier’s fill calculations.
2. Cable trays installation shall comply with NFPA 70.

D. Permitted prefabricated bracket or trapeze type support system per area designations and tray material:
1. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.
2. Tray material shall be compatible with the support system material.
a. Galvanized steel system may be used with zinc coated trays.

E. Whenever cable tray system spans a structural expansion joint provide one of the following:
1. Expansion connector allowing a minimum of 1 IN straight-line movement of sections.
2. A 2 IN discontinuity (gap) in the cable tray to allow horizontal and vertical movement.

F. Maintain electrical continuity of the cable tray system.
1. Bolt connectors to each section or fitting.
2. Span expansion connectors by a bonding jumper.
3. Tighten all bolted connections to manufacturer's recommendations to ensure electrical continuity.

G. Cable Tray System Grounding:
1. See Specification Section 26 05 26 - Grounding.

H. Provide UV resistant nylon type protective grommets on all sharp edges of the trays, including the ends of each tray run.

I. Cable trays not permitted to be mounted directly to concrete surfaces. Provide stainless steel framing strut.
   1. Provide aluminum conduit where raceway is required to be run from the THP train structural steel out to equipment or devices where tray would not be protected and subject to damage.

J. Secure cables, in vertical runs of cable tray, or side-mounted tray, with cable clamps or ties as near as practical to the top and bottom of the vertical run and at a maximum of 6 FT spacing over the length of the run.
   1. Plastic wire ties to be UV resistant type.

K. Install flat, solid, flanged covers on vertical cable tray to a minimum 6 FT above finished floor and walkways.

L. Cover cable tray systems passing under open grating type walkways and platforms.
   1. Peak flanged.

M. Install barrier strips in cable tray systems containing both control and instrumentation wiring to physically separate the control cables from the power cables, otherwise, provide separate cable tray.

N. Cable Installation:
   1. All cables shall be multi-conductor cable type, without exception.

3.2 FIELD QUALITY CONTROL

A. Tray Fill Calculations:
   1. Cable tray fill shall not exceed NFPA 70 requirements.
      a. The Supplier shall coordinate the installation of all cables and maintain cable fill calculations and schedule of cables in the trays.

B. Where galvanized steel cable tray is cut, drilled, or where the protective coating has otherwise been damaged during installation, immediately coat the exposed steel surface with a rust-inhibitor and a finish coat of zinc-rich paint.

C. Remove trash and accumulated dirt from the entire cable tray system at the completion of the project and install covers where applicable.

D. Tagging and warning signs:
   1. See Specification Section 10 14 00 – Identification Devices.

END OF SECTION

SECTION 26 08 13
ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for acceptance testing.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 61 03 - Equipment - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.
   2. InterNational Electrical Testing Association (NETA):
      a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
   3. Nationally Recognized Testing Laboratory (NRTL).

B. Qualifications:
   1. Testing firm qualifications: See Specification Section 01 61 03 - Equipment - Basic Requirements.
   2. Field personnel:
      a. See Specification Section 01 61 03 - Equipment - Basic Requirements.
      b. As an alternative, supervising technician may be certified by the equipment manufacturer.
   3. Analysis personnel:
      a. See Specification Section 01 61 03 - Equipment - Basic Requirements.
      b. As an alternative, supervising technician may be certified by the equipment manufacturer.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 01 61 03 - Equipment - Basic Requirements for electrical equipment and connection testing plan submittal requirements.

B. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Prior to energizing equipment:
      a. Photocopies of all continuity tests.
   3. Within two weeks after successful completion of Demonstration Period (Commissioning Period):
      a. Single report containing information including:
         1) Summary of Project.
         2) Information from pre-energization testing.
         3) See testing and monitoring reporting requirements in Specification Section 01 61 03 - Equipment - Basic Requirements.

PART 2 - PRODUCTS

2.1 FACTORY QUALITY CONTROL

A. Provide Division 26 equipment with all routing factory tests required by the applicable industry standards or NRTL.

B. Factory testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section and Specification Section 01 61 03 - Equipment - Basic Requirements.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. General:
   1. Complete electrical testing in three phases:
      a. Pre-energization testing phase.
      b. Equipment energized with no load.
      c. Equipment energized under load.
   2. Perform testing in accordance with this Specification Section and NETA ATS.
   3. Provide field setting and programming of all adjustable protective devices and meters to settings as determined by the approved coordination study.
   4. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
      a. Contract Drawings and Specifications.
      b. Related construction change documentation.
      c. Approved Shop Drawings.
      d. Approved Operation and Maintenance Manuals.
      e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plan:
   1. Approved in accordance with Shop Drawing submittal schedule.
   2. Included as a minimum:
      a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
      b. List and description of testing and analysis equipment to be utilized.
      c. List of all equipment to be testing, including:
         1) Name and tag numbers identified in the Contract Documents.
         2) Manufacturer's serial numbers.
         3) Other pertinent manufacturer identification,

C. Instruments Used in Equipment and Connections Quality Control Testing:
   1. Minimum calibration frequency:
      a. Field analog instruments: Not more than 6 months.
      b. Field digital instruments: Not more than 12 months.
      c. Laboratory instruments: Not more than 12 months.
      d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.
   2. Carry current calibration status and labels on all testing instruments.
   3. See individual testing programs for additional instrumentation compliance requirements.

D. Testing and Monitoring Program Documentation:
   1. Provide reports with tabbed sections for each piece of equipment tested.
   2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
      a. Include legible copies of all forms used to record field test information.

3. Prior to start of testing, submit one copy of preliminary report format for Engineer review and comment:
    a. Include data gathering and sample test report forms that will be utilized.
4. In the final report, include as a minimum, the following information for all equipment tested:
    a. Equipment identification, including:
        1) Name and tag numbers identified in the Contract Documents.
        2) Manufacturer's serial numbers.
        3) Other pertinent manufacturer identification,
    b. Date and time of each test.
    c. Ambient conditions including temperature, humidity, and precipitation.
    d. Visual inspection report.
    e. Description of test and referenced standards, if any, followed while conducting tests.
    f. Results of initial and all retesting.
    g. Acceptance criteria.
    h. "As found" and "as left" conditions.
    i. Corrective action, if required, taken to meet acceptance.
    j. Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.
    k. Instrument calibration dates of all instruments used in testing.
5. Provide three (3) bound final reports prior to Project final completion.

E. Electrical Equipment and Connections Testing Program:
1. See individual Division 26 Specification Sections for equipment specific testing requirements.
2. Test all electrical equipment.
    a. Perform all required NETA testing.
    b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.

3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

A. Thermographic survey:
1. Components:
    a. Motor connections.
    b. Motor disconnect switch connections.
    c. Power terminal blocks or strips in termination boxes.
2. Perform inspections and tests per NETA ATS 9.
3. Provide comprehensive report including, but not limited to:
    a. Description of equipment and nameplates.
    b. Any discrepancies.
    c. Any temperature differences and causes.
    d. Areas inspected and tested.
    e. All test parameters and current load conditions, include all tripping and clearing times, pick-up and delay settings, resistance measurements, all operational dimensions and tolerances, and testing equipment used.
    f. Recommended actions.
    g. Photographs as required.

B. Cable - Low Voltage:
1. Perform inspections and tests per NETA ATS 7.3.2.

C. Grounding:
1. Perform inspections and tests per NETA ATS 7.13.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

D. Motors:
   1. Perform inspections and tests per NETA ATS 7.15.
   2. See Specification Section 01 61 03 - Equipment - Basic Requirements.

END OF SECTION

SECTION 26 28 16
SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Safety switches.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 26 05 00 - Electrical - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Enclosed and Dead-Front Switches.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 - Electrical - Basic Requirements for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Appleton Electric Company.
   5. Crouse-Hinds.
   6. Killark.

2.2 SAFETY SWITCHES

A. General:
   1. Non-fusible or fusible.
   2. NEMA Type HD heavy-duty construction.
   3. Switch blades will be fully visible in the OFF position with the enclosure door open.
   4. Quick-make/quick-break operating mechanism.
   5. Deionizating arc chutes.
   6. Manufacture double-break rotary action shaft and switchblade as one common component.

7. Clear line shields to prevent accidental contact with line terminals.
8. Operating handle (except NEMA 7 and NEMA 9 rated enclosures):
    a. Red and easily recognizable.
    b. Padlockable in the OFF position.
    c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.

B. Ratings:
1. Horsepower rated of connected motor.
2. Voltage and amperage: As determined by Supplier.
3. Short circuit withstand:
    a. Non-fused: 10,000A.
    b. Fused: 200,000A.

C. Accessories, when indicated in PART 3 of this Specification Section:
1. Neutral kits.
2. Ground lug kits.
3. Auxiliary contact kits:
    a. Opens before main switch.
    b. Rated 10A at 125/250 Vac.
    c. One (1) N.O. and one (1) N.C. contact.

D. Enclosures:
1. NEMA 4X rated (metallic):
    a. Body and cover: Type 316 stainless steel.
    b. No knockouts, external mounting flanges, hinged and gasketed door.

E. Standards: NEMA KS 1, UL 98.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide safety switches for each 480 volt equipment load on the THP train.
1. Provide cabling from the safety switch to the equipment.

B. Install in accordance with manufacturer's instructions and recommendations and NFPA 70.

C. Provide switches for all motors.

D. Install switches adjacent to the equipment they are intended to serve and in a readily accessible location.

E. Provide auxiliary contact kit on all safety switches.

END OF SECTION

SECTION 40 41 13
HEAT TRACING CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Heat tracing cable as required for heat tracing of pipes.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 26 05 00 - Electrical - Basic Requirements.
   3. Section 46 34 50 - Pre-Engineered, Fabricated Thermal Hydrolysis Process System.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronic Engineers (IEEE):
      a. 515, Testing, Design, Installations, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
   3. Underwriters Laboratories, Inc. (UL):
      a. 1588, Roof and Gutter De-Icing Cable Units.
      b. 2049, Residential Pipe Heating Cable.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Product types and all accessories.
      b. Power requirements for each circuit based upon actual length of heat trace and maintained temperature.
      c. Circuit breaker rating based upon inrush current at minimum expected start-up temperature.
      d. Length of heat tape for each pipe size and run.
      e. Coordinate and verify length and Watts/FT of heat tape required based upon pipe size and insulation thickness.
         1) Include the calculations to support the heat tape output.
      f. See Section 26 05 00 for additional requirements.

   3. Fabrication and/or layout drawings:
      a. Wiring diagrams showing physical locations of thermostats and heat trace power supply.

B. Operation and Maintenance Manual:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Miscellaneous:
   1. Test reports: Megger test results.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shall be stored such that they are not exposed to sunlight or other UV rays.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Thermon.
   2. Chemelex Division; Raychem Corp.
   3. Chromalox.

2.2 HEAT TRACING

A. Design Parameters:
   1. Pipe diameter, length and material: See Drawings and relevant piping Specifications.
   2. Flange, valve, pipe support size: See Drawings and relevant piping Specifications.
   3. Pipe insulation type and thickness: See Drawings and relevant piping Specifications.
   4. Temperatures requirements:
      a. Low ambient temperature for the specific location: -20 DegF.
      b. Start-up temperature: 40 DegF.
      c. Maintain temperature: 40 DegF.
      d. High temperature exposure with power off: 185 DegF.
   5. Wind factor for the specific location: 50 MPH.
   6. Electrical requirements:
      a. Voltage: 120 VAC.
      b. Circuit breaker:
         1) Standard circuit breaker.
         2) Field coordinate if other than 20A required.
   7. Safety factor: 10 percent.

B. Self-regulating or power-limiting parallel circuit construction consisting of an inner core of conductive material between parallel copper bus wires, with inverse temperature - conductivity characteristics with metal overbraid.

C. Controller:
   1. Enclosure: NEMA 4X, stainless steel.
   2. Number of output heat trace circuits: One.
   3. Voltage: 120VAC from standard breaker. Controller shall inherently provide ground fault sensing required by NEC and tripping of output circuit.
   4. Alarms:
      a. One common trouble alarm contact rated 120VAC, 1.0 A minimum.

D. Thermostats:
   1. Ambient sensing type:
      a. Enclosure: NEMA 4X, polyurethane-coated cast-aluminum housing, stainless steel hardware.
      b. One 3/4 IN NPT conduit hub.
      c. Set-point range: 15 DegF to 140 DegF.
      d. Housing exposure limits: -40 DegF to 160 DegF.
      e. Switch: SPDT.
      f. Electrical rating: 22A @ 125/250/480 VAC.
      g. Accuracy: +/- 6 DegF.
      h. Deadband: 3 DegF to 9 DegF above actuation temperature.

i. Set-point repeatability: +/- 3 DegF.
j. Sensor type: Fixed fluid-filled (silicone) bulb and capillary.
k. Sensor material: Stainless steel.

E. All necessary or required components and accessories, such as power connection boxes, end seals, straps, tape and fitting brackets.

F. Provide power connection kit with signal light for each heat trace cable location. Where one heat trace circuit is used to power two or more individual and separate pipe lengths, provide a power connection kit for each pipe length. Indicating light shall be LED type which is on during the heating cycle. Locate indicating light in an accessible and viewable location.

G. In non-corrosive and non-hazardous locations, insulation shall be Polyolefin.

H. In corrosive, hazardous and hydrocarbon locations insulation shall be Fluoropolymer (Teflon).

PART 3 - EXECUTION

3.1 PREPARATION

A. Install materials after piping has been tested and approved.

3.2 INSTALLATION

A. Insulate and heat trace wet pipe systems as required in other specification sections.
1. If equipment supplied or field conditions dictate a larger heat tracing load than shown or specified, requiring additional equipment, Supplier shall provide additional wiring, conduit, circuit breakers, and any other equipment required for a complete insulation and heat tracing system at no additional cost to the Owner.

B. Install materials in accordance with manufacturer's instructions.
1. Each circuit shall not exceed the manufacturer's recommended maximum length.

C. For metallic piping:
1. Heat tracing shall be installed completely wired.
2. Cut heat trace to lengths as required and secure to pipe with glass or polyester fiber tape.

D. For non-metallic piping:
1. Allow for extra heat trace output because non-metallic pipe has a lower heat transfer. Heat tracing shall be installed completely wired.
2. Cut heat trace to lengths as required and secure to pipe with aluminum tape throughout the length of the trace.

E. Protection and Control Requirements:
1. Protection by a GFEPCI circuit breaker supplied by others.
2. Provide an ambient sensing thermostat for heat trace power.
3. The alarm thermostat shall be placed on the opposite end of the circuit from the power thermostat or power connection to allow for annunciation of partial failure of a circuit or the loss of power from a tripped GFEPCI circuit breaker.
4. Provide a monitoring module that monitors the voltage (circuit breaker status) to each circuit.
5. The alarm from the alarm thermostat and monitor module shall be annunciated on the indicated control system.

3.3 TESTING

A. Megger the cables at the manufacturers recommended voltage level three times.
1. Before installation.
2. After attachment to pipe but before insulation is installed.

3. After pipe insulation is installed but before energization.

END OF SECTION

SECTION 40 61 13
PROCESS CONTROL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for complete instrumentation system for process control.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 10 14 00 - Identification Devices.
   3. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
   4. Section 40 67 00 - Control System Equipment Panels and Racks.

C. Description of Work:
   1. Instrumentation and Control System: The work consists of controls and instrumentation for the thermal hydrolysis system and interface to the existing Distributed Control System.
   2. Programming: Programming for the thermal hydrolysis system shall be provided by Supplier to result in a complete and fully functional system that meets the performance requirements included in Specification Section 46 34 50.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Arlington County Water Control Bureau Plant Control Systems Standards, Revision 03/25/2019.
   2. Canadian Standards Association (CSA).
   3. FM Global (FM).
   4. The International Society of Automation (ISA):
      a. 7.0.01, Quality Standard for Instrument Air.
      b. S5.1, Instrumentation Symbols and Identification.
      c. S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
      d. S5.4, Standard Instrument Loop Diagrams.
      e. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
      f. ISA 88, Batch Control.
      g. ISA 101, Human Machine Interface.
      h. ISA/IEC 62443, Security for Industrial Automation and Control Systems.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. National Institute of Standards and Technology (NIST).
   8. Rockwell Automation, Ethernet Network Design, June 18, 2016.
   9. Underwriters Laboratories, Inc. (UL):
      a. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

B. The Owner will provide sample power distribution, I/O module and network diagrams.

C. PCS and PLC equipment and software used must be approved by the County. A list of approved and current manufacturers, with models, and versions will be provided.
   1. The current approved PCS and PLC manufacturers are Allen Bradley ControlLogix and Allen Bradley MicroLogix 1400. The current approved Operator Interface Panels are Allen Bradley PanelView panels. FactoryTalk is the approved HMI software.
   2. Arlington County currently uses the following versions of control software. The Supplier is responsible to coordinate with Arlington County for the most current software versions in use prior to procurement.
      a. FactoryTalk version 10.
      b. RS500 version 10.0.
      c. Studio 5000 designer v33+.

D. PCS panels.
   1. Utilize standard catalogued PLC equipment approved by Arlington County and suitable for use in industrial water/wastewater processing environment.
   2. Include components shown on contract drawings and accessories and hardware not shown but necessary to meet manufacturer recommendations and/or Arlington County specifications.
   3. Equipment: Installed following manufacturer's recommendations. Follow manufacturer's installation manuals for guidance and details not shown on contract drawings.

E. Qualifications:
   1. Instrumentation Subcontractor:
      a. Experience.
         1) The Instrumentation Subcontractor shall be required to demonstrate a minimum of five years recent, past experience in the design, manufacture and commissioning of instrumentation and Control Systems of comparable size, type and complexity to the proposed project. The Subcontractor shall be required to have his/her own in house capability to handle complete Control System engineering, fabrication, and testing.
         2) Employ a professional Control Systems Engineer or Electrical Engineer registered in the Commonwealth of Virginia to supervise or perform the work required by this Specification.
         3) Employ personnel on this project who have successfully completed ISA or manufacturers training courses on general process instrumentation and configuration and implementation of the specific process controllers, computers, and software proposed for this project, such as the ISA Certified Control System Technical (CCST) certification or ISA Certified Automation Professional (CAP).
            a) Have performed work of similar or greater complexity on at least five previous projects utilizing the same hardware/software platform to be furnished and installed under this Contract.
            b) Have been actively engaged in the type of work specified in this Specification for a minimum of five years.
            c) Have been actively engaged in industrial process control programming and system integration for a minimum of 10 years.
            d) Have been actively engaged in PLC configuration utilizing IEC 61131 Function Block programming, HMI programming utilizing FactoryTalk and system integration for a minimum of five years.

F. Miscellaneous:
   1. Comply with electrical classifications and NEMA enclosure types shown on Drawings and as designated by Supplier, based on Supplier's evaluation of THP Train.

G. Process Equipment Coordination:
   1. Division 13 specified equipment shall be coordinated for proper operation with equipment related process equipment specified in other Divisions.
   2. Equipment shall be integrated, furnished, and installed in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.
   3. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Owner before proceeding.

1.3 DEFINITIONS

A. Architecturally finished area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.

B. Non-architecturally Finished Area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.

C. Hazardous Areas: Class I, II or III areas as defined in NFPA 70.

D. Highly Corrosive and Corrosive Areas: Rooms or areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.

E. Outdoor Area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.

F. Instrument Air Header: The segment of air supply piping and tubing which transports air from the compressed instrument air source through the branch isolation valve of any takeoff (branch) line.

G. Branch Line: The segment of air supply piping and tubing which transports air from the outlet of the air header branch isolation valve through an air user's isolation valve.

H. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

I. Calibrate: To standardize a device so that it provides a specified response to known inputs.

1.4 SYSTEM DESCRIPTION

A. Control System Requirements:
   1. This Specification Section provides the general requirements for the instrument and control system.
   2. The instrument and control system consists of all primary elements, transmitters, switches, controllers, computers, recorders, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special or shielded cable, special grounding or isolation, auxiliaries, software, wiring, and other devices required to provide complete control of the plant as specified in the Contract Documents.

B. All signals shall be directly linearly proportional to measured variable unless specifically noted otherwise.

C. Systems Instrumentation Subcontractor:
   1. Furnish and coordinate instrumentation system through a single instrumentation subcontractor.
      a. The instrumentation subcontractor shall be responsible for functional operations of all systems, performance of control system engineering, supervision of installation, final connections, calibrations, preparation of Drawings and Operation and Maintenance

Manuals, start-up, training, demonstration of substantial completion and all other aspects of the control system.

2. Ensure coordination of instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.
3. Prior to Shop Drawing preparation, the Instrumentation Subcontractor shall inspect the Owner's existing equipment and as-constructed electrical documentation so as to be able to fully coordinate the interface of new and existing instrumentation, PCS equipment, vendor furnished control panels and controls. All costs associated with this work shall be incorporated into the original bid. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure, complete and compatible installation.
4. Instrumentation Subcontractor shall review, coordinate, and integrate all instrumentation submittals before they are submitted to the Owner for review.
5. Instrumentation Subcontractor shall prepare all submittals, plan for, and coordinate instrumentation-related shutdowns, testing and start-up activities as required by Specification Sections 01 75 00 - Facility and System Start-up.
6. Instrumentation Subcontractor shall attend all PCS and instrumentation-related coordination meetings, workshops, tests and training. Instrumentation Subcontractor shall schedule and coordinate all training between Owner-personnel and PCS and instrumentation equipment manufacturers.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Division 1 for requirements for the mechanics and administration of the submittal process.
   2. Submittals shall be original printed material or clear unblemished photocopies of original printed material.
      a. Facsimile information is not acceptable.
   3. Limit the scope of each submittal to one Specification Section.
      a. Each submittal must be submitted under the Specification Section containing requirements of submittal contents.
      b. Do not provide any submittals for Specification Section 40 61 13 – Process Control System General Requirements.
   4. Product technical data including:
      a. Equipment catalog cut sheets.
      b. Instrument data sheets:
         1) ISA S20 or approved equal.
         2) Separate data sheet for each instrument.
      c. Materials of construction.
      d. Minimum and maximum flow ranges.
      e. Pressure loss curves.
      f. Physical limits of components including temperature and pressure limits.
      g. Size and weight.
      h. Electrical power requirements and wiring diagrams.
      i. NEMA rating of housings.
      j. Submittals shall be marked with arrows to show exact features to be provided.
   5. Provide electronic spreadsheets for I/O points, instrumentation, and valves.
   6. Loop diagrams per ISA S5.4 as specified in Specification Section 01 33 00.
   7. Comprehensive set of wiring diagrams as specified in Specification Section 01 33 00.
   8. Panel fabrication drawings as specified in Specification Section 01 33 00.
   9. PLC/DCS equipment drawings.
   10. HMI graphics.

11. Nameplate layout drawings.
12. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3.
    a. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be employed exclusively throughout submittals.
13. All Shop Drawings shall be modified with as-built information/corrections.
14. All panel and wiring drawings shall be provided in both hardcopy and softcopy.
    a. Furnish electronic files on CD-ROM or DVD-ROM media.
    b. Drawings in AUTOCAD format.
15. Provide a parameter setting summary sheet for each field configurable device.
16. Certifications:
    a. Documentation verifying that calibration equipment is certified with NIST traceability.
    b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA.
        1) Certification documentation is required for all equipment for which the specifications require independent agency approval.
17. Testing reports: Source quality control reports.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
    a. See Division 1 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. Warranties: Provide copies of warranties and list of factory authorized service agents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Division 1. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed and permanent connections are made.

1.7 SITE CONDITIONS

A. Unless designated otherwise on the Drawings, area designations are as follows:
1. Outdoor area:
    a. Wet.
    b. Corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.
    c. Below grade vaults and manholes:
        1) Subject to temporary submergence when specifically designated on the Drawings or Specifications.
2. Architecturally finished area:
    a. Dry.
    b. Noncorrosive unless designated otherwise on the Drawings or in the Specifications.
    c. Nonhazardous unless designated otherwise on the Drawings or in the Specifications.
3. Non-architecturally finished area: As designated elsewhere on the Drawings or in the Specifications.

PART 2 - PRODUCTS

2.1 NEMA TYPE REQUIREMENTS

A. Provide enclosures/housing for control system components in accordance with the following:
1. Areas designated as wet: NEMA Type 4.
2. Areas designated as wet and/or corrosive: NEMA Type 4X.

3. Areas designated as Class I hazardous, Groups A, B, C, or D as defined in NFPA 70:
    a. NEMA Type 7 unless all electrical components within enclosure utilize intrinsically safe circuitry.
        1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
4. Areas designated as Class II hazardous, Groups E, F, or G as defined in NFPA 70:
    a. NEMA Type 9 unless all electrical components within enclosure utilize intrinsically safe circuitry.
        1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
5. Either architecturally or non-architecturally finished areas designated as dry, noncorrosive, and nonhazardous: NEMA Type 12.
6. Areas designated to be subject to temporary submersion: NEMA 6P.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. System Operating Criteria:
    1. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two cycles per minute or a magnitude of movement of 0.5 percent full travel.
    2. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
    3. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.
    4. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position final element.
    5. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0 percent of full scale.

B. Furnish any additional interposing relays and signal isolators required to interface existing equipment or control panels with the PCS.

C. Owner Required PLC Monitoring:
    1. Provide PLC and panel equipment to accept field wiring and to monitor equipment and devices designated by the Owner during the submittal process. These devices shall also be configured and included in Supplier's configuration screens.
        a. Owner's standards for motor operated valves:
            1) Valve fully closed: Closed limit switch is made and Opened limit switch is not made.
            2) Valve traveling from Fully Closed to Fully Opened: Both limit switches are made.
            3) Valve fully open: Opened limit switch is made and Closed limit switch is not made.
            4) Reverse requirements when valve traveling in opposite direction.
        b. Emergency stop pushbuttons.

2.3 ACCESSORIES

A. Provide identification devices for instrumentation system components in accordance with Specification Section 10 14 00 - Identification Devices.

B. Provide corrosion resistant spacers to maintain 1/4 IN separation between equipment and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Clarifiers, Digesters, Reservoirs, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes.

B. Install electrical components per the requirements of the Electrical design.

C. Panel-Mounted Instruments:
   1. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
   2. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.

D. See Division 26.

3.2 FIELD QUALITY CONTROL

A. See Specification Section 01 75 00 – Facility and System Start-up.

B. Supplier shall be responsible to coordinate the requirements outlined in subsequent paragraphs with the Contractor.

C. Maintain accurate daily log of all start-up activities, calibration functions, and final setpoint adjustments.
   1. Documentation requirements include the utilization of the forms located at the end of this Specification Section.
      a. Loop Check-out Sheet.
      b. Instrument Certification Sheet.
      c. Final Control Element Certification Sheet.

D. In the event that instrument air is not available during calibration and testing, supply either filtered, dry, instrument quality air from a portable compressor or bottled, dry, instrument quality air.
   1. Do not, under any circumstances, apply hydrostatic test to any part of the air supply system or pneumatic control system.

E. Pneumatic Signal Tubing Testing:
   1. Before the leak test is begun, blow clean with dry air.
   2. Test signal tubing per ISA 7.0.01, except for tubing runs of less than 10 FT where simple soap bubble testing will suffice.
   3. If a leak is detected, repair the leak and repeat the leak test.
   4. After completion of the leak test, check each signal line for obstructions.
      a. If any are indicated, remove and retest.

F. Instrumentation Calibration:
   1. Verify that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
   2. Calibrate all field-mounted instruments, other than local pressure and temperature gages, after the device is mounted in place to assure proper installed operation.
   3. Provide calibration report for all instruments using Instrumentation Certification / Calibration Sheet provided.
   4. Calibrate in accordance with the manufacturer's specifications.
   5. Bench calibrate pressure and temperature gages.
      a. Field mount gage within seven days of calibration.
   6. Check the calibration of each transmitter and gage across its specified range at 0, 25, 50, 75, and 100 percent.
      a. Check for both increasing and decreasing input signals to detect hysteresis.
   7. Replace any instrument which cannot be properly adjusted.

8. Stroke control valves with clean dry air to verify control action, positioner settings, and solenoid functions.
9. Calibration equipment shall be certified by an independent agency with traceability to NIST.
    a. Certification shall be up-to-date.
    b. Use of equipment with expired certifications shall not be permitted.
10. Calibration equipment shall be at least three times more accurate as the device being calibrated.

G. Loop Testing:
1. Open Loop Testing:
    a. General: The open loop test encompasses testing signaling from field devices, such as MCC drives, pumps, valves, instrumentation, and other controls/controllers connected to process control system PLC or RIO panels. It provides the ability to test a device's wiring prior to the RIO panel being made completely functional with the PCS. Testing can be scheduled only after all devices within a given panel are completely wired, permanently terminated, and energized from permanent sources.
        1) Conduct test after field conductors have been terminated and identified within process control system PLC or RIO panel and at field terminations.
        2) Conduct test in presence of Owner.
        3) Verify that equipment wiring, instrumentation, limit switches, drives, MCC, and other controls/controllers have been properly connected and calibrated.
        4) Develop system test document, including an I/O point list, and have approved by Owner.
        5) Use approved system test document to record testing results for each loop.
        6) Connect field equipment to permanent power source and energize during test. Signals should not jumpered unless there is a safety or process reason.
        7) Deficiencies: Retest and correct prior to Close Loop testing.
2. Conducting Open Loop Test:
    a. For analog inputs, at field terminals using sourcing meter or using field device, induce a 4 to 20 mA DC signal.
        1) Test signal at 0 percent, 50 percent, and 100 percent.
        2) Observe and record the change of state at I/O module within PCS PLC or RIO panel.
    b. For digital inputs, operate field device or any equipment connected thereto or jumper applicable terminals at field device.
        1) Observe and record the change of state at I/O module within PCS PLC or RIO panel.
    c. For analog outputs;
        1) If control network has been successfully tested, PLC will induce signal.
            a) Test output at 0 percent, 50 percent, and 100 percent at terminals within the RIO enclosure to field device.
        2) Otherwise, disconnect one associated loop wire or fuse from terminal within PCS RIO panel and generate signal.
            a) Test output at 0 percent, 50 percent, and 100 percent.
        3) Observe and record the change of state at I/O at field device.
    d. For digital outputs;
        1) If control network has been successfully tested, PLC will induce output signal.
        2) Otherwise, jumper the signal at terminal within PCS RIO panel.
        3) Observe and record change of state at I/O at field device.
3. Prerequisite Requirements to Closed Loop Test:
    a. Process control network must be successfully tested and made operational prior to closed loop testing.
    b. Successfully calibrate field instrumentation, limit switches, MCC devices, VFDs, and ancillary field devices.
    c. Submit calibration certification.

d. Verify field equipment is fully functional, powered, and made available to be controlled by PLC.
e. Notify Owner 10 days before commencement of pre-final testing of equipment.
f. For a given device or system, after Open Loop testing is complete, provide Owner five days' notice before commencing Closed Loop Testing.

4. Conducting Closed Loop Test:
   a. Accomplish test with coordination between the Contractor operating equipment and County verification at PCS monitoring control panel, servers, and or operator station(s).
   b. For analog inputs, induce by field device a 4 to 20 mA DC signal. Test signal at 0 percent, 50 percent, and 100 percent and observe at PCS monitoring control panel, servers, and or operator station(s).
   c. For digital inputs, operate field device/contact to observe change of state at PCS monitoring control panel, servers, and/or operator station(s).
   d. For analog outputs, induce a signal with a varying output. Test signal at 0 percent, 50 percent, and 100 percent from PCS monitoring control panel, servers and or operator station(s) to field device and observe at equipment or field device.
   e. Digital outputs are a change of state initiated by the PCS monitoring control panel, servers and or operator station(s).
      1) Observe operation of equipment and/or device at both field and PCS monitoring control panel, servers, and/or operator station(s).

H. Final Testing:
   1. For the purposes of control strategy proofing, 10 days prior to final testing. Contractor will provide access and ability to operate equipment through the PCS. This proofing may last up to 10 days.

I. Provide verification of system assembly, power, ground, and I/O tests.

J. Verify existence and measure adequacy of all grounds required for instrumentation and controls.

3.3 INTERFACE WITH PCS

A. The Supplier shall assist the Owner in the integration of the PLC database information into the PCS by supplying a Register Mapping Table of all holding register information after the factory acceptance testing and prior to shipment.
   1. Provide unique tag names for each I/O point. Repeat tag names are not permitted. This shall apply to similar I/O for identical process trains.

B. This interface shall have a heartbeat to indicate the communication channel status.

END OF SECTION

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Loop Check-out Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	Page 1 of 2
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	10050-211-134	Date: 12/19/98	
Control Loop No.	107		

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.
P201 Start Sig				VFD-107	21, 22	PLC Cab	103, 104
P201, Speed inp				VFD-107	27, 28	PLC Cab	67, 68, 69
P201 Start out				VFD-107	31, 32	PLC Cab	72, 73, 74
Press transmit	PIT-107	JS	--	PIT-107	+ / -	PLC Cab	98, 99, 100

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT
MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR	PI-107A	SI-107				
EQUIP STATUS	P201 ON	P201 OFF	V-107 open	V-107 close		
ALARM POINT	PAH-107					

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION
H-O-A sel sw	HS-107A	VFD-107				
L-O-R sel sw	HS-107B	@ P201				
S/S switch	HS-107C	MCC	HS-107D	MCC		

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point
PAH-107	120 psi				
SC-107		2.0	5.0	0.2	80 psi

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

(1) HS-107B in Local: (a) start/stop operation via HS-107A and HS-107C, D (b) Manual/auto operation via HS-107A. In auto, pump stopped on hi press, started on lo press. (2) HS-107B in Remote: Observed operation from PLC-pump stopped on hi press, started on lo press. (3) Observed V-107 open/close automatically in accord with pump run condition. (4) Observed all indications and terminations shown above. (5) Tuned SC-107

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by: Joe Smith (Work Performed By) Date: 12/19/98

Loop Check-out Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	Page 2 of 2
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	10050-211-134	Date: 12/19/98	
Control Loop No.	107		

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.
V-107 open ZS				ZSO-107	+ / -	PLC Cab	112, 113
V-107 close ZS				ZSC-107	+ / -	PLC Cab	114, 115

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT
MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS	ZOI-107	ZCI-107				
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

Checked terminations and verified indications shown above.

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by: Joe Smith (Work Performed By) Date: 12/19/98

(Version 2.0, May 2014)

Loop Check-out Sheet

Project Name:	Owner's Project No. (if applicable):	Page of
Project Owner:	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	Date:	

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT

MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS						
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by:_____ Date:_____

(Work Performed By)

(Version 2.0, May 2014)

Instrument Certification Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.	10050-211-134	Date: 12/19/98	
Control Loop No.:	222		
Instrument Tag No.	TSH-222	Transmitter/gauge span:	
Manufacturer:	ACE, Inc.	Switch set-point:	50 F
Model No.	TL-2983-SH5	Switch dead band:	5 F
Serial No.	10293583	Switch range:	32-200 F

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)	49.8 F	Contact Close	0.1%	45.1 F	Contact Open	0.2%
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): 1.0% Switch Range

Remarks:

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?
Temperature (dry block) calibrator	Hart Scientific XL5897T	0.1 F	Yes

Certified by: Joe Smith Date Certified: 12/19/98

Instrument Certification Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.	10050-211-134	Date:	12/19/98
Control Loop No.:	106		
Instrument Tag No.	PIT-106A	Transmitter/gauge span:	0-200 psi
Manufacturer:	ACE, Inc.	Switch set-point:	
Model No.	1275-X	Switch dead band:	
Serial No.	3049569TSH	Switch range:	

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%	0.00 psi	4.02 mA	0.13	0.00 psi	4.00 mA	0.00
25%	50.00 psi	8.00 mA	0.00	50.00 psi	8.01 mA	0.06
50%	100.00 psi	12.01 mA	0.06	100.00 psi	12.00 mA	0.00
75%	150.00 psi	16.00 mA	0.00	150.00 psi	16.01 mA	0.06
100%	200.00 psi	20.00 mA	0.00	200.00 psi	19.99 mA	0.06
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): 0.15% span

Remarks: Adjusted zero-otherwise no adjustments required

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?
Pressure calibrator	Hathaway/Beta XL5946P	0.025% full scale	Yes
Pressure module	Hathaway/Beta XL5948P-6:0-150 psi	0.025% full scale	Yes

Certified by: Joe Smith Date Certified: 12/19/98

Instrument Certification Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	
Instrument Tag No.	Transmitter/gauge span:
Manufacturer:	Switch set-point:
Model No.	Switch dead band:
Serial No.	Switch range:

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): _____

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by: _____ Date Certified: _____

Final Control Element Certification Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.	10050-211-134	Date:	12/19/98
Control Loop No.:	056		

Tag No.	LCV-056A
Description:	Control Valve
Manufacturer:	ACE, Inc.
Model No.	XYZ-123
Serial No.	748569AP2

Actuator:	Pneumatic: X Electric:
Positioner:	Direct: X Reverse:
Positioner:	Input: 9-15 psi Output: 0-100%
I/P Converter:	Input: 4-20 mA Output: 3-15 psi
Valve to	Open on air failure
Valve to	Open on power failure

I/P CONVERTER

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	OUTPUT	ERROR (% of span)	INPUT	OUTPUT	ERROR (% of span)
0%	4.00 mA	3.01 psi	0.08	4.00 mA	3.02 psi	0.17
25%	8.00 mA	6.04 psi	0.33	8.00 mA	6.05 psi	0.42
50%	12.00 mA	9.00 psi	0.00	12.00 mA	9.01 psi	0.08
75%	16.00 mA	11.97 psi	0.25	16.00 mA	12.03 psi	0.25
100%	20.00 mA	14.99 psi	0.08	20.00 mA	14.99 psi	0.08

Specified I/P converter accuracy: 0.50% % of span.

FINAL CONTROL ELEMENT

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	TRAVEL	ERROR (% of full travel)	INPUT	TRAVEL	ERROR (% of full travel)
0%	9.00 psi	0%	-	9.00 psi	0%	-
25%	10.50 psi	25%	-	10.50 psi	25%	-
50%	12.00 psi	50%	-	12.00 psi	50%	-
75%	13.50 psi	75%	-	13.50 psi	75%	-
100%	15.00 psi	100%	-	15.00 psi	100%	-

Remarks: LCV-056A is not furnished with position transmitter, so travel checks were visual.

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?
Multi-fct calibrator	Fluke-XL743B	0.01% Rdg + 0.015% FS	Yes
Pressure Module	Fluke-XL700POS (0-30")	0.05% FS	Yes

Certified by: Joe Smith Date Certified: 12/19/98

Final Control Element Certification Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	

Tag No.	
Description:	
Manufacturer:	
Model No.	
Serial No.	

Actuator:	Pneumatic: _____ Electric: _____
Positioner:	Direct: _____ Reverse: _____
Positioner:	Input: _____ Output: _____
I/P Converter:	Input: _____ Output: _____
Valve to	_____ on air failure
Valve to	_____ on power failure

I/P CONVERTER

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						

Specified I/P converter accuracy: _____ % of span.

FINAL CONTROL ELEMENT

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**TRAVEL**	**ERROR (% of full travel)**	**INPUT**	**TRAVEL**	**ERROR (% of full travel)**
0%						
25%						
50%						
75%						
100%						

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by: _____ Date Certified: _____

(Version 2.0, May 2014)

SECTION 40 61 43

SURGE PROTECTION DEVICES (SPD) FOR INSTRUMENTATION AND CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Type IC1 SPD - Dedicated 120 Vac circuit, series connection, control panel mounted.
   2. Type IC3 SPD - Discrete 120 Vac control signal, control panel mounted.
   3. Type IC5 SPD - Analog instrumentation signal, control panel mounted.
   4. Type IC7 SPD - Discrete low voltage control signal, control panel mounted.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 40 61 13 - Process Control System General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. LS 1, Low Voltage Surge Protection Devices.
   3. Underwriters Laboratories, Inc. (UL):
      a. 497B, Standard for Safety Protectors for Data Communications and Fire-Alarm Circuits.
      b. 1283, Standard for Safety Electromagnetic Interference Filters.
      c. 1363, Standard for Safety Relocatable Power Taps.
      d. 1449, Standard for Safety Transient Voltage Surge Suppressors.

B. Qualifications:
   1. Provide devices for a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
   2. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

1.3 DEFINITIONS

A. Clamping Voltage: The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge when the applied surge is induced at the 90 degree phase angle of the applied system frequency voltage.

B. Let-Through Voltage: The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge when the applied surge is induced at the 90 degree phase angle of the applied system frequency voltage.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet it specification within its rated temperature.

D. Maximum Surge Current:
   1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 percent deviation of clamping voltage at a specified surge current.
   2. Listed by mode, since number and type of components in any SPD may vary by mode.

E. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

F. Surge Current per Phase:
   1. The per phase rating is the total surge current capacity connected to a given phase conductor.
   2. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
      a. The N-G mode is not included in the per phase calculation.

G. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 120 V system the L-N peak voltage is 170 V).

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. For named products, submit only a catalog cut sheet.
      a. For all other products, submit the data required below.
   3. See Specification Section 40 61 13 - Process Control System General Requirements.
   4. Product technical data for non-specified models:
      a. Manufacturer's experience.
      b. Standard catalog cut sheet.
      c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
      d. Create a Product Data Sheet for each different model number of SPD provided.
         1) Data in the Product Data Sheet heading:
            a) SPD Type per PART 2 of the Specification.
            b) Manufacturer's Name.
            c) Product model number.
         2) Data in the Product Data Sheet body:
            a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
            b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.
         3) Data in the Product Data Sheet closing:
            a) Signature of the manufacturer's official (printed and signed).
            b) Title of the official.
            c) Date of signature.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.5 WARRANTY

A. The manufacturer shall provide a minimum of a five-year Limited Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers model numbers listed in the individual product paragraphs below are acceptable.

2.2 TYPE IC1 SPD

A. Approved Products:
   1. Eaton AGPH 12015.
   2. ASCO 252.
   3. MTL MA15/D/1/SI.
   4. Phoenix Contact SFP 1-20/120AC (2856702).

B. Standards: UL 1449.

C. Design:
   1. General:
      a. Surge arrestor with RFI filter.
      b. Automatic device reset.
      c. Mounted internally to control panels for point-of-use loads.
      d. MOV based or multi-stage hybrid solid state high performance suppression system.
      e. Designed for series connection.
      f. Enclosure: Metallic or plastic, flange or DIN rail mounting.
      g. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.
      h. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the units suppression filter system or power loss in any of the phases.
   2. Operating voltage: 120 Vac.
   3. Operating current: 15 A minimum.
   4. Operating frequency: 47 to 63 Hz.
   5. Modes of protection: All modes, L-N, L-G and N-G.
   6. Maximum continuous operating voltage: Less than 130 percent of system peak voltage.
   7. Maximum surge current: 20,000A per phase, 10,000A per mode minimum.
   8. Minimum repetitive surge current capacity: 1000 impulses with no degradation of more than 10 percent deviation of the clamping voltage.
   9. Fusing: Optional integral unit level and/or component level short circuit and/or thermal overload protection.
      a. External protection as recommended by manufacturer.
   10. Maximum clamping voltages, dynamic test with voltages measured from the zero voltage reference and 90 degree phase angle:

System Voltage	Test Mode	IEEE C62.41		UL 1449
		B Comb. Wave	A Ring Wave	
L-N = 120 V	L-N	400 V	300 V	330 V
	L-G	500 V	400 V	400 V
	N-G	500 V	400 V	400 V

2.3 TYPE IC3 SPD

A. Approved Products:
   1. MTL MA-15/D/1/SI.
   2. MTL SD-150X.
   3. Phoenix Contact PT 2x1VA-120AC-ST (2839185) with PT BE/FM (2839282) base for non-isolated wiring.

4. Phoenix Contact PT-2 PE/S-120 AC-ST (2839334 with PT-BE/FM (2839282) base for isolated wiring.

B. Standards: UL 497B or UL 1449.

C. Design:
1. General:
a. Mounted internally to control panels for point-of-use loads.
b. Multi-stage hybrid solid state high performance suppression system.
c. Designed for series connection.
d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
e. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.
f. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the units suppression filter system or power loss in any of the phases.
2. Operating voltage: 120 Vac.
3. Operating current: 3 A minimum.
4. Operating frequency: 45 to 65 Hz.
5. Modes of protection: L-N; when ground conductor is present L-G and N-G.
6. Maximum continuous operating voltage: Less than 130 percent of system peak voltage.
7. Maximum surge current: 6000 A per phase, 3000A per mode minimum.
8. Minimum repetitive surge current capacity:
a. The SPD shall meet one (1) of the following:
1) 1000 occurrences of a 200A, 10x1000 microsecond waveform.
2) 400 occurrences of a 500A, 10x1000 microsecond waveform.
3) 100 occurrences of a 400A, 10x700 microsecond waveform.
4) 100 occurrences of a 2000A, 8x20 microsecond waveform.
9. Maximum clamping voltages, measured from the zero voltage reference:
a. The SPD shall meet one of the following:
1) 400A, 10x700 microsecond waveform: 200 percent of system voltage.
2) IEEE B3 combination wave: 250 percent of system voltage.
3) IEEE B3 ring wave: 200 percent of system peak voltage.
4) IEEE A3 ring wave: 200 percent of system peak voltage.
5) Mode N-G clamping voltage may be 175 percent higher than the L-G levels.

2.4 TYPE IC5 SPD

A. Approved Products:
1. Eaton DHW2P036.
2. MTL SD32 or SD32X.
3. Phoenix Contact PT 2x2-24DC-ST (2838228) with PT 2x2-BE (2838208) or PT 2x2+F-BE (2839224) base.

B. Standards: UL 497B.

C. Design:
1. General:
a. Mounted internally to control panels for protection of equipment connected to analog signal loops.
b. Multi-stage hybrid solid state high performance suppression system.
c. Designed for series connection.
d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
e. Field connection: The unit shall have external terminal screws for line and ground conductors.
2. Operating voltage: 24 Vdc or as indicated on the Drawings.
3. Modes of protection: All modes, L-L and L-G.
4. Maximum continuous operating voltage: Less than 130 percent of system peak voltage.

5. Maximum surge current: 10,000 A.
6. Minimum repetitive surge current capacity:
    a. The SPD shall meet one of the following:
        1) 1000 occurrences of a 200A, 10 x 1000 microsecond waveform.
        2) 400 occurrences of a 500A, 10 x 1000 microsecond waveform.
        3) 100 occurrences of a 400A, 10 x 700 microsecond waveform.
        4) 100 occurrences of a 2000A, 8 x 20 microsecond waveform.
        5) 10 occurrences of a 10,000A, 8 x 20 microsecond waveform.
7. Maximum clamping voltages, L-L:
    a. The SPD shall meet one of the following:
        1) 400A, 10x700 microsecond waveform: 400 percent of system voltage.
        2) 10,000A, 8x20 microsecond waveform: 400 percent of system voltage.
        3) IEEE B3 combination wave: 225 percent of system voltage.
8. Maximum clamping voltages, L-G:
    a. The SPD shall meet one of the following:
        1) 400A, 10x700 microsecond waveform: 200 percent of system voltage.
        2) 10,000A, 8x20 microsecond waveform: 200 percent of system voltage.
        3) IEEE B3 combination wave: 300 percent of system voltage.

2.5 TYPE IC7 SPD

A. Approved Products:
1. Eaton DDIN Series.
2. MTL SD Series.
3. Phoenix Contact: TTC Series.

B. Standards: UL 497B.

C. Design:
1. General:
    a. Mounted internally to control panels for protection of equipment connected to a discrete signal.
    b. Multi-stage hybrid solid state high performance suppression system.
    c. Designed for series connection.
    d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
    e. Field connection: Provide unit with external terminal screws for line and ground conductors.
2. Operating voltage: 24 Vdc or 24 Vac or 120 Vac or as indicated on the Drawings.
3. Modes of protection: All modes:
    a. AC applications: L-N, L-G, N-G
    b. DC applications: Pos-Neg, Pos-Gnd, Neg-Gnd.
4. Maximum continuous operating voltage: Less than 130 percent of system peak voltage.
5. Maximum surge current: 10,000 A.
6. Minimum repetitive surge current capacity:
    a. The SPD shall meet one of the following:
        1) 1000 occurrences of a 200A, 10 x 1000 microsecond waveform.
        2) 400 occurrences of a 500A, 10 x 1000 microsecond waveform.
        3) 100 occurrences of a 400A, 10 x 700 microsecond waveform.
        4) 100 occurrences of a 2000A, 8 x 20 microsecond waveform.
        5) 10 occurrences of a 10,000A, 8 x 20 microsecond waveform.
7. Maximum clamping voltages, L-L (Pos-Neg):
    a. The SPD shall meet one of the following:
        1) 400A, 10x700 microsecond waveform: 400 percent of system voltage.
        2) 10,000A, 8x20 microsecond waveform: 400 percent of system voltage.
        3) IEEE B3 combination wave: 250 percent of system voltage.

8. Maximum clamping voltages, L-G:
    a. The SPD shall meet one of the following:
        1) 400A, 10x700 microsecond waveform: 200 percent of system voltage.
        2) 10,000A, 8x20 microsecond waveform: 200 percent of system voltage.
        3) IEEE B3 combination wave: 300 percent of system voltage.

2.6 SOURCE QUALITY CONTROL

A. Performance tests to be performed or independently verified by a certified testing laboratory.

B. The SPD are to be tested as a complete SPD system including: Integral unit level and/or component level fusing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. SPD devices shall not be installed on any circuit type which connects to DCS equipment, without exception.
    1. Types IC3, IC5, and IC7 devices are specified herein for PLC systems provided by equipment suppliers.

B. Install products in accordance with manufacturer's instructions.

C. Type IC1 SPD:
    1. Provide on the following applications:
        a. Incoming 120 V power to all control panels.
        b. Line side of 120 V power terminals to equipment (e.g., PLCs, transmitters).
    2. Connected in series with the panel's or equipment’s branch circuit.
    3. Provide fuse protection as recommended by manufacturer.
    4. Flange mount or DIN rail mount in control panel.
    5. Connect all SPDs in the panel to the same grounding point.

D. Type IC3 SPD:
    1. Provide on the following applications:
        a. 120 V discrete PLC signals into a control panel from float switches, position switches, etc., where the device is mounted outdoors or in a remote building or structure from the control panel and where the control conductors are routed above grade or underground.
    2. Connected in series with the equipment.
    3. Provide fuse protection as recommended by manufacturer.
    4. Flange mount or DIN rail mount in control panel.
    5. Connect all SPDs in the panel to the same grounding point.

E. Type IC5 SPD:
    1. Provide on the following applications:
        a. Incoming 4-20mA signals into a control panel from transmitters (flow, level, etc.) where the transmitter is mounted outdoors or in a remote building or structure from the control panel and the signal conductors are routed above grade or underground.
    2. Connect in series with the equipment.
    3. Flange mount or DIN rail mount in control panel.
    4. Connect all SPDs in the control panel to the same grounding point.
    5. Verify SPDs series resistance and capacitance does not interfere with the transmitters signal.

F. Type IC7 SPD:
    1. Provide on the following applications:
        a. Low voltage (e.g., 24 Vac, 24 Vdc) discrete PLC signals into a control panel from float switches, position switches, etc., where the device is mounted outdoors or in a remote

building or structure from the control panel and where the control conductors are routed above grade or underground.

b. Low voltage (e.g., 24 Vac, 24 Vdc) discrete PLC signals into a control panel from float switches, position switches, etc., where both the device and control panel are mounted outdoors and the control conductors are routed above grade or underground.

2. Connect in series with the equipment.
3. Flange mount or DIN rail mount in control panel.
4. Connect all SPDs in the control panel to the same grounding point.

END OF SECTION

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SECTION 40 62 05
COMPUTER SYSTEM HARDWARE AND ANCILLARIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Computer network and HMI hardware requirements, which include, but are not necessarily limited to:
      a. Panel Mounted OIT (Operator Interface Terminals).
      b. Ethernet Switches.
      c. Fiber Optic Patch Panels – Panel Mounted.

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 40 61 13 – Process Control System General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 802.3, Information Technology - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
         1) 802.3u: IEEE Standards for Local and Metropolitan Area Networks: Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100 Mb/s Operation, Type 100BASE-T.
         2) 802.3x: IEEE Standards for Local and Metropolitan Area Networks: Specification for 802.3 Full Duplex Operation.

1.3 DEFINITIONS

A. HMI: Human Machine Interface.

B. LCD: Liquid Crystal Display.

C. OIT: Operator Interface Terminal.

D. OPC: "OLE for Process Control", a software standard utilizing a client/server model that makes interoperability possible between automation/control applications and field systems/devices.

E. PC: Personal Computer.

F. RAID: Redundant Array of Independent Disks, a method of storing the same data in different places on multiple hard disks.

G. RAM: Random Access Memory.

H. SCSI: Short for Small Computer System Interface, a parallel interface standard used for attaching peripheral devices to computers.

I. SDRAM: Synchronous Dynamic RAM.

J. SNMP: Simple Network Management Protocol, a set of protocols for managing complex networks.

K. TFT: Thin-Film Transistor, a technology for building LCD screens.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13 – Process Control System General Requirements.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed within the following Articles are acceptable.

2.2 PANEL MOUNTED OPERATOR INTERFACE PANELS (OIT)

A. Acceptable Manufacturers:
   1. Allen-Bradley PanelView Plus 7.

B. Provide Panel Mounted Operator Interface Panels (OITs) as shown on the Drawings and the Schedule herein.

C. Design and Fabrication:
   1. Display: Color graphics.
   2. Touch screen.
   3. 120 Vac power supply.
   4. Real time battery-backed clock, time stamp data.
   5. Communicate via Ethernet/IP to Plant's HMI Network.
   6. Provide password protection to prevent unauthorized entries for a minimum of two (2) levels:
      a. Authorization to operate.
      b. Authorization to adjust setpoints.
   7. Operating temperature: 32 DegF to 131 DegF.
   8. Humidity: 10 to 90 percent RH non-condensing.
   9. Configuration software:
      a. Provide latest version of configuration software licensed to Owner.

2.3 ETHERNET SWITCHES

A. Acceptable Manufacturers:
   1. DCU/RIO Panels: Allen-Bradley Stratix 5700 industrial access switch (or latest version).
   2. Local Control Panels: Allen-Bradley Stratix 2500 switch (or latest version), Ethernet Tap (ETAP).

B. Managed Ethernet Switches:
   1. Design and fabrication:
      a. Support Ethernet 100 MBit/s.
      b. Backbone ports for connection to multimode fiber via type ST connectors.
         1) Quantity as required for communication with devices as depicted in the Contract Documents.

c. 10/100/1000 MBit/s twisted pair ports (RJ45) as required for communication with devices as depicted in the Contract Documents.
   1) Unless otherwise noted, provide at least two (2) spare 10/100/1000 MBit/s port (twisted pair) at each Ethernet switch.
d. Check all received data for validity.
   1) Discard invalid and defective frames or fragments.
e. Monitor connected TP/TX line segments for short-circuit or interrupt using regular link test pulses in accordance with IEEE 802.3.
f. Monitor attached fiber optic lines for open circuit conditions in accordance with IEEE 802.3.
g. As applicable, meet requirements of IEEE 802.3.
h. Power switch with 24 Vdc power input.
i. Provide LED status lights to indicate:
   1) Power: Supply voltage present.
   2) Fault.
   3) Port status.
j. Environmental rating:
   1) Operating temperature: 32 Deg F to 122 Deg F.
   2) Humidity: 95 percent relative humidity, non-condensing.

2.4 FIBER PATCH PANELS

A. Fiber Patch Panel
   1. Acceptable Manufacturers:
      a. Corning, Model EDC-12P-NH.
   2. Lock-style cabinet.
   3. Install fiber patch panels in locations specified on drawings.
      a. Fiber patch and distribution panels shall not be located inside control panels.
   4. Construction:
      a. Indoors Dry Location (located in control panels, electrical room, or communication room): NEMA 1, powder coated steel.
      b. Indoors Wet Location (located in process area): NEMA 4X, fiberglass.
      c. Outdoors: Outdoor rated, NEMA 4X, fiberglass.
   5. Sized to accept 12 fibers, minimum.
   6. Provide sufficient number of connector housings to terminate all fibers as specified on drawings.
   7. Connector type: ST.

B. Network Topology:
   1. Fiber from PLCs to PCS shall be configured in a star topology.

2.5 ACCESSORIES AND MAINTENANCE MATERIALS

A. Provide all accessories required to furnish a complete computer-based network for the control system to accomplish the requirements of the Drawings and Specifications.

B. Furnish Owner with the following extra materials:
   1. One (1) spare Ethernet switch of each type utilized.

PART 3 - EXECUTION

3.1 DEMONSTRATION

A. Demonstrate system in accordance with Specification Section 01 75 00 – Facility and System Start-up.

3.2 INSTALLATION AND CHECKOUT

A. Provide installation and checkout in accordance with Specification Section 40 61 13.

END OF SECTION

SECTION 40 63 43
PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Programmable logic controller (PLC) control system, including software, programming, and training for the THP System Control Panel.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 61 03 - Equipment - Basic Requirements.
   3. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
   4. Section 40 61 13 - Process Control System General Requirements.
   5. Section 40 67 00 - Control System Equipment Panels and Racks.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C37.90.2, Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
      b. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
   2. National Electrical Manufacturers Association (NEMA):
      a. ICS 1, Industrial Control and Systems General Requirements.

B. Qualifications:
   1. Installation supervisor shall have had experience in overseeing installation and start-up of at least three (3) similar installations within the last five years.
   2. Programmer(s) shall have had experience in programming PLCs for at least two (2) projects of similar size and complexity.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Sections 40 61 13 and 46 34 50.
   3. Product technical data including:
      a. Annotated hard copies of PLC software programs.
         1) Submit program for logic in ladder diagram format as used for the specific PLC system. Annotate program listing to include the following:
            a) Written description of each function block or rung's function.
            b) Reference to control loop number for each function block or rung where applicable.
            c) Reference to instrumentation tag number of I/O devices for each function block or rung where applicable.
         2) Provide written descriptions completely defining all function blocks used in program.
         3) Provide list of all addresses referenced in logic diagram with description of data associated with each address.
      b. Results of factory testing procedures.

c. Arrangement drawings for PLC system components.
d. Panel and enclosure plans, sections and details.
e. Access opening locations and required clearances for each panel and enclosure.
f. Enclosure internal wiring and terminal blocks.
g. Full size diagrams of all HMI (operator interface) process control displays with identification of actual colors.

B. Operation and Maintenance Manuals:
1. See Specification Section 01 33 00 for requirements for:
a. The mechanics and administration of the submittal process.
b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturer is acceptable:
1. Distributed control Unit (DCU) panels: Rockwell Automation Allen-Bradley ControlLogix 5580 controllers (version 33 or latest version with approval).
2. Remote I/O panels: ControlLogix, FLEX 5000 I/O platform.
3. Local Control Panels: CompactLogix 5380 (or latest version), Micro850/Micro 870 (version 33 or latest version with approval).

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. See Specification Section 40 61 13 – Process Control System General Requirements.

B. The PLC system shall accomplish the control requirements of the Loop Descriptions, Drawings, and Specifications.

C. PLC programming shall be documented and factory tested.

D. The PLC system shall operate in ambient conditions of 32 to 140 DegF temperatures and 5 to 95 percent relative humidity without the need for purging or air conditioning.

E. Environmental Controls:
1. Furnish circulation fans in solid state control system enclosures.
2. Over-temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.
3. Air conditioning applications shall include means of preventing moisture condensation.

F. Where the PLC is utilized to control multiple trains of equipment and where the equipment in each train operates as a unit relatively independent of other equipment trains (e.g., facility with multiple boiler units or filter trains), the PLC components (I/O modules, power supplies, etc.) shall be assigned so that the failure of any one (1) component does not affect equipment on all trains.
1. I/O modules shall be segregated on a train basis unless required otherwise for safety reasons.
2. Where several equipment units operate in parallel, but are not considered assigned to a particular equipment train (e.g., multiple raw water pumps or chemical feed pumps all discharging into a common system), the PLC I/O modules associated with each equipment unit shall be assigned so that the failure of any one (1) I/O module does not affect all of the parallel operating equipment units.

2.3 HARDWARE

A. Processor shall include diagnostic indicators for power, mode, low battery, communications ports, and memory and I/O errors.

B. I/O modules shall be capable of being replaced while under power.

C. Analog output modules shall have a resolution of at least 12 bits.

D. All analog I/O modules shall utilize be 4-20ma signals.
   1. Include signal converters necessary to interface control panel with field devices.

E. Provide electric isolation between logic and field device.

F. Field wiring shall not be disturbed when removing or replacing an I/O module.

G. Power Supply Units:
   1. Electrical service to PLC system is 105 to 125 V, 60 Hz, +/- 10 percent, 1 PH power.

H. All PLC control system components shall be capable of meeting or exceeding electromagnetic interference tests per IEEE C37.90.2.

I. Incorporate the following minimum safety measures:
   1. Watchdog function to monitor:
      a. Internal processor clock failure.
      b. Processor memory failure.
      c. Loss of communication between processor and I/O modules.
      d. Processor ceases to execute logic program.
   2. Safety function wiring: Emergency shutdown switches shall not be wired into the controller.
   3. Safe wiring:
      a. Unless otherwise specified, activation of alarms and stopping of equipment shall result from the de-energization of control circuits, rather than the energization of control circuits.
      b. Low voltage control signal wires:
         1) Place in conduit segregated for that purpose only.
         2) Twisted shielded wire pair.
         3) Not located in the same conduit or bundle with power wiring.
   4. Initial safety conditions:
      a. Utilize program module to dictate output states in a known and safe manner prior to running of control program.
      b. Utilize program each time PLC is re-initiated and the control program activated.
   5. Monitoring of internal faults and display:
      a. Internal PLC system status and faults shall be monitored and displayed.
         1) Monitored items shall include:
            a) Memory ok/loss of memory.
            b) Processor ok/processor fault.
            c) Scan time overrun.
   6. Control of programs: Capable of protecting access to PLC program loading with password protection or with locked, key operated selector switches.
      a. Provide passwords and/or keys to owner at Substantial Completion.
   7. Design PLC system with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, relay and circuit breaker noise or conducted and radiated radio frequency interference.
   8. Operator intervention:
      a. Logic system failure shall not preclude proper operator intervention.
      b. Safety shutdown of equipment or a system shall require manual operator intervention before the equipment or system operation may be reestablished.

2.4 SOFTWARE

A. All software will be furnished and licensed to owner:
   1. Once project is accepted as complete, transfer all licenses and media to owner.
   2. All software must be of the same version as the Owners current system.

B. Programming:
   1. Languages supported: All application programming in IEC 61131-3 compliant language.
   2. All programming is to be written in ladder logic.
   3. All tags must be scoped at the controller or global level.
   4. Coordinate with the Owners Process Control Group for tag naming and I/O identification abbreviation list.
   5. Protect program via removable key switch or password to prevent unauthorized changes. Provide password and/or programming keys to owner.
   6. Capable of on-line and off-line programming.

C. PLC program Structure:
   1. Clear, concise, well-annotated logic.
   2. Implement a modular design to allow specific functions to be replicated to ensure consistency.
   3. Program shall align with the control strategies. Include comments reflecting alignment with control strategies.
   4. Include named variables that reflect the actual use of the variable.
   5. In ControlLogix:
      a. Alias I/O points to named variables.
      b. Scale Analog Inputs and Outputs to engineering units at the card level.
   6. All PLC controlled field devices shall have its own distinct ladder.
   7. Software Remote/Local shall not be used. All controlled devices are required to have a mechanical AHO switch.
   8. Annotate program listing to include the following (using the features of the appropriate PLC programming software):
      a. Clearly identified variables, I/O points, contacts, and analog values.
      b. Written description of each functional area.
      c. Written description of each rung's function.
      d. Reference to control loop number for each rung where applicable.
      e. Reference to instrumentation tag number of I/O devices for each rung where applicable.

D. PLC Health monitoring:
   1. Provide heartbeat tag that the plant PCS will use to monitor the PLC health.
   2. Report all I/O card failures to the plant PCS.
   3. Upon detecting a PLC processor failure or loss of communication to the I/O each output must be configured to be ON, OFF or LAST STATE.
   4. Include logic to detect analog transmitter failure. Where possible disable control logic associated with that transmitter.

E. E-Stops, equipment safety and personal protection interlocks:
   1. Shall not rely on PLCs.
   2. Shall be monitored by the PLC for alarming only.

2.5 COMPONENTS

A. PLC System Central Processor Unit (CPU):
   1. CPU shall provide communications with other control systems and man-machine interfaces as specified.
   2. CPU shall include capability to modify logic via an Ethernet port without taking processor off line.

3. Memory:
    a. Battery-backed RAM.
    b. Non-volatile program storage via flash EEPROM:
        1) Automatically download to RAM in the event RAM is corrupted.
4. Memory battery backup shall be capable of 180 days memory retention with fresh battery:
    a. Provide visual indication of battery status and alarm low battery voltage.
    b. Memory battery backup shall be capable of 28 days memory retention after the "Battery Low" indicating LED is on.
5. Plug-in card designed to allow quick field replacement of faulty devices:
    a. Provide unit designed for field replacement and expansion of memory without requiring rewiring or use of special tools.
6. 20 percent minimum spare useable memory capacity after all required programming is in place and operating.
7. Capable of executing all control functions required by the Specifications and Drawings.
8. Built-in three-mode (proportional-integral-derivative) control capabilities:
    a. As directly selectable algorithms requiring no user knowledge of programming languages.
9. Lighted status indicators for "RUN" and "FAILURE."
10. Capable of manual or automatic control mode transfer from the operating console stations or from within the control strategy.
    a. Transfer shall be bumpless and balanceless.

B. Input/output (I/O) Modules:
1. Provide plug-in modular-type I/O racks with cables to connect to all other required PLC system components.
2. Provide I/O system with:
    a. I/O solid state boards with status lights indicating I/O status.
    b. Electric isolation between logic and field device.
    c. Capability of withstanding low energy common mode transient to 1000 V without failure.
    d. Incorporate noise suppression design.
    e. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
    f. Capable of being removed and inserted into the I/O rack under power, without affecting any other I/O modules in the rack.
    g. Install 20 percent spare I/O points for each type.
3. Input/output connection requirements:
    a. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.
    b. Prewire I/O modules to terminal blocks.
    c. Provide terminal blocks with continuous marking strip.
    d. Size terminals to accommodate all active data base points and spares.
    e. Provide terminals for individual termination of each signal shield.
    f. Field wiring shall not be disturbed when removing or replacing an I/O module.
4. Discrete I/O modules:
    a. Interface to ON/OFF devices.
    b. I/O status indicator on module front.
    c. Voltage rating to match circuit voltage.
    d. Output module current rating:
        1) Match maximum circuit current draw.
        2) Minimum 1.0 continuous A/point for 120 Vac applications.
    e. Isolated modules for applications where one (1) module interfaces with devices utilizing different sources of power.
5. Discrete outputs shall be fused:
    a. Provide one (1) fuse per common or per isolated output.
    b. Provide blown fuse indication.

c. External fusing shall be provided if output module does not possess internal fusing.
d. Fuses provided external to output model shall:
1) Be in accordance with module manufacturer's specifications.
2) Be installed at terminal block.

6. Analog I/O modules:
a. Input modules to accept signals indicated on Drawings or Specifications.
b. Minimum 12 bit resolution.
c. I/O chassis supplied power for powering connected field devices.
d. Differential inputs and outputs.
e. User configurable for desired fault-response state.
f. Provide output signals as indicated on Drawings and Specifications.
g. Individual D/A converter for each output module.
h. Individual A/D converter for each input module.

C. Power Supply Units:
1. Provide regulated power units:
a. Designed to operate with PLC system and shall provide power to:
1) All components of PLC system.
2) All two-wire field instruments.
3) Other devices as indicated on Drawings or Specifications.
b. Capable of supplying PLC system when all of the specified spare capacity is utilized.
c. Each power supply shall be sized such that it will carry no more than 75 percent of capacity under normal loads.
2. Electrical service to PLC system is 105 to 125 V, 60 Hz, +1 percent, 1 PH power.
3. Separate AC circuit breakers shall be provided for each power supply.
4. If the PLC system is field expandable beyond the specified spare capacity, and if such expansion requires power supply modification, note such requirements in the submittals and allow room for power supply modification in the PLC system enclosure.
5. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
6. Power distribution:
a. Immune to transients and surges resultant from noisy environment.
b. Shall provide constant voltage level DC distribution to all devices.
7. Provide uninterruptible power supply (UPS) to sustain full power to UPS powered loads listed below for a minimum of 45 minutes following loss of primary power and to ensure that the transient power surges and dips do not affect the operation of the PLC system.
a. UPS powered loads:
1) All rack mounted PLC components.
2) Local operator consoles.
3) All power supplies furnished with the PLC and associated loads.
b. Input:
1) 120 Vac +10 percent.
2) 60 Hz.
3) Line fuse protection.
c. Output:
1) 120 Vac 5 percent.
2) 60 Hz.
3) Short circuit protected.
4) Instantaneous transfer time.
d. IEEE C62.41 Class A voltage surges of 6000 V attenuated to less than 50 V on the output.
e. Battery: Maintenance free lead acid.

D. PLC System Enclosure:
1. In accordance with Specification Section 40 67 00 - Control System Equipment Panels and Racks.

2. Component placement:
    a. Mount all controller components vertically within the enclosure to allow maximum convection cooling.
    b. Either install power supplies above all other equipment with at least 10 IN of clearance between the power supply and the enclosure top, or adjacent to other components, but with sufficient spacing for circulation of cooling air.
    c. Do not place I/O racks directly above the CPU or power supply.
    d. Locate incoming line devices (isolation or constant voltage transformers, local power disconnects, surge suppressors, etc.) so as to keep power wire runs within an enclosure as short as possible.
    e. If items such as magnetic starters, contactors, relays, and other electromagnetic devices must be located within the same enclosure as the PLC system components, place a barrier with at least 6 IN of separation between the magnetic area and the control area.
    f. Place circulating fans close to major heat generating devices.
    g. Segregate input/output modules into groups of identical type.
3. Wiring and grounding to be in accordance with Specification Section 40 67 00 - Control System Equipment Panels and Racks.
4. Termination requirements:
    a. In accordance with Specification Section 40 67 00 - Control System Equipment Panels and Racks.
    b. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the enclosure.
    c. Prewire I/O modules to terminal blocks.
    d. Size terminals to accommodate all active database points and spares.
    e. Provide terminals for individual termination of each signal shield.
    f. Field wiring shall not be disturbed when removing or replacing an I/O module.

E. PLC System Software and Programming:
1. Provide all hardware and programming required to provide communication between the PLC and the human-machine interface.
2. Coordinate with HMI programmer to allow modification of all setpoint through the HMI utilizing appropriate security considerations.
3. Provide programming to accomplish all control and monitoring requirements of the Drawings and Specifications.
4. Full documentation capability.
5. Online and offline programming.
6. Offline simulation prior to download.
7. Program over network capability.
8. Two-step commands requiring PLC programmer verification prior to modification of any programming.

2.6 ACCESSORIES

A. Provide all accessories required to install and test a complete PLC control system to accomplish the requirements of the Drawings and Specifications.

B. Provide all programming cables required to configure the PLC logic.

2.7 SOURCE QUALITY CONTROL

A. Provide a performance test after factory completion and prior to shipment.
1. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, printing, keyboard functions, alarm responses, and on/off sequencing control.
2. Conduct testing with simulated I/O to verify each control loop operation.
3. Allow for Owner representatives to witness program testing.
    a. Provide minimum of 15 days' notice prior to testing.

4. Do not ship prior to successful completion of this testing program.

2.8 MAINTENANCE MATERIALS

A. Furnish Owner with the following extra materials:
   1. One (1) spare CPU for every 10 field CPUs or fraction thereof installed.
   2. One (1) spare I/O card of each card type for every 10 cards or fraction thereof installed.
   3. One (1) spare power supply for every 10 power supplies or fraction thereof installed.

B. Include a complete bill of materials indicating detailed part model number.

C. Include a complete set of all special tools required to install, maintain and test the PLCs.

PART 3 - EXECUTION

3.1 FUNCTIONALITY

A. Complete System.
   1. Provide all programming, configuration, coordination, integration, and testing required for furnishing a fully functioning system.

3.2 FACTORY TESTING

A. After assembly, wiring, configuration, and programming, and prior to shipment of the control system to the project site, verify system functionality by applying test signals to all input points and observing system response at output points.

B. Submit a factory test report indicating how the system was tested and which items were tested.

C. After Owner has had sufficient time to review the factory test report, provide an opportunity for Owner and Owner’s technical representative to witness a factory acceptance test.

D. Retain the system in test configuration until approval of the factory acceptance test.

3.3 INSTALLATION

A. Install PLC control system in accordance with manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise adjustments and installation checks.
   3. Maintain and submit an accurate daily or weekly log of all commissioning functions.
      a. All commissioning functions may be witnessed by the Owner.
      b. All reports shall be cosigned by the Supplier and Contractor if witnessed.
   4. Conduct start-up of equipment and perform operational checks.
   5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

3.5 ACCEPTANCE

A. Demonstrate system in accordance with Specification Section 01 75 00 – Facility and System Start-up.

3.6 TRAINING

A. Employee of the manufacturer or certified representative to provide one week of operation and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.

B. As a minimum, training shall cover:
   1. Hardware overview.
   2. Software overview.
   3. Documentation.
   4. Maintenance.
   5. Trouble shooting.
   6. Operation, e.g., changing set points, passwords, etc.

3.7 DOCUMENTATION

A. Update O&M manuals to reflect as-built conditions.

3.8 SUPPORT

A. Provide on-call technical support for a period of one year after substantial completion. Include a minimum of two site visits to work with owner on any final modifications to the logic.

END OF SECTION

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SECTION 40 67 00
CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for control panels and enclosures utilized as follows:
      a. Unless noted otherwise, all control panels and enclosures housing control components that are specified in Specification Section 40 79 00 – Primary Elements and Transmitters, Specification Section 40 78 00 – Control Auxiliaries, Specification Section 40 61 43 – Surge Protection Devices (SPD) for Instrumentation and Control Equipment or Specification Section 40 6343 – Programmable Logic Controllers.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 10 14 00 - Identification Devices.
   3. Section 46 34 50 - Pre-Engineered, Fabricated, Thermal Hydrolysis Process System.
   4. Section 40 61 13 - Process Control System General Requirements.
   5. Section 40 61 43 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment.
   6. Section 40 63 43 - Programmable Logic Controllers.
   7. Section 40 78 00 - Control Auxiliaries.
   8. Section 40 79 00 - Primary Elements and Transmitters.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. ASTM International (ASTM):
      a. B75, Standard Specification for Seamless Copper Tube.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 4, Industrial Control and Systems: Terminal Blocks.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 409, Industrial Control Panels.
         2) Article 504, Intrinsically Safe Systems.
      b. NFPA 79, Electrical Standard for Industrial Machinery.
   5. Underwriters Laboratories, Inc. (UL):
      a. 508A, Standard for Safety Industrial Control Panels.
      b. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
      c. 913, Standard for Safety Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

B. Miscellaneous:
   1. Approved supplier of Industrial Control Panels under provisions of UL 508A or UL 698A.
      a. Entire assembly shall be affixed with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
      b. Control panel(s) without an affixed UL 508A or UL 698A label shall be rejected and sent back to the Supplier’s factory.

C. Listed Products:
   1. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose.
   2. The control panels shall have factory applied UL 508A labels.

D. Factory Testing:
   1. Prior to shipment, the manufacturer shall test the functional operation of the control panel**.**

E. Shipment, Protection and Storage:
   1. Equipment shipment, protection and storage shall conform to the requirements specified in Specification Section 01 65 00 – Product Delivery Requirements.

F. PCS panels.

1.3 DEFINITIONS

A. Panel: Control panels or enclosures listed in the schedule included in this Specification Section.

B. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.

C. Intrinsically Safe:
   1. A device, instrument or component that will not produce sparks or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture.
   2. Designed such that electrical and thermal energy limits inherently are at levels incapable of causing ignition.

D. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

E. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

F. Instrumentation Cable:
   1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
   2. Instrumentation cable is typically either TSP (twisted-shielded pair) or TST (twisted-shielded triad), and is used for the transmission of low current or low voltage signals.

G. Ground Fault Circuit Interrupter (GFCI): A type of device (e.g., circuit breaker or receptacle) which detects an abnormal current flow to ground and opens the circuit preventing a hazardous situation.

H. Programmable Logic Controller (PLC): A specialized industrial computer using programmed, custom instructions to provide automated monitoring and control functions by interfacing software control strategies to input/output devices.

I. Remote Terminal Unit (RTU): An industrial data collection device designed for location at a remote site, that communicates data to a host system by using telemetry such as radio, dial-up telephone, or leased lines.

J. Input/Output (I/O): Hardware for the moving of control signals into and/or out of a PLC or RTU.

K. Supervisory Control and Data Acquisition (SCADA): Used in process control applications, where programmable logic controllers (PLCs) perform control functions but are monitored and supervised by computer workstations.

L. Highway Addressable Remote Transducer (HART): An open, master-slave protocol for bus addressable field instruments.

M. Digital Signal Cable: Used for the transmission of digital communication signals between computers, PLCs, RTUs, etc.

N. Uninterruptible Power Supply (UPS): A backup power unit that provides continuous power when the normal power supply is interrupted.

O. Loop Calibrator: Portable testing and measurement tool capable of accurately generating and measuring 4-20ma DC analog signals.

1.4 SUBMITTALS

A. General: Submittals and transmittal procedures for submittals are defined in Specification Section 01 33 00. Submit In accordance with the procedures set forth in Specification Section 01 33 00 that include drawings, information and technical data for all equipment and as required in Specification Section 40 61 13. Submittal information shall be included in one complete submittal.
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
      a. A check mark shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Supplier, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.
      b. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Supplier with the specifications.
      c. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. A marked copy of Specification Section 40 61 13.
   3. A marked copy of Specification Section 46 34 50.
   4. A copy of the contract document Process and Instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required."
      a. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   5. Control Schematic diagrams related to the submitted equipment.
   6. Control Single Line diagrams related to the submitted equipment.
   7. List of miscellaneous items, cables, spare and replenishment parts, and chemicals to be provided, including MSDS information if applicable.

B. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13 - Process Control System General Requirements.
   3. See Specification Section 46 34 50.
   4. Prepared with computer aided design (CAD) software.
   5. Printed on 11 by 17 IN sheets.
   6. Drawings shall include a title block containing the following:
      a. Plant or facility name where panel(s) are to be installed.
      b. Drawing title.
      c. Drawing number.
      d. Revision list with revision number and date
      e. Drawing date.
      f. Drawing scale.

g. Manufacturer name, address, and telephone number.

7. Cover sheet for each drawing set shall indicate the following:
   a. Plant or facility name.
   b. Project name.
   c. Submittal description.
   d. Revision number.
   e. Issue date.
8. Table of contents sheet(s) shall indicate the following for each drawing in the set:
   a. Drawing number.
   b. Drawing title.
   c. Sheet number.
9. Legend and abbreviation sheet shall indicate the following:
   a. Description of symbols and abbreviations used.
   b. Panel construction notes including enclosure NEMA rating, finish type and color, wire type, wire color strategy, conductor sizes, and wire labeling strategy.
   c. Confirmation that the panel(s) are to be affixed with a UL 508A label prior to shipment from the factory.
10. Bill of Material for each panel shall include the following component information:
    a. Instrument tag number.
    b. Quantity.
    c. Functional name or description.
    d. Manufacturer.
    e. Complete model number.
    f. Size or rating.
11. Panel exterior layout drawings to scale and shall indicate the following:
    a. Panel materials of construction, dimensions, and total assembled weight.
    b. Panel access openings.
    c. Conduit access locations.
    d. Front panel device layout.
    e. Alarm annunciator window engraving schedule.
    f. Layouts of graphic panels or mosaic displays.
    g. Enclosure elevation drawing showing location of externally mounted equipment.
12. Panel interior layout drawings shall be drawn to scale and shall indicate the following:
    a. Sub-panel or mounting pan dimensions.
    b. Interior device layouts.
    c. PLC/RTU general arrangement layouts.
    d. Wire-way locations, purpose, and dimensions.
    e. Terminal strip designations.
    f. Location of external wiring and/or piping connections.
    g. Location of lighting fixtures, switches and receptacles.
13. Panel assembly drawings including sections showing clearances between face and rear mounted equipment.
14. Wiring diagrams shall consist of the following:
    a. Panel power distribution diagrams.
    b. Control and instrumentation wiring diagrams.
    c. PLC/RTU I/O information:
       1) Model number of I/O module.
       2) Description of I/O module type and function.
       3) Rack and slot number.
       4) Terminal number on module.
       5) Point or channel number.
       6) Programmed point addresses.
       7) Signal function and type.
    d. Wiring diagrams shall identify each wire as it is to be labeled.

e. Communication and remote I/O interface module wiring diagrams.
f. Operator interface terminal (OIT) wiring diagram if applicable.

15. Nameplate engraving schedule:
    a. Indicate engraving by line.
    b. Character size.
    c. Nameplate size.
    d. Panel and equipment tag number and description.

C. Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.

D. Electrical load calculations for each panel:
1. Total connected load.
2. Peak electrical demand for each panel.

E. Climate control calculations for each panel.
1. Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.

F. Contract Closeout Information:
1. Operation and Maintenance Data:
    a. See Specification Section 01 33 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. See Specification Section 40 61 13 - Process Control System General Requirements.

G. Informational Submittals:
1. Record Drawings:
    a. Updated panel drawings delivered with the panel(s) from the Supplier's factory.
    b. Drawings shall be enclosed in transparent plastic and firmly secured within each panel.

1.5 ENVIRONMENTAL CONDITIONS

A. Refer to Specification Section 40 61 13 - Process Control System General Requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Enclosures:
    a. Hoffman Engineering Co.
    b. Rittal.
    c. Hammond Manufacturing.
    d. Hammond Manufacturing.
2. Panel heaters:
    a. Hoffman Enclosures, Inc.
    b. Rittal.
    c. Hammond Manufacturing.
3. Heat exchangers and air conditioners:
    a. Hoffman Enclosures, Inc.
    b. Rittal.
    c. Hammond Manufacturing.
    d. Saginaw Control and Engineering
    e. Pfannenberg.
    f. Kooltronic.

4. Cooling fans and exhaust packages:
    a. Hoffman Enclosures, Inc.
    b. Rittal.
    c. Hammond Manufacturing.
    d. Saginaw Control and Engineering.
5. Internal corrosion inhibitors:
    a. Hoffman Enclosures, Inc.; Model A-HCI.
    b. Northern Technologies International Corporation (NTIC); Model Zerust VC.
    c. Cortec Corporation; Model VpCl Emitting Systems.
6. Circuit Breakers
    a. Allen-Bradley.
    b. Phoenix Contact.

2.2 ACCESSORIES

A. Panel Nameplates and Identification:
    1. See Specification Section 10 14 00 - Identification Devices.

2.3 GENERAL REQUIREMENTS

A. Provide ancillary equipment such as, termination strips, interface hardware, wiring, cabling, intrinsically safe barriers and accessories necessary to provide completely operational interface between the control panel to MCC, instrumentation, and all other field control panels.
    1. Ancillary equipment shall not be mounted in the Owner furnished PCS panels.

B. Furnish necessary accessories such as instrument loop power supplies, mounting hardware, terminal blocks, control circuit breakers, and other items which may be required to complete the system.

C. Analog signals received from the field at panels shall be 4-20 ma DC signals.
    1. Furnish signal conversion necessary for compatibility with panel mounted instruments and interface to digital process control system.

D. Provide control components such as relays, timers and other equipment necessary to provide the interfacing and/or interlocking required between the motor starter and associated protective circuits, or other type of control circuit function applicable to a particular final control element, pre-mounted and wired in the applicable panel.

E. Control Panel Wiring Identification:
    1. Identify and label I/O field wiring originating from process control enclosure to field device and/or equipment throughout.
    2. Alphanumeric wire identification: derived from the base/slot/point position where wire is connected.
    3. Base/slot/point positions are identified at terminal within the control panel enclosure and/or on as-shipped panel drawings provided.

2.4 FABRICATION

A. General:
    1. Fabricate panels with instrument arrangements and dimensions identified in the Contract Documents.
    2. Provide panel(s) with the required enclosure rating per NEMA 250 to meet classifications identified in the Contract Documents.
    3. Devices installed in panel openings shall have a NEMA enclosure rating at least equal to the panel enclosure rating.
        a. Devices that cannot be obtained with an adequate NEMA rating shall be installed behind a transparent viewing window.
        b. The window shall maintain the required NEMA rating of the enclosure.

4. Panel(s) shall be completely assembled at the Supplier's factory.
    a. No fabrication other than correction of minor defects or minor transit damage shall be performed on panels at the jobsite.
5. General:
    a. Enclosures which contain PLC processor and communication modules: Equipped with door-mounted factory window kits to enable viewing of status LEDs.
    b. Provide enclosures with print pocket mounted inside door. Include one copy of relevant as-built drawings prior to shipment.
    c. Factory back panels for mounting control panel components and equipment.
        1) Side panels may be used to increase amount of available panel space.
        2) 24 IN deep or greater that contain back panel: Supplied with studs for future installation of full length side panels on both sides of enclosure.
    d. Designed for connection to 120VAC branch circuits. Equipment that requires higher voltage sources, e.g. VFDs and uV reactor controls: Supplied in separate enclosures.
    e. Enclosures that contain interlocked control circuits or circuit supplied from external power source which cannot be de-energized by panel disconnect: Furnish with following warning label; CAUTION: THIS EQUIPMENT MAY HAVE MORE THAN ONE POWER SOURCE OR IS INTERLOCKED WITH OTHER EQUIPMENT.
    f. Provide threaded ground lugs on inside of enclosure doors and on at least one interior enclosure surface.
    g. Contain incandescent or LED light package equipped with manually operated switch. At least one GFCI-type duplex utility outlet: Provided on control panel.
    h. Fully enclosed units with front and/or rear access doors, designed to fit in space available, as specified contract drawings.
    i. Front door-mounted nameplate that identifies panel inside, e.g., PLC-D, CHEM RIO-4.
        1) Nameplates.
            a) As shown on contract drawings or listed in specifications.
            b) Laminated plastic having black letters on white background and attached using stainless steel screws.
    j. Print pocket mounted inside door.
        1) Include one copy of relevant as-built drawings prior to shipment.
    k. Sufficient structural reinforcements to limit vibration and prevent distortion or damage to panel and components during shipment, installation and operation.
6. Enclosures:
    a. NEMA Rating: Follow standards for NEMA type indicated on drawings or as specified herein.
        1) NEMA Type 12 dust-tight:
            a) Provided for indoor controlled environment locations as shown on drawings. Provide continuous gasket around door opening.
            b) Phosphate coating for rust proofing and white enamel panel interior finish.
                (1) Exterior finish: Hoffman custom paint color #RAL7021 (T014) or ANSI-61 gray powdercoat.
                (2) Enclosures requiring legs: Paint color to match enclosure.
        2) NEMA Type 4 watertight and dust-tight: Provided for indoor or outdoor locations as shown on Drawings.
        3) NEMA Type 4X corrosion resistant: Provided for indoor and outdoor locations as shown on Drawings.
        4) Door clamps and hinge pins: Stainless steel.
        5) NEMA-rated enclosures for PLC and Remote I/O panels: Hoffman Brand or equal.
7. Painting:
    a. Panels fabricated from steel shall have their internal and external surfaces prepared, cleaned, primed, and painted.
        1) Mechanically abrade all surfaces to remove rust, scale, and surface imperfections.

2) Provide final surface treatment with 120 grit abrasives or finer, followed by spot putty to fill all voids.
3) Utilize solvent or chemical methods to clean panel surfaces.
4) Apply surface conversion of zinc phosphate prior to painting to improve paint adhesion and to increase corrosion resistance.
5) Electrostatically apply polyester urethane powder coating to all inside and outside surfaces.
6) Bake powder coating at high temperatures to bond coating to enclosure surface.
a) Panel interior shall be white with semi-gloss finish.
b) Panel exterior shall be ANSI #61 gray with flat finish.
7) Application of alkyd liquid enamel coating shall be allowed in lieu of polyester urethane powder for wall mounted NEMA 1 or NEMA 12 rated panels.

b. Panels fabricated from stainless steel, aluminum, or fiberglass shall not be painted.

8. Finish opening edges of panel cutouts to smooth and true surface conditions.
a. Panels fabricated from steel shall have the opening edges finished with the panel exterior paint.
9. Panel shall meet all requirements of UL 508A:
a. If more than one (1) disconnect switch is required to disconnect all power within a panel or enclosure, provide a cautionary marking with the word "CAUTION" and the following or equivalent, "Risk of Electric Shock-More than one (1) disconnect switch required to de-energize the equipment before servicing."
10. Provide control panel in accordance with NFPA 70, Article 409:
a. In the event of any conflict between NFPA 70, Article 409 and UL 508A, the more stringent requirement shall apply.
11. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes:
a. Determine the SCCR rating by one of the following methods:
1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

B. Free-Standing Panels:
1. Single door: 12-gauge sheet steel.
2. Multiple door: 10-gauge steel.
3. Back panels and side panels: Minimum 12-gauge steel.
a. Full sized.
b. Equipped with stiffeners and heavy duty supports as needed to ensure rigidity.
4. Welded construction.
5. Completely enclosed, self-supporting, and gasketed dusttight.
6. Rolled lip around all sides of enclosure door opening.
7. Seams and corners welded and ground smooth to touch and smooth in visual appearance.
8. Full height, fully gasketed flush pan doors.
9. Full length piano hinges rated for 1.5 times door plus instrument weight.
10. Doors with keyed alike locking handles and three-point catch.
11. Floor stands or foot kits, when required, as shown on panel drawings.

12. Provide steel stiffeners as necessary to prevent deflection of back panels and doors due to heavy panel-mounted or door-mounted components.
    a. Stiffener: Minimum 0.25 IN deep by 1 IN wide tack welded to back of the panel or door.
13. Appropriate conduit, wiring, and instrument openings shall be provided.
14. Removable lifting lugs on top of enclosure designed to facilitate rigging and lifting of enclosure during installation.
    a. Plugs: Provided to fill the lifting ring holes after installation is complete.

C. Wall Mounted Panels:
1. 14-gauge steel.
2. Back panels and side panels: Minimum 12-gauge steel.
3. Seams continuously welded and ground smooth.
4. Rolled lip around all sides of enclosure door opening.
5. Gasketed dust tight.
6. Door clamps and hasp/staple for padlocking.
7. Three-point latching mechanism operated by oil tight key-locking handle.
8. Key doors alike.
9. Continuous heavy GA hinge pin on doors.
    a. Hinges rated for 1.5 times door plus instrument weight.
10. Front full opening door.
11. Brackets for wall mounting.

D. Internal Panel Wiring:
1. Panel wire duct shall be installed between each row of components, and adjacent to each terminal strip.
    a. Route wiring within the panel in wire-duct neatly tied and bundled with tie wraps.
    b. Follow wire-duct manufacturer's recommended fill limits.
    c. Wire-duct shall have removable snap-on covers and perforated walls for easy wire entrance.
    d. Wire-duct shall be constructed of nonmetallic materials with rating in excess of the maximum voltage carried therein.
2. Exposed wire bundles connecting door-mounted devices and side panels to back panel are allowed.
    a. Fastened down at suitable intervals, not to exceed 12 IN in length
3. Wiring shall be installed such that if wires are removed from one (1) device, source of power will not be disrupted to other devices.
4. Splicing and tapping of wires permitted only at terminal blocks.
5. Wire bunches to doors shall be secured at each end so that bending or twisting will be around longitudinal axis of wire.
    a. Protect bend area with sleeve.
6. Arrange wiring neatly, cut to proper length.
    a. Arrange wiring with sufficient clearance.
    b. Provide abrasion protection for wire bundles that pass through openings or across edges of sheet metal.
7. Run in continuous lengths from screw terminal to screw terminal.
8. Provide wire service loops to simplify removal of panel components.
9. Do not splice wiring.
10. Identified at both ends with white machine printed, sleeve-type labels.
    a. Hand lettered wire labels are not allowed.
    b. Brady Pro Plus marker printer or equal.
11. All PLC I/O module wiring: Numbered according to I/O point base/slot/point assignments.

12. AC circuits shall be routed separate from analog signal cables and digital signal cables.
    a. Separate by at least 6 IN, except at unavoidable crossover points and at device terminations.
13. Intrinsically safe circuitry shall not be permitted to be mounted within the control panel. Provide a separately mounted enclosure for mounting near the control panel.
    a. Provide at least 6 IN of separation between intrinsically safe devices and circuits and non-intrinsically safe devices and circuits.
14. Wiring to pilot devices or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without removing terminations.
15. Conductors for AC and DC circuits shall be type THHN stranded copper listed for operation with 600 V.
    a. No solid conductor wire is permitted
    b. Conductor size shall be as required for load and 16 AWG minimum.
    c. Internal panel wiring color code:
        1) AC circuits:
            a) Power wiring:
                (1) 120 VAC circuits:
                    (a) Line: Black.
                    (b) Neutral: White.
                    (c) Ground: Green.
                    (d) Minimum: No. 14 AWG.
            b) Control interconnections: Yellow.
            c) AC control circuits at line voltage which are controlled by a relay contact or other control element: Red
        2) 24 VDC circuits:
            a) Line: Blue.
            b) DC Common: Blue with White stripe.
            c) Minimum: No. 14 AWG.
        3) Discrete input wiring:
            a) Signal: Red.
            b) Minimum: No. 14 AWG.
        4) Discrete output wiring:
            a) 120 VAC: Red.
            b) 24 VDC: Blue.
            c) Minimum: No. 14 AWG.
        5) Foreign voltage circuits which cannot be de-energized by control panel disconnect: Yellow.
16. Analog signal cables shall be of 300 V insulation, stranded copper, twisted-shielded pairs with a minimum of six twists per foot and including continuous foil shield with drain wire. PVC-coated and rated for operation at conductor temperatures not to exceed 90 DegC.
    a. Conductor size: 18 AWG minimum.
        1) Color code:
            a) Red: Positive.
            b) Black: Negative.
    b. Individual Pair Shield: 1.35 mil, double-faced aluminum synthetic polymer overlapped for 100 percent coverage.
    c. Outer Jacket: 45-mil nominal thickness.
    d. Dimension: 0.31 IN nominal OD.
    e. Conductors:
        1) Bare soft annealed copper, Class B, 7-strand concentric, following ASTM B8.
        2) 20 AWG, 7-strand tinned copper drain wire.
        3) Insulation: 15-mil nominal PVC.
        4) Jacket: 4-mil nominal nylon.

f. Terminate shield drain conductors to ground only at one (1) end of the cable.
    1) Ground terminals: Green in color.
    2) Include ground terminals that connect directly to panel ground through DIN rail.

17. Ethernet cable:
    a. CAT6 cable.
        1) No. 24 AWG.
        2) Unshielded twisted pair (UTP) plenum rated and supports 100 Mbps minimum.
18. High precision 250 ohm resistors with 0.25 percent accuracy shall be used where 4-20 mA DC analog signals are converted to 1-5 Vdc signals.
    a. Resistors located at terminal strips.
    b. Resistors terminated using individual terminal blocks and with no other conductors.
    c. Resistor leads shall be un-insulated and of sufficient length to allow test or calibration equipment (e.g., HART communicator, loop calibrator) to be properly attached to the circuit with clamped test leads.
19. Analog signals for devices in separate enclosures shall not be wired in series.
    a. Loop isolators shall be used where analog signals are transmitted between control enclosures.
20. Wire and cable identification:
    a. Wire and cables numbered and tagged at each termination.
    b. Wire tags:
        1) Slip-on, PVC wire sleeves with legible, machine-printed markings.
        2) Adhesive, snap-on, or adhesive type labels are not acceptable.
    c. Markings as identified in the Shop Drawings.

E. Arlington County PLC and Panel Wiring Practices:
1. 120 VAC Discrete Inputs: The PCS panel will provide 120VAC to field equipment for signaling purposes only:
    a. Wires shall be Red.
    b. Field equipment shall be equipped with 120VAC rated dry contacts and will operate the dry contacts.
    c. For each dry contact, a pair of wires shall be installed and landed from the PCS panel to the dry contact. One wire shall be hot (+) and the other shall be used to return power back to the PCS when the dry contact is closed. Both wires shall be continuous home-runs from field equipment panel to PCS panel with NO intermediate terminations or splices. A sample drawing will be provided and followed.
2. 120 VAC or 24VDC Relay Outputs: The PCS panel will be Supplied with120VAC or 24 VDC control power from the field equipment for control purposes only:
    a. Wires shall be Yellow to indicated foreign voltage.
    b. The PCS Discrete Output card will provide a dry contact to switch power on and off. Each dry contact will only have one function and serve only one piece of field equipment (for example, a single dry contact cannot be used to turn on a pump and used to illuminate a panel light).
    c. For each dry contact, a pair of wires shall be installed and landed from the PCS panel to the field equipment. One wire shall be hot (+) and the other shall be used to return power back to the field equipment when the dry contact is closed. De-energizing the field equipment will consequently de-energize the 120VAC or 24VDC control power. Both wires shall be continuous home-runs from field equipment panel to PCS panel with NO intermediate terminations or splices. A sample drawing will be provided and followed.
    d. In general, the current for Allen Bradley 1756 output modules shall not exceed 2 Amps and never exceed the manufacturer's limitations. The A-B relay output module (1756-OW16I) used on PCS panels does not have on board fusing, therefore one of the 2 terminals provided for field connections, typically the line side, will be equipped with a 2A rated fast blow fuse.

e. In general, the current for output modules shall not exceed 5 Amps and never exceed the manufacturer's limitations. The relay output module used on PCS panels shall be equipped with on board fusing, therefore standard thru terminals may be used for field connections.

F. Grounding Requirements:
1. Equipment grounding conductors shall be separated from incoming power conductors at the point of entry.
2. Minimize grounding conductor length within the enclosure by locating the ground reference point as close as practical to the incoming power point of entry.
3. Bond electrical racks, chassis and machine elements to a central ground bus.
   a. Nonconductive materials, such as paint, shall be removed from the area where the equipment contacts the enclosure.
4. Bond the enclosure to the ground bus.
   a. It is imperative that good electrical connections are made at the point of contact between the ground bus and enclosure.
5. Panel-mounted devices shall be bonded to the panel enclosure or the panel grounding system by means of locknuts or pressure mounting methods.
6. Sub-panels and doors shall be bonded to ground.
7. Install minimum 10-terminal ground bus on back panel near 120VAC bus.
8. Ground terminals on all electronic and control equipment, (24VDC power supply, AC line filter, PLC chassis, PLC power supply, door-mounted HMI panel, etc.) to be connected to ground bus.

G. Termination Requirements:
1. Wiring to circuits external to the panel connected to interposing terminal blocks.
2. Terminal blocks rigidly mounted on 35mm DIN rail mounted on standoffs to provide easy access to terminal screws.
3. Terminal strips located to provide adequate space for entrance and termination of the field conductors.
4. One (1) side of each strip of terminal blocks reserved exclusively for the termination of field conductors.
5. Terminal block markings:
   a. Marking shall be the same as associated wire marking or if connected to PLC I/O modules: Numbered according to I/O point base/slot/point assignments.
   b. Legible, machine-printed markings.
   c. Markings as identified in the shop drawings.
6. Terminal block mechanical characteristics, and electrical characteristics shall be in accordance with NEMA ICS 4.
7. Common connections and jumpers required for internal wiring on field side of terminal is not allowed.
8. No more than two wires terminated at any single screw terminal.
9. Through terminals and fuse terminals ganged together to create common voltage buses: Utilize internal screw jumpers.
   a. Wire jumpers and comb jumpers are not allowed.
10. I/O module points, including unused spares: Connected to terminal blocks.
    a. Terminal block assemblies for power distribution: Include minimum 25 percent spare fuse terminals, connected to AC or DC bus via internal jumpers.
11. Fused terminal blocks.
    a. Follow typical wiring diagrams for power distribution and I/O modules.
    b. Required for overcurrent protection of analog input modules and discrete output modules not equipped with internal fuses or protected by interposing relays.
    c. Provided with blown-fuse indicator and fast-acting, 5 x 20mm fuses, unless otherwise noted.

12. Terminals shall facilitate wire sizes as follows:
    a. 120 Vac applications: Conductor size 12 AWG minimum.
    b. Other: Conductor size 14 AWG minimum.
13. Analog signal cable shield drain conductors shall be individually terminated.
14. Install minimum of 20 percent spare terminals.
15. Bladed, knife switch, isolating type terminal blocks where control voltages enter or leave the panel.
16. Fused terminal blocks shall be used in the following circuits:
    a. Control voltage is used to energize a solenoid valve.
    b. DC power is connected to 2-wire, loop-powered instruments.
17. Fused terminal blocks shall be provided with blown fuse indicators.
18. When control circuits require more than one (1) field conductor connected to a single wiring point, a sufficient number of terminal points shall be connected internally to allow termination of only one (1) field conductor per terminal block.
19. DIN rail mounting channels shall be installed along full length of the terminal strip areas to facilitate future expansion.
20. Connections to devices with screw type terminals shall be made using spade-tongue, insulated, compression terminators.

H. Component Mounting and Placement:
1. Components shall be installed per manufacturer instructions.
2. Control relays and other control auxiliaries shall be mounted on DIN rail mounting channels where practical, extend DIN rail into un-used space.
3. Front panel devices shall be mounted within a range of 36 to 62 IN above the finished floor, unless otherwise shown in the Contract Documents.
4. PLC/RTU and I/O rack installation:
    a. Located such that the LED indicators and switches are readily visible with the panel door open.
    b. Located such that repair and/or replacement of component can be accomplished without the need to remove wire terminations or other installed components.
5. Locate power supplies with sufficient spacing for circulation of air.
6. Where components such as magnetic starters, contactors, relays, and other electromagnetic devices are installed within the same enclosure as the PLC/RTU system components, provide a barrier of at least 6 IN of separation between the “power area containing the electromagnetic devices” and the “control area.”
7. Components mounted in the panel interior shall be fastened to an interior sub-panel using machine screws.
    a. Fastening devices shall not project through the outer surface of the panel enclosure.
8. Excess mounting space of at least 20 percent for component types listed below to facilitate future expansion:
    a. Fuse holders.
    b. Circuit breakers.
    c. Control relays.
    d. Time delay relays.
9. Components installed on sub-panels shall be provides with a minimum spacing between component and wire duct of 1 IN.
    a. Minimum of 2 IN separation between terminal strips and wire ducts.
10. Panel mounted devices.
    a. Designed to facilitate removal and maintenance of equipment after installation.
    b. Located between 30 IN and 62 IN from floor.
    c. Identified by markers placed adjacent to, but not on, given device.
        1) Display device tagnames and/or descriptive names.
        2) Engraved plastic nameplates or labels printed with indelible ink. Hand lettered markers are not allowed.

11. Pneumatic tubes and appurtenances:
    a. Connect panel air piping and tubing penetrations with bulkhead fittings.
    b. Pneumatic control tubing shall be 1/4 IN OD.
        1) Tubing material: Either soft annealed ASTM B75 copper or flame-resistant polyethylene.
    c. Main headers within panels shall be minimum 1 IN.
    d. Compression-type pressure fittings.
    e. Equip panel instrument leads with ball type isolation valve.
    f. Route tubing neatly and mount securely.
    g. Do not route tubing in front of or in wire ducting.
    h. Code terminal plates.
    i. Pneumatic devices shall be served by a dual function filter regulator.

I. Power Distribution:
1. PCS panels: Furnished with two 120VAC, 20A-rated circuits.
    a. Line filtered circuit for powering the PLC, relay outputs, field contacts for digital inputs, 24VDC power supply, instrumentation, etc.
    b. Panels that contain the PLC processor and communication modules: Furnished with 120V receptacle on line filtered circuit for powering transceiver.
    c. Auxiliary circuit for powering enclosure lights and utility receptacle.
2. Provide master disconnect switch and auxiliary branch circuit protectors (miniature circuit breakers).
    a. Circuit breakers: Used on AC inputs to power supplies and auxiliary circuits.
    b. Provide fused terminal blocks for 24VDC-powered devices and for connecting power to bottom tier of digital input terminal block assemblies.
3. Input terminals, branch circuit protectors, and fuse terminals: Mounted on din rail and grouped according to function.
4. Main incoming power circuits shall be protected with a thermal magnetic circuit breaker.
    a. Limit load to maximum of 80 percent of circuit breaker rating.
5. Component types listed below shall be individually fused so that they may be individually de-energized for maintenance:
    a. PLC/RTU power supply modules.
    b. Single-loop controllers.
    c. Recorders.
    d. Alarm annunciators.
6. Each control panel with PLC/RTU components shall be furnished with power protection in the form of a double conversion UPS.
7. Equip each panel with necessary power supplies with ratings required for installed equipment and with minimum 25 percent spare capacity.
8. Constant voltage transformers, balancing potentiometers, and rectifiers as necessary for specific instrument requirements.
9. For control panels containing a PLC CPU provide two sources of power to the PLC panel. One circuit to come from the panel board and power a 24V DC power supply. The 2nd circuit to come from the UPS and powers a second 24V power supply. Power supplies will require a redundancy option. Size both power supplies to independently carry the 24VDC load for the panel.

J. UPS:
1. The online uninterruptible power supply (UPS) shall be provided for clean power and to protect the PLC. The Supplier must size the UPS according to the equipment supported, based on the requirements herein.
2. Provide MBB bypass transfer switch, quick disconnect cables with twistlock connectors, and caster kit.

3. Batteries:
    a. Sizing: The UPS shall be sized such that it is normally operating at not more than 70 percent full load. Additional battery cabinets may be used to achieve run-time requirements.
    b. Battery Cells: Maintenance-free sealed lead-acid batteries, with suspended electrolyte; the batteries shall be leak proof. Batteries shall be user replaceable and hot swappable.
    c. Reserve Time: The UPS shall supply power to all connected equipment for a minimum of 45 minutes.
4. Operation:
    a. Transfer Time: The transfer time including detection shall be no more than 2 milliseconds.
    b. On-Battery Output Voltage: Sine wave output.
    c. 120 VAC units can withstand input surges of up to 570J without damage per criteria listed in IEEE C62.41, Category A, Level 3.
    d. Withstand all surge voltages up to + 6 kV peak.
    e. Filtering: Full time multi-pole noise filtering; 0.3 percent IEEE surge let-through; zero clamping response time; meets UL 1449.
    f. UPS will report alarms and status through hard-wired digital outputs into the PCS. See P&ID sheets for further requirements.
    g. Operating Ambient Temperature.
    h. UPS Module: 0 DegC to 55 DegC.
    i. Battery: 0 DegC to 45 DegC.
    j. Storage/Transport Ambient Temperature: -15 DegC to 45 DegC.
    k. Relative Humidity: 0 to 95 percent, non-condensing.
5. All UPS equipment shall be manufactured by Veriv/Liebert GXT series.
6. Electrical Load Calculations: Electrical load calculations shall be provided to determine the UPS sizing and capacity.
7. UPS status:
    a. UPS equipment identified on the UPS P&ID sheet shall be provided the following contacts for monitoring by the PCS:
        1) UPS on.
        2) UPS on bypass.
        3) UPS on battery.
        4) UPS low battery.
        5) UPS fault.
        6) UPS summary alarm.

K. External Diagnostics: Each network node shall support standard connector ports for attachment of all devices and insertion of portable protocol analyzers, portable network performance monitors, or similar external monitoring and diagnostic devices. The external monitoring devices supplied by the PCS Manufacturer shall be capable of passive attachment to the interfaces. Communication between the monitored device and the Network shall in no way be impeded.

L. Internal Panel Lighting and Service Receptacles:
1. Panels less than or equal to 4 FT wide:
    a. One (1) electrical GFCI duplex receptacle.
    b. One (1) compact fluorescent light fixture with manual switch(es).
2. Panels or panel faces greater than 4 FT wide:
    a. One (1) duplex electrical GFCI receptacle per 6 FT of length.
    b. Continuous fluorescent lighting strip with manual switches.

M. Environmental Controls:
   1. Indoor panels located in a designated electrical room or control room:
      a. Thermostat controlled cooling fans with exhaust louvers if required to maintain temperature inside panel(s) below the maximum operating temperature rating of the internal components.
      b. Internal corrosion inhibitors.
   2. Indoor panels not located within a designated electrical room or control room:
      a. Thermostat controlled heaters to maintain temperature approximately 10 DegF above ambient for condensation prevention inside the panels.
      b. Automatically controlled, closed-loop heat exchangers or closed-loop air conditioners where required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel(s).
      c. Internal corrosion inhibitors.
   3. Outdoor panels:
      a. Outdoor temperature range of 0 DegF through 120 DegF.
      b. Thermostat controlled heaters to maintain temperature approximately 10 DegF above ambient for condensation prevention inside the panels.
      c. Outdoor temperature range of 0 DegF through 120 DegF.
      d. Thermostat controlled closed-loop heat exchangers or closed-loop air conditioners if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel.
      e. Internal corrosion inhibitors.
   4. Environmental control components:
      a. Panel heaters:
         1) Thermostat controlled.
         2) Fan driven.
         3) Components mounted in an anodized aluminum housing.
         4) Designed for sub-panel mounting.
         5) Powered from 120 Vac and protected with a dedicated circuit breaker.
      b. Cooling fans and exhaust packages:
         1) Cooling fan with louver or grill and replaceable filter.
         2) Designed to be mounted within a panel cutout to provide positive airflow through the panel.
         3) Cooling fan and exhaust louvers shall be designed and listed to maintain a NEMA 12 enclosure rating.
         4) Fitted with replaceable, high-density foam or synthetic fiber.
         5) Cooling fan controlled with a separately mounted thermostat with bi-metal sensor and adjustable dial for temperature setting.
         6) Powered from 120 Vac and protected with a dedicated circuit breaker.
      c. Heat exchangers and air conditioners:
         1) Dual-loop design to isolate panel interior air from exterior air.
         2) Thermostat controlled.
         3) Operate from 120 Vac and protected with a dedicated circuit breaker.
      d. Internal corrosion inhibitors:
         1) Contains chemical which vaporizes and condenses on surfaces in the enclosure.
         2) Inhibitor shall be applied in accordance with manufacturer instructions for the enclosure volume.

2.5 MAINTENANCE MATERIALS

A. Extra Materials:
   1. Quantity of 25 percent replacement lamps for each type installed (minimum of 12 of each type).
   2. Minimum 12 replacement filters for each type installed.
   3. One (1) quart of exterior finish touch-up paint.

4. One (1) complete set of replacement corrosion inhibitors in sealed packages for each panel.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Scope: Inspect and test entire panel assembly to verify readiness for shipment.

B. Location: Supplier's factory.

C. Factory Tests:
   1. Provide 5 working days' notice prior to starting factory testing. Arlington County will typically witness testing, but may waive this requirement on case-by-case basis.
   2. Tests shall be fully documented and signed by the Supplier's factory supervisor.
   3. The panel shop shall fully test the control panel for correct wiring.
      a. Each I/O point shall be checked by measuring or connecting circuits at the field terminal blocks.
   4. Burn-in test: Panel(s) shall be fully energized for a minimum period of 48 HRS.
   5. A PLC Central Processing Unit (CPU) shall be obtained and connected to the panel(s) if necessary for testing purposes.
   6. Testing equipment (such as digital multi-meters, analog loop calibrators, and laptop computers with PLC programming software) shall be used as required for testing.
      a. Personal computer and software necessary to create PLC hardware configuration for testing: Provided by factory.
      b. Arlington County will provide CPU rack for testing remote I/O panels upon request.
   7. The following functions shall be tested as a minimum:
      a. Demonstrate functions of the panel(s) required by the Contract Documents.
      b. Correctness of wiring from all panel field terminals to all I/O points and to all panel components.
      c. Simulate and test each discrete signal at the field terminal strips.
      d. Simulate and test each analog signal using loop calibrators.
      e. Correct operation of communications between PLC system Central Processing Units (CPUs) and Remote I/O bases.
      f. Correct operation of single-loop controllers (including digital communication to microprocessor based devices).
      g. Correct operation of all digital communication devices.
      h. Demonstrate online and offline diagnostic tests and procedures.
      i. The Supplier shall notify the Owner in writing a minimum of 15 calendar days prior to the Factory Tests.
         1) Owner has the option to witness all required tests.
   8. Make following documentation available to the Owner at test site during the tests:
      a. Contract Documents.
      b. Factory Demonstration Testing procedures.
      c. List of equipment to be testing including make, model, and serial number.
      d. Shop Drawing submittal data for equipment being tested.
   9. Deficiencies shall be corrected prior to shipment from the Supplier's factory.
   10. Patent defects in equipment: Repaired or replaced, as required, at no cost to the Owner, until substantial completion.
      a. If Latent defects are found notify the Owner immediately.
   11. Any factory modifications to PCS panels must be approved, tested, and documented prior to final acceptance.

D. Post Testing
   1. Submit following documentation within 14 days of finishing factory panel testing.
      a. As-built versions of shop drawings listed herein.

b. Fully annotated PLC logic backed up on CD-ROM.
c. OIT configuration, tags and screens backed up CD-ROM.
d. Complete I/O list following Process Control Group format,

2. Submit final as-shipped drawings prior to shipment for approval and provide one copy within enclosure(s) to be shipped.
3. Provide for protection, insurance and proper storage of equipment until received and inspected by the owner.
4. Deliver spare parts for PCS panels, as specified in contract drawings and documentation, prior to panel installation.

3.2 SCHEDULE

A. Panel Schedule:

	Panel No.	Spec / P&ID	Features *	Enclosure Type	Panel Title	E-Dwgs / Notes
1	LCP-XX	46 34 50	1, 2, 3, 4, 5, 6, 7	NEMA-12	THP Control Panel	TBD
	OIP-XX	46 34 50	2,4,5,6,7,9	NEMA-4X	THP System Local Operator Interface Panel	TBD

1* - Programmable Logic Controller (PLC) or Remote I/O devices
2* - Panel mounted Operator Interface Panel (OIP)
3* - Hardwired control logic required
4* - Windowed outer door and inner door for displays or devices.
5* - UPS
6* - Fans
7* - Heating
8* - Air Conditioning
9* - Sun/Rain Hood

END OF SECTION

SECTION 40 78 00
CONTROL AUXILIARIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Signal modules:
      a. Loop isolator.
      b. Pneumatic/current transducer.
   2. Pilot devices:
      a. Selector switches.
      b. Pushbuttons.
      c. Indicating lights.
      d. Potentiometer
   3. Relays/timers:
      a. Program timers.
      b. Percentage timers.
      c. Reset timers.
      d. Control relay.
      e. Signal-level switching relays.
      f. Time delay relays.
   4. Termination equipment:
      a. Terminal blocks.
      b. Fuse holders.
   5. Power supplies:
      a. DC power supplies.
      b. Isolation transformers.
   6. Voltage surge protection devices.
   7. Running time indicator.
   8. Instrument air compressor.
   9. Clocks.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 40 61 13 - Process Control System General Requirements.
   3. Section 40 61 43 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   2. Underwriters Laboratories, Inc. (UL).

B. Miscellaneous:
   1. Assure units comply with electrical area classifications and NEMA enclosure type shown on Drawings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13 - Process Control System General Requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Provide similar components from the same manufacturer for uniformity of appearance, operations, and maintenance.

2.2 SIGNAL MODULE

A. Loop Isolators:
   1. Acceptable manufacturers:
      a. AGM Electronics.
      b. Moore Industries.
      c. Weidmuller.
      d. Phoenix Contact.
   2. Design and fabrication:
      a. Solid state electronics.
      b. Transmit analog output signal directly proportional to measured input signal.
      c. Power source: 24 Vdc.
      d. Analog input: 4-20 mA DC or 1-5 Vdc.
      e. Output signal: 4-20 mA DC into 1400 ohms.
      f. Impedance:
         1) Voltage input: 10 Meg.
         2) Current input: 50 ohms.
         3) Voltage output: 1 ohm.
         4) Current output: 1650 ohms.
      g. Accuracy: Better than ± 0.10 percent of span.
      h. Isolation: Up to 500 V rms (input, output and case).
      i. Temperature effect: ±0.0025 percent of span per DegF.
      j. Ambient temperature range: 0-140 DegF.
      k. Factory calibrated.

B. Current/Pneumatic Transducer:
   1. Acceptable manufacturer:
      a. Fisher Controls.
   2. Materials:
      a. Housing: Cast aluminum or fiberglass.
   3. Design and fabrication:
      a. Force balance device.
      b. Capable of receiving an electronic signal and converting it to a directly proportional pneumatic signal.

c. Input signal: 4-20 mA DC.
d. Output signal: 3-15 psi.
e. Accuracy (maximum error): +0.50 percent of output span.
f. Ambient temperature range: 0-140 DegF.

2.3 PILOT DEVICES

A. Selector Switches:
1. Acceptable manufacturers:
a. Siemens Class 52.
b. Rockwell Automation Allen-Bradley Bulletin 800H.
c. Schneider Electric Class 9001.
d. GE CR104P.
e. Eaton.
f. Or equal.
2. Design and fabrication:
a. Heavy-duty type.
b. NEMA 13.
c. Oil-tight.
d. Rotary cam units conforming to NEMA ICS 2-216.22.
e. Mounting hole: 30 mm.
f. Supply switches having number of positions required with contact blocks to fulfill functions shown and specified.
g. Switch operation for local-remote, auto-manual, and computer-manual selection: Maintained in all positions.
h. Spring return selector switches: Required where indicated on Contract drawings
i. UL listed.
j. Maintained contact type.
k. Lever type operators.
l. Black colored operators.
m. Designed with cam and contact block with approximate area of 2 IN SQ.
n. Contact block terminals: Labeled for identification purposes and contain no less than one single-pole, double-throw contact.
o. Contact block requirements:
1) Dry and indoor locations: Heavy Duty contact blocks rated for 10 A at 120 V continuous current.
2) Wet or outside locations: Hermetically sealed contact blocks. Heavy Duty contact blocks rated for 10 A at 120 Vcontinuous current.

B. Pushbuttons:
1. Acceptable manufacturers:
a. Siemens Class 52.
b. Rockwell Automation Allen-Bradley Bulletin 800H.
c. Eaton.
d. Schneider Electric Harmony 9001K Series.
e. GE CR104P.
f. Or equal.
2. Materials:
a. Backing diaphragm: Buna-N.
3. Design and fabrication:
a. Heavy-duty type.
b. NEMA 13.
c. Oil-tight.
d. Conforming to NEMA ICS 2-216.22.
e. Mounting hole: 30 mm.
f. Diaphragm backed.

g. Flush head bezels.
h. UL listed.
i. Emergency stop pushbuttons to have mushroom head operator and two sets of maintained normally open (NO) and normally closed (NC) contacts.
j. Non-illuminated type:
    1) Momentary contact with necessary contact blocks.
    2) Molded, solid color melamine buttons.
    3) Standard flush operators with full shroud.
    4) Stop and emergency stop pushbuttons: Red in color unless otherwise noted.
        a) Other pushbuttons: Black unless otherwise noted.
    5) Black colored buttons for START or ON and black color for STOP or OFF.
    6) Appropriate contact blocks to fulfill functions shown or specified.
k. Contact block requirements:
    1) Contact block requirements:
        a) Dry and indoor locations: Heavy Duty contact blocks rated for 10 A at 120 Vcontinuous current.
    2) Wet or outside locations: Hermetically sealed contact blocks. Heavy Duty contact blocks rated for 10 A at 120 Vcontinuous current.
    3) Legend plate marked per Contract Documents.
l. Illuminating type:
    1) Momentary contact.
    2) Serves as both pushbutton control and indicating light.
    3) Red colored lenses for start or on and green for STOP or OFF.
    4) Resistor-type full voltage light unit with lens and panel gasket.
    5) Contact block terminals: Labeled for identification purposes and contain no less than one single-pole, double-throw contact.
m. Contact block requirements:
    1) Dry and indoor locations: Heavy Duty contact blocks rated for 10 A at 120 V continuous current.
    2) Wet or outside locations: Hermetically sealed contact blocks. Heavy Duty contact blocks rated for 10 A at 120 Vcontinuous current.
    3) Appropriate contact blocks to fulfill functions shown or specified.

C. Indicating Lights:
1. Acceptable manufacturers:
    a. Siemens Class 52.
    b. Rockwell Automation Allen-Bradley Bulletin 800H.
    c. Eaton.
    d. GE CR104P.
    e. Or equal.
2. Design and fabrication:
    a. Heavy duty.
    b. NEMA 13.
    c. Oil-tight.
    d. Type allowing replacement of bulb without removal from control panel.
    e. Transformer type LED.
    f. UL listed.
    g. 24 V lamp rated for 120V operation.
    h. Legends marked per Contract Documents.
    i. Nominal 2 IN SQ face.
    j. Mounting hole: 30 mm.
    k. Push-to-test indicating lights.
    l. Glass lens.

m. Color code lights as follows:
    1) Green:
        a) OFF.
        b) CLOSED.
    2) Red:
        a) ON.
        b) OPEN.
    3) Blue:
        a) MANUAL.
        b) LOCAL.
    4) White:
        a) LOW.
        b) FAIL.
        c) TRIPPED.
        d) HIGH.
        e) AUTOMATIC.
        f) REMOTE.
        g) POWER ON.
n. Legend plate engraved for each light.

D. Potentiometer:
1. Acceptable manufacturers:
    a. Eaton.
    b. Allen-Bradley.
2. Design and fabrication:
    a. Heavy-duty, NEMA 13 type.
    b. Mounting hole: 30 mm.
    c. UL listed.
    d. Linear adjustment through 0-1000 ohms with 1 percent resolution.
    e. 3-wire interface.
    f. Dial plate with 0-100 percent scale.
    g. Panel mounted.
    h. One-turn adjustment knob.

2.4 RELAYS/TIMERS

A. Program Timers:
1. Acceptable manufacturers:
    a. Rockwell Automation Allen-Bradley.
    b. Phoenix Contact.
2. Design and fabrication:
    a. Microprocessor based.
    b. Serve as time program actuator control of final control elements.
    c. 24 HR time control.
    d. Up to 3 operations per day.
    e. Programmable from panel face keys.
    f. Skip-A-Day feature allowing schedule to be skipped for an entire day or days.
    g. SPDT switch contact rated at 15 amps at 120 Vac.
    h. Battery carryover to maintain time and program during power outage for 275 HRS.

B. Percentage Timer:
1. Acceptable manufacturer:
    a. Rockwell Automation Allen-Bradley.
    b. Phoenix Contact.

2. Design and fabrication:
    a. Dial setting made by turning a knob located in the center of dial.
    b. Dial calibrated with 100 divisions and a pointer to indicate percentage of each total cycle that the contact is closed.
    c. Set accuracy: 1 percent.
    d. Repeat accuracy: 1/2 percent of full scale.
    e. Percentage timer shall allow 0 to 100 percent time selector of the specified time range time setting of 24 HR timer control.
    f. Automatic repeat cycle-type timer.
    g. Switch rating: 25 amps at 120 Vac.
    h. Current input: 120 V, 1 PH, 60 HZ.
    i. Time range of percentage timer equal to 15 minutes.

C. Reset Timer:
1. Acceptable manufacturer:
    a. Rockwell Automation Allen-Bradley.
    b. Phoenix Contact.
2. Design and fabrication:
    a. Heavy duty.
    b. Consisting of adjustable time delay with automatic reset feature when period is timed out.
    c. Auxiliary relays as required to perform functions specified or shown on Drawings.
    d. Operate on 117 Vac (+10 percent) power source.
    e. Nominal dimensions: 4 x 4 IN.
    f. Switch rating: 10 amps.
    g. Dial range: 60 minutes.

D. Control Relays:
1. Acceptable manufacturers:
    a. Rockwell Automation Allen-Bradley.
    b. Phoenix Contact.
2. Design and fabrication:
    a. Plug-in general purpose relay.
    b. Blade connector type.
    c. Switching capacity: 10 A.
    d. Contact material: Silver cadmium oxide.
    e. Provide relays with a minimum of 3 SPDT contacts.
    f. Coil voltage: 120 Vac or 24 Vdc.
    g. Relay sockets are DIN rail mounted.
    h. Internal neon or LED indicator is lit when coil is energized.
    i. Clear polycarbonate dust cover with clip fastener.
    j. Check button.
    k. Temperature rise:
        1) Coil: 85 DegF max.
        2) Contact: 65 DegF max.
    l. Insulation resistance: 100 Meg min.
    m. Frequency response: 1800 operations/hour.
    n. Operating temperature: -20 to +150 DegF.
    o. Life expectancy:
        1) Electrical: 500,000 operations or more.
        2) Mechanical: 50,000,000 operations or more.
    p. UL listed or recognized.

E. Signal-Level Switching Relays:
   1. Acceptable manufacturers:
      a. Rockwell Automation Allen-Bradley.
      b. Phoenix Contact.
   2. Design fabrication:
      a. Minimum of 2 SPDT gold-flashed, bifurcated contacts.
      b. Hermetically sealed.
      c. Rated at 3 A resistive at 120 Vac or 24 Vdc.

F. Interposing Relay
   1. Acceptable manufacturers:
      a. Rockwell Automation Allen-Bradley.
      b. Phoenix Contact
   2. Used in conjunction with discrete inputs when field equipment being monitored is not compatible with 120VAC.
   3. Discrete outputs: Energize interposing relays interlocked with field control circuits, unless otherwise specified.
      a. Coils rated to match field equipment.
      b. Contacts rated for no less than 5A.
      c. Only one Form C contact per relay.
      d. LEDs to indicate when coil is energized.
      e. Manual override switches for testing.
   4. Provide surge suppressors on DC operated relay coils to reduce high transient voltage generated when circuit to operating coil is opened.
   5. May be required when using unfused PLC relay output modules.

G. Time Delay Relays:
   1. Acceptable manufacturers:
      a. Rockwell Automation Allen-Bradley.
      b. Phoenix Contact
   2. Design and fabrication:
      a. Melt design test and performance requirements of NEMA ICS 2-218.
      b. Heavy-duty.
      c. Solid-state construction.
      d. External adjusting dial.
      e. Auxiliary relays as required to perform functions specified or shown on Drawings.
      f. Operates on 117 Vac (±10 percent) power source.
      g. Contact rating: A150 per NEMA ICS 2-125.
      h. Furnish with "on" and "timing out" indicators.

2.5 TERMINATION EQUIPMENT

A. Terminal Blocks:
   1. Acceptable manufacturers:
      a. Rockwell Automation Allen-Bradley.
      b. Phoenix Contact.
      c. Or equal.
   2. Design and fabrication:
      a. Screw type with pressure plate (compressor type) requiring no lugs on connecting wires.
      b. Screws: Stainless steel.
      c. Current bar: Nickel-plated copper allow.
      d. Thermoplastic insulation rated for -40 to +90 DegC.
      e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
      f. Install end sections and end stops at each end of terminal strip.
      g. Install machine-printed terminal markers on both sides of block.

h. Spacing: 6 mm.
i. Wire size: 22-12 AWG.
j. Rated voltage: 600 V.
k. Din rail mounting.
l. UL listed.
m. Cage clamp style terminals are not allowed.
n. Prefabricated terminal strips are not allowed.
o. Discrete input terminal block assemblies require 2-tier terminals. The top tier is used for the individual inputs. The terminals on the bottom tier are ganged together using internal screw jumpers to form a voltage bus for wetting of field contacts.

3. Standard-type block:
   a. Rated current: 30 A.
   b. Color: Gray body.
4. Bladed-type block:
   a. Terminal block with knife blade disconnect which connects or isolated the two (2) sides of the block.
   b. Rated current: 10 A.
   c. Color:
      1) Panel control voltage leaves enclosure - normal: Gray body, orange switch.
      2) Foreign voltage entering enclosure: Orange body, orange switch.
5. Grounded-type block:
   a. Electrically grounded to mounting rail.
   b. Use to terminal ground wires and analog cable shields.
   c. Color: Green and yellow body.

B. Fuse Holders:
1. Acceptable manufacturers:
   a. Phoenix Contact.
   b. Allen-Bradley.
   c. Or equal.
2. Design and fabrication:
   a. Modular-type with screw compression clamp.
   b. Screws: Stainless steel.
   c. Current bar: Nickel-plated copper alloy.
   d. Thermoplastic insulation rated for -40 to +105 DegC.
   e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
   f. Blocks can be ganged for multi-pole operation.
   g. Install end sections and end stops at each end of terminal strip.
   h. Install machine-printed terminal markers on both sides of block.
   i. Cross section not greater than 8mm.
   j. Wire size: 30-12 AWG.
   k. Rated voltage: 300 V.
   l. Rated current: 12 A.
   m. Fuse size: 5 x 20 mm.
   n. Blown fuse indication.
   o. DIN rail mounting.
   p. UL listed.

2.6 POWER SUPPLIES

A. DC Power Supplies:
1. Acceptable manufacturers:
   a. Allen-Bradley Bulletin 1606 (or latest version).
   b. Pepperl+Fuchs.
   c. Phoenix Contact.

2. Design and fabrication:
    a. Converts 120 Vac input to DC power at required voltage.
    b. DIN rail mount with enclosure (i.e., not open frame).
    c. Switching type.
    d. AC input: 120 Vac +/-15 percent, nominal 60 Hz.
    e. Efficiency: Minimum 86 percent.
    f. Rated mean time between failure (MTBF): 500,000 HRS.
    g. Voltage regulation:
        1) Static: Less than 1.0 percent V_{out}.
        2) Dynamic: +/-2 percent V_{out} overall.
    h. Output ripple/noise: Less than 100 mV peak to peak (20 MHz).
    i. Overload, short circuit and open circuit protection.
    j. Temperature rating: 0 to 60 DegC full rated, derated linearly to 50 percent at 70 DegC.
    k. Humidity rating: Up to 90 percent, non-condensing.
    l. LED status indication for DC power.

B. Isolation Transformers:
1. Design and fabrication:
    a. Protects sensitive electronic equipment from electrical noise.
    b. Common-mode noise attenuation: 146 dB at 0.0005 pF coupling capacitance.
    c. Normal-mode attenuation: 60 dB.
    d. Input voltage range: ±10 percent of rated.
    e. Regulation: 3.5 percent or less from full-load to no-load.
    f. Dielectric strength: 2,500 Vac minimum.
    g. Harmonic distortion: 1 percent maximum.
    h. Electromagnetic interference: 0-1 gauss maximum at 18 IN.
    i. UL listed.

2.7 VOLTAGE SURGE PROTECTION DEVICES

A. See Specification Section 40 61 43 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment.

2.8 RUNNING TIME INDICATORS

A. Acceptable Manufacturer:
1. Eagle Signal Controls.

B. Design and Fabrication:
1. Six-digit wheels including a 1/10 digit.
2. Non-reset type.
3. Time range in hours.
4. Automatic recycle at zero.
5. Accuracy: 1 percent.
6. Sealed against dirt and moisture.
7. Tamperproof.

2.9 INSTRUMENT AIR COMPRESSOR

A. Acceptable Manufacturer:
1. Gast.

2.10 CLOCKS

A. Acceptable Manufacturers:
1. Newport.
2. Kessler-Ellis.

B. Design and Fabrication:
   1. Panel/face mounted.
   2. Electronic digital.
   3. Main panel locations:
      a. Red LED dot matrix digits with 1-1/2 IN minimum height.
   4. Secondary panels:
      a. Red LED dot matrix digits with 0.6 IN minimum height.
   5. Format: 24HR.
   6. Standby power with internal battery for main panel locations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Mount adder/subtractors, multiplier/dividers, square root extractors, transducers and program timers on separate subpanel in control panel.

C. Instrument Air Compressors:
   1. Pipe condensate outside panel to nearest floor drain.
   2. Mount compressors with rubber vibration isolators.

END OF SECTION

SECTION 40 79 00
PRIMARY ELEMENTS AND TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Flow components.
   2. Pressure components.
   3. Level components.
   4. Temperature components.
   5. Pipe, tubing and fittings.
   6. Instrument valves.
   7. Accessories.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Division 43 - Process Gas and Liquid Handling, Purification and Storage Equipment.
   3. Division 40 - Process Interconnections.
   4. Division 46 - Water and Wastewater Equipment

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Gas Association (AGA):
      a. Gas Measurement Committee Report #3.
   2. American Iron and Steel Institute (AISI).
   3. American National Standards Institute (ANSI).
   4. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings.
      b. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
      c. B31.1, Power Piping.
      d. PTC 19.3, Instruments and Apparatus, Part 3 Temperature Measurement.
      e. PTC 19.5, Application of Fluid Meters, Part 2.
      f. Section II, Part A SA-182, Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      g. Section II, Part A SA-479, Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
   5. ASTM International (ASTM):
      a. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A182, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      d. A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      e. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      f. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      g. A276, Standard Specification for Stainless Steel Bars and Shapes.

h. A479, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
i. B16, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
j. B32, Standard Specification for Solder Metal.
k. B75, Standard Specification for Seamless Copper Tube.
l. B88, Standard Specification for Seamless Copper Water Tube.
m. B124, Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes.
n. B283, Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed).
o. B453, Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Rod, Bar, and Shapes.
p. B626, Standard Specification for Welded Nickel and Nickel-Cobalt Alloy Tube.

6. Federal Communications Commission (FCC):
   a. 47 CFR 15, Radio Frequency Devices.
7. Instrumentation, Systems, and Automation Society (ISA):
   a. MC96.1, Temperature Measurement Thermocouples.
8. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
9. US Department of Interior Bureau of Reclamation (USDIBR):
   a. Water Measurement Manual.

1.3 SYSTEM DESCRIPTION

A. The instruments specified in this Section are the primary element components for the control system required as specified in Specification Section 46 34 50.These instruments are integrated with other control system components specified in Division 13 to produce the functional control required for a complete and functioning system.

B. All instruments shall display and be calibrated in traditional systems of weights and measures for the United States.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Comply with Specification Section 01 33 00.

B. Operation and Maintenance Manuals: Comply with Division 01 requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

2.2 PRESSURE COMPONENTS (INSTALLED ON THP TRAIN)

A. Pressure Switches:
   1. Locations: Pulpers, Reactors, Flash tanks, Pulper Circulation/Reactor Feed Pumps, Digester Feed Pumps, and Process Gas Unit.
   2. Model: Ashcroft, B-Series.
      a. Type: Diaphragm Operated Pressure Switch with adjustable set point.
      b. Process connection size: 1/2 IN NPT connection.

c. Pulpers, Flash tanks, Pulper Circulation/Reactor Feed Pumps, and Digester Feed Pumps:
   1) Setpoint range: 0 to 100 psig.
   2) Flange pressure class: ANSI 150 LB.
d. Reactors and Process Gas Unit:
   1) Setpoint range: 0 to 400 psig.
   2) Flange pressure class: ANSI 300 LB.
e. Enclosure: Watertight meeting NEMA 4X requirements.
f. Actuator Seal: 316L Stainless Steel.

3. Voltage: 120 VAC.

B. Pressure Transmitters:
1. Location: Pulpers, Reactors, Flash tanks, Pulper Circulation/Reactor Feed Pumps, Digester Feed Pumps, Process Gas Drum, Steam Supply, Air Supply, and Utility Water Connections.
2. Model: Siemens SITRANS P DS III:
   a. Pulpers, Flash tanks, Pulper Circulation/Reactor Feed Pumps, Digester Feed Pumps, Air Supply, and Utility Water:
      1) Flange pressure class: ANSI 150 LB.
   b. Reactors, Steam Supply, and Process Gas Drum:
      1) Flange pressure class: ANSI 300 LB.
   c. Process connection size: 2 IN stainless steel flange.
   d. Setpoint range: 2.32 to 232 psig.
   e. Measuring cell filling: Silicone oil.
   f. Wetted parts: 316L stainless steel.
   g. Non-wetted part housing: Cast aluminum.
   h. Visible display: Yes.
   i. Provide quality inspection certificate (five step factory calibration) to IEC 60770-2.
   j. Provide temperature decoupler.
3. Signal: 4 - 20 mA
4. Voltage: 24 VDC.

2.3 TEMPERATURE COMPONENTS (INSTALLED ON THP TRAIN)

A. Temperature Transmitters:
1. Locations: Pulpers, Flash tanks (discharge), Process Gas Cooler (discharge), and Process Gas Unit.
2. Type: Siemens SITRANS TS500.
   a. Wetted parts: 316L stainless steel.
   b. Process connection size: 1/2 IN NTP.
   c. Insertion length: As recommended by manufacture based on pipe size.
   d. Head material: aluminum with low hinged cover and screw connection.
   e. Sensor: PT100, -50 to 400 DegC range.
   f. Sensor accuracy: Single, basic accuracy.
   g. Intrinsically safe.
   h. Five point test protocol.
3. Signal: 4 - 20 mA.
4. Voltage: 24 VDC.

2.4 FLOW COMPONENTS (INSTALLED ON THP TRAIN EXCEPT FOR DIGESTER FEED)

A. Magnetic Flow Meters Larger Than 8 IN:
1. Location: Reactor Feed, Digester Feed, and Dilution Water Feed to Flash tank.
2. Type: Siemens Sitrans F M Mag 3100 electromagnetic flow sensor.
   a. Flange Pressure class: ANSI 150 LB flange.
   b. Flange material: 304 stainless steel.
   c. Liner material: PTFE.

d. Electrode material: 316L stainless steel.
e. Size:
1) Reactor feed process size: 4 IN.
2) Digester feed process size: 2-1/2 IN.
3) Dilution water to flash tank size: 1 IN.
f. Visible display: Yes.
g. Provide HART communication.
3. Signal: 4 - 20 mA.
4. Voltage: 120 VAC.

B. Magnetic Flow Meters Less Than 8 IN:
1. Location: Reactor Feed, Digester Feed, and Dilution Water Feed to Flash tank.
2. Type: Enders & Hause Proline Promag P200 or equal 2wire electromagnetic flow sensor.
a. Flange Pressure class: ANSI 150 LB flange.
b. Flange material: 304 stainless steel.
c. Liner material: PTFE.
d. Electrode material: 316L stainless steel.
e. Size:
1) Reactor feed process size: 4 IN.
2) Digester feed process size: 2-1/2 IN.
3) Dilution water to flash tank size: 1 IN.
f. Visible display: Yes.
g. Provide HART communication.
3. Signal: 4 - 20 mA.
4. Power Supply: 18-35 VDC.

2.5 LEVEL COMPONENTS (INSTALLED ON THP TRAIN)

A. Level Transmitters:
1. Location: Pulpers and Flash tanks.
2. Model: Siemens SITRANS P DS III differential pressure:
a. Pressure range: 2.409 to 240.9 IN WC.
b. Measuring cell filling: Silicone oil.
c. Wetted parts: 316L stainless steel.
d. Non-wetted part housing: Cast aluminum.
e. Visible display: Yes.
f. Diaphragm seal size: 3 IN, ANSI 150 LB pressure class.
g. Flushing ring: 3 IN ANSI 150 LB pressure class with 1/2 IN flush NPT ports.
h. Capillary length: 20 FT.
i. Provide certificate of calibration.
j. Explosion proof.
3. Signal: 4 - 20 mA.
4. Voltage: 24 VDC.

B. Level Switches:
1. Location: Pulpers, Flash tanks, and Process Gas Drum.
2. Model: Siemens Pointek CLS300 capacitance level switch.
a. Pulper and flash tank process size connection: 2 IN ANSI 150 LB flange.
b. Process gas drum process size connection: 2 IN ANSI 300 LB flange.
c. Flange material: 316L stainless steel.
d. Wetted seals: Viton.
e. Probe material: 316L stainless steel.
f. Provide thermal isolator.
3. Voltage: 120 VAC.

2.6 PIPE, TUBING, AND FITTINGS

A. Acceptable Manufacturers:
   1. Tube fittings:
      a. Swagelok.
      b. Or equal.

B. Instrument Tubing and Fittings:
   1. Material:
      a. Tubing: ASTM A269, Grade TP 316 stainless steel.
      b. Straight fittings: 316 stainless steel per ASME SA-479 or ASTM A276.
      c. Shaped bodies: ASME SA-182 F316 stainless steel.
   2. Design and fabrication:
      a. Tubing:
         1) Seamless.
         2) Fully annealed.
         3) Maximum hardness: 80 Rb.
         4) Free from surface scratches and imperfections.
         5) Diameter: 1/2 IN OD unless specified otherwise.
         6) Wall thickness:
            a) Meet requirements of ASME B31.1, Paragraph 122.3.
            b) Minimum 0.049 IN for 1/2 IN OD tubing.
      b. Fittings:
         1) Flareless.
         2) Compression type.

C. Instrument Piping:
   1. For applications where the instrument is supported solely by the sensing line, (e.g., pressure gauge directly mounted to process line) utilize piping as specified below.
      a. Diameter: 1/2 IN unless specified otherwise.
      b. Schedule 80.
      c. 316 stainless steel.

D. Pneumatic Signal Tubing:
   1. Material: stainless steel per ASTM B75.
   2. Design and fabrication:
      a. Soft annealed.
      b. Free from surface scratches and imperfections.
      c. Wall thickness:
         1) 0.030 IN for 1/4 IN OD.
         2) 0.035 IN for 3/8 IN OD.

E. Pneumatic Tube Fittings:
   1. Material:
      a. Straight fittings: stainless steel per ASTM B16 and ASTM B453.
      b. Shaped bodies: stainless steel per ASTM B124 Alloy 377 or ASTM B283.
   2. Design and fabrication:
      a. Flareless.
      b. Compression type.

F. Isolation Valves in Stainless Steel Instrument Air Tubing:
   1. Acceptable manufacturer:
      a. Whitey Co.
      b. Or equal.
   2. Materials:
      a. Packing: Graphite or Teflon.
      b. Body: 316 stainless steel.

c. Stem: 316 stainless steel per ASTM A276.
d. Ball: 316 stainless steel per ASTM A276.
e. Support rings: 316 stainless steel per ASTM A276.
f. Seats:
1) Metal: 316 stainless steel per ASTM A276.
2) Soft:
a) Teflon, Delrin.
b) Only utilized on applications where manufacturer's temperature and pressure ratings exceed process design conditions.

3. Design and fabrication:
a. Ball valve with 1/4 turn activation.
b. Provide body wall thickness sufficient for process design conditions per ASME B31.1.

2.7 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
1. Materials, unless otherwise specified, shall be as follows:
a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
b. Mounting brackets, plates, angles, stands: 316 stainless steel.

B. Tubing Support Angles and Brackets:
1. Type 316 stainless steel.

C. Tubing Tray or Channel:
1. Aluminum.
2. Provide dielectric material between tray or channel and tubing.

D. Provide handheld communicator compatible with all intelligent transmitters furnished.
1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
2. If these features are provided with the intelligent transmitter, the hand held communicator is not required.

E. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

2.8 MAINTENANCE MATERIALS

A. Furnish all special tools, parts and supplies necessary for one year of operation as recommended by the Manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Install all instrumentation to allow for maintenance activities and changing out instruments, including double block and bleed, for each device.

D. Instrument Valves:
1. Orient stems for proper operation.
2. Install arrays orderly and neat in appearance with true horizontal and vertical lines.
3. Provide a minimum of 2 IN clearance between valve handle turning radius where there are multiple valve handles appearing in a straight line.
4. Valves shall have bonnets and any soft seals removed during welding or soldering into the line.
a. When cool, reassemble the valves.

5. Support each valve individually.
    a. The tubing system does not qualify as support for the valve.

E. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.

F. Keep foreign matter out of the system.

G. Remove all oil on piping and tubing with solvent before piping and tubing installation.

H. Plug all open ends and connections to keep out contaminants.

I. Tubing Installation:
1. General:
    a. Install such that tube shows no sign of crumpling, bends of too short a radius, or flattening, etc.
    b. Make tube runs straight and parallel or perpendicular to the floor, equipment and piping runs.
    c. For liquid and steam applications, slope continuously from the process to the instrument with a minimum slope of 0.50 IN per foot.
    d. For gas and air applications, slope continuously from the instrument to the process with a minimum slope of 0.50 IN per foot.
    e. If the sensing line cannot be continuously sloped, install high point vents and low point drains.
    f. Keep instrument tubing clean during all phases of work.
    g. Blow out with clean, dry, oil-free air immediately before final assembly.
    h. Cut by tuber cutter and debur.
2. Bending:
    a. Make each bend with tube bender of the correct size for the tube.
    b. Make all bends smooth and continuous.
    c. Rebending is not permitted.
    d. Make bends true to angle and radius.
    e. Maintain a true circular cross section of tubing without buckling or undue stretch of tube wall.
    f. Allowable tolerance for flattening out of tubing bends: Maximum of 8 percent of the OD for stainless steel tubing.
    g. Minimum bending radius for stainless steel tubing:

Tube OD, Inches	Minimum Bending Radius, Inches
1/4	9/16
3/8	15/16
1/2	1-1/2

3. Tubing support:
    a. Intermittently support by clamping to support angle.
    b. Install supports to be self-draining, supported by hangers, or cantilevered from walls or structural beams.
    c. Support at 5 FT-0 IN maximum spans for horizontal or vertical runs.
    d. Use tubing trays in areas where spans between supports are greater than 5 FT and for all signal tubing support.
    e. Support each tubing tray at 10 FT maximum spans.
    f. Align tubing in orderly rows and retain in the tray by bolted clips.
        1) The use of spring or speed clips is not acceptable.
    g. Maintain order of the tubing throughout the length of the tray.

h. Locate angle, channel and tray installation to protect tubing from spills and mechanical damage.
i. Locate support members to clear all piping, conduit, equipment, hatchways, monorails, and personnel access ways and allow access for equipment operation and maintenance.
j. Support trays to prevent torsion, sway or sag.
k. Permanently attach supports to building steel or other permanent structural members.
l. Arrange supports and trays so that they do not become a trough or trap.

4. Routing and orientation:
   a. Route to maintain a minimum headroom clearance of 8 FT.
   b. Locate and orient valves and specialties so that they are accessible for operation and maintenance from the operating floor.
      1) Do not route through or over equipment removal areas, below monorails or cranes nor above or below hatches.
5. Expansion and vibration provisions:
   a. Provide horizontal expansion loops at the process connections.
   b. Route tubing parallel to relative motion through sleeved supports that allow linear tube movement.
   c. Cold springing of tubing to compensate for thermal expansion is prohibited.
   d. Utilize flexible hoses to connect pneumatic tubing to air users which may move or vibrate.

J. Air Supply:
1. Connect all instruments requiring air to air supply piping and tubing.
2. Provide connections as follows:
   a. Terminate branch supply line not more than 36 IN from the device with a 1/2 IN isolation valve.
   b. For remaining line, use 1/4 or 3/8 IN tubing of a length to allow for normal equipment movement and vibration.
   c. Use flexible hoses to connect pneumatic tubing to air users which may experience significant movement or vibration.
   d. Make branch connections to individual instruments from the top of the supply header.
   e. Purge instrument air piping of extraneous material by blowing clean, dry, oil-free air through the system prior to final connection.

K. Threaded Connection Seals:
1. Use Tite-Seal or acceptable alternate.
2. Use of lead base pipe dope or Teflon tape is not acceptable.
3. Do not apply Tite-Seal to tubing threads of compression fittings.

L. Capillary Tubing:
1. Route capillary tubing in tubing tray.
2. Install capillary tubing with a 2 IN minimum bend radius which does not kink or pinch the capillaries.
3. Do not cut or disconnect at any point.
4. Coil excess capillary tubing and secure at the instrument.

M. Temperature Elements:
1. Assemble in the following sequence:
   a. Remove temperature sensor sheaths and terminal blocks from the head and nipple assembly.
   b. Connect nipple and head to thermowell installed in the pipe.
   c. Insert sheath and terminal block until it seats in the thermowell.
   d. Connect to the head.

N. Instrument Mounting:
1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.

2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
3. Mount instruments level, plumb, and support rigidly.
4. Mount to provide:
    a. Protection from heat, shock, and vibrations.
    b. Accessibility for maintenance.
    c. Freedom from interference with piping, conduit and equipment.

3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00 Facility and System Start-up.

END OF SECTION

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SECTION 40 79 00
PRIMARY ELEMENTS AND TRANSMITTERS
40 79 00A - INSTRUMENT SCHEDULE

DEVICE TYPE	SERVICE/LOCATION	DEVICE TYPE	METER SIZE	INDICATOR REQUIREMENTS	CALIBRATED RANGE / SETPOINT	SEAL	SPEC SECTION	COMMENTS
PSHX	Pulper Tank Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package
LSHX	Pulper Tank Level Switch	Level Switch	N/A	N/A	By Manufacturer	N/A	13442-2.5B	Manufacturer Package
PEXX/PITX	Pulper Tank Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
LEXX/LITX	Pulper Tank Level	Level Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.5A	Manufacturer Package
TEXX/TITX	Pulper Tank Temperature	Temperature Transmitter	N/A	N/A	By Manufacturer	N/A	13442-2.3A	Manufacturer Package
PEXX/PITX	Pulper Recirculation/Reactor Feed Pump No. 1 Discharge Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
PSHX	Pulper Recirculation/Reactor Feed Pump No. 1 Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package
PSHX	Pulper Recirculation/Reactor Feed Pump No. 2 Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package
PEXX/PITX	Pulper Recirculation/Reactor Feed Pump No. 2 Discharge Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
FEXX/FITX	Reactor Flow Meter No. 1	Magnetic Flow Meter	4	Local	By Manufacturer	N/A	13442-2.4A	Manufacturer Package
FEXX/FITX	Reactor Flow Meter No. 2	Magnetic Flow Meter	4	Local	By Manufacturer	N/A	13442-2.4A	Manufacturer Package
PEXX/PITX	Reactor No. 1 Tank Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
PSHX	Reactor No. 1 Tank Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package
PEXX/PITX	Reactor No. 2 Tank Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
PSHX	Reactor No. 2 Tank Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package
PEXX/PITX	Reactor No. 3 Tank Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
PSHX	Reactor No. 3 Tank Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package
PEXX/PITX	Reactor No. 4 Tank Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
PSHX	Reactor No. 4 Tank Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package
FEXX/FITX	Dilution Water to Flash Tank	Magnetic Flow Meter	1	Local	By Manufacturer	N/A	13442-2.4A	Manufacturer Package
PEXX/PITX	Utility Water Pressure No. 1	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
PEXX/PITX	Utility Water Pressure No. 2	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
LSHX	Flash Tank Level Switch	Level Switch	N/A	N/A	By Manufacturer	N/A	13442-2.5B	Manufacturer Package
PSHX	Flash Tank Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package
PEXX/PITX	Flash Tank Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
TEXX/TITX	Flash Tank Temperature (discharge)	Temperature Transmitter	N/A	N/A	By Manufacturer	Diaphragm	13442-2.3A	Manufacturer Package
LEXX/LITX	Flash Tank Level	Level Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.5A	Manufacturer Package
PEXX/PITX	Digester Feed Pump No. 1 Discharge Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
PSHX	Digester Feed Pump No. 1 Discharge Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package
PEXX/PITX	Digester Feed Pump No. 2 Discharge Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
PSHX	Digester Feed Pump No. 2 Discharge Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package
TEXX/TITX	Digester Feed Temperature	Temperature Transmitter	N/A	N/A	By Manufacturer	N/A	13442-2.3A	Manufacturer Package
FEXX/FITX	Digester Feed Flow Meter No. 1	Magnetic Flow Meter	2 1/2	Local	By Manufacturer	N/A	13442-2.4A	Manufacturer Package
FEXX/FITX	Digester Feed Flow Meter No. 2	Magnetic Flow Meter	2 1/2	Local	By Manufacturer	N/A	13442-2.4A	Manufacturer Package
FEXX/FITX	Digester Feed Flow Meter No. 3	Magnetic Flow Meter	2 1/2	Local	By Manufacturer	N/A	13442-2.4A	Manufacturer Package
TEXX/TITX	Foul Gas Cooler Outlet Temperature	Temperature Transmitter	N/A	N/A	By Manufacturer	N/A	13442-2.3A	Manufacturer Package
TEXX/TITX	Foul Gas Unit Temperature	Temperature Transmitter	N/A	N/A	By Manufacturer	N/A	13442-2.3A	Manufacturer Package
PSHX	Foul Gas Tank Pressure Switch	Pressure Switch	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2A	Manufacturer Package

SECTION 40 79 00
PRIMARY ELEMENTS AND TRANSMITTERS
40 79 00A - INSTRUMENT SCHEDULE

DEVICE TYPE	SERVICE/LOCATION	DEVICE TYPE	METER SIZE	INDICATOR REQUIREMENTS	CALIBRATED RANGE / SETPOINT	SEAL	SPEC SECTION	COMMENTS
PEXX/PITX	Foul Gas Tank Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
LSLX	Foul Gas Tank Level Switch	Level Switch	N/A	N/A	By Manufacturer	N/A	13442-2.5B	Manufacturer Package
PEXX/PITX	Instrument Air Supply Pressure to THP	Pressure Transmitter	N/A	N/A	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package
PEXX/PITX	Steam Boiler Steam Supply Pressure	Pressure Transmitter	N/A	Local	By Manufacturer	Diaphragm	13442-2.2B	Manufacturer Package

SECTION 43 39 00
PROGRESSIVE CAVITY PUMPS FOR HYDROLYZED SOLIDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material, design, fabrication and installation requirements for progressing cavity pumps for the thermally hydrolyzed solids (THS), complete with electric motors and other appurtenances as specified in this specification.
   2. Progressing cavity pumps:
      a. Pulper Circulation/Reactor Feed Pump Nos. 1, 2, 3 and 4.
      b. Digester Feed Pump Nos. 1 and 2.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Division 26 - Electrical.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 40 79 00 - Primary Elements and Transmitters.
   5. Section 46 34 50 - Pre-Engineered, Fabricated Thermal Hydrolysis Process System.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have experience in manufacturing progressing cavity pumping equipment of similar size and configuration to the equipment specified herein that are specifically designed for THS. For a manufacturer to be determined acceptable for providing the progressing cavity pumps on this project, they must show evidence of a minimum of five installations and five years of experience in the design and manufacturing of progressing cavity pump equipment of similar size and type as specified herein for THS.

B. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
      a. AGMA 6010-E-88, Spur, Helical, Herringbone, and Bevel Enclosed Drive.
      b. AGMA 6019-E-89, Gear Motors Using Spur, Helical, Herringbone, Straight Bevel, or Spiral Bevel Gears.
      c. AGMA 6023-A88, Design Manual for Enclosed Epicyclic Gear Drives.
   3. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   4. American National Standards Institute (ANSI).
   5. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
   6. Hydraulic Institute (HI).
   7. National Electrical Manufacturers Association (NEMA).
   8. Steel Structures Painting Council, American National Standards Institute (SSPC).

C. Coordinate all mechanical seal systems specified to ensure pump and seal compatibility.

D. Pump/motor and VFD coordination: See Specification Section 01 61 03 - Equipment - Basic Requirements.

1.3 DEFINITIONS

A. The abbreviations used in this section are defined as follows:
   1. NPSH3: Net Positive Suction Head for 3 percent head loss.
   2. PTFE: Polytetrafluoroethylene.

3. VFD: Variable Frequency Drive.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See specification 01 61 03 - Equipment - Basic Requirements.
   3. Product technical data including:
      a. Performance data and curve with flow (gpm), head (psi), horsepower, hydraulic efficiency, pump rotating speed (rpm), and NPSH3 requirements.
      b. Pump accessory data.
      c. Bearing supports, shafting details and lubrication provisions.
      d. Bearing life calculations.
      e. Solids passage information.
      f. Gearbox sizing calculations.
   4. Mill certifications confirming hardness of rotor.
   5. Performance guarantee for minimum stator service life of 5,000 hours when operating continuously.
   6. Source quality control test reports.
   7. Written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Progressing cavity pumps:
      a. Moyno EZstrip High Temperature Pump.
      b. Seepex.
   2. Mechanical seals:
      a. EagleBurgmann.
      b. Or approved equal.
   3. Removable insulation:
      a. As provided by THP train Supplier.

B. No like, equivalent or "or-equal" item or substitution is permitted unless stated otherwise.

2.2 MATERIALS

A. Progressing cavity pumps:
   1. Pump body: Cast iron, ASTM A48 Class 25 or 35B.
   2. Rotor: Medium carbon steel, AISI 1045, with chrome plating.
   3. Coupling rod: 420 stainless steel.
   4. Joint sleeve material: Viton.
   5. Stator: Specifically designed for THS.
      a. Viton H5.
   6. Base plate: Fabricated steel.
   7. Stuffing box gland: Ductile iron.

8. Seal: Elastomer bellows seal, single acting mechanical seal, unbalanced type and independent of direction of rotation.
    a. Springs: Hastelloy C-4.
    b. Seal face: Tungsten carbide.
    c. Seat face: Tungsten carbide.
    d. Elastomers: Viton.

B. Manufacturer's standard assembly and anchor bolts, nuts, and washers: 316 stainless steel.

2.3 EQUIPMENT

A. Performance and Configuration Requirements:
1. Quantity: Four (4) Pulper Circulation/Reactor Feed Pump Nos. 1 - 4.
    a. Location: Outdoors.
    b. Pumping application:
        1) Diluted thermally hydrolyzed solids.
        2) Maximum temperature of solids: 107 DegC (225 DegF).
        3) pH: 5.0 to 9.0.
        4) Dry solids concentration: 12 to 16 percent.
    c. Operation: Continuous, 24 hours per day.
    d. Design Condition: 200 gpm at 45 psig, and maximum pump speed of 160 rpm.
    e. Minimum number of pump stages: 1.
    f. Pump Configuration: Counter-clockwise.
    g. Minimum nameplate drive horsepower: 15.
    h. Drive type: Variable speed, constant torque.
    i. Drive configuration: Direct drive, vertical motor configuration.
    j. Suction size: 8 IN, ANSI Class 300 LB flange
    k. Discharge size: 6 IN, ANSI Class 300 LB flange.
2. Quantity: Two (2) Digester Feed Pump Nos. 1 and 2.
    a. Location: Outdoors.
    b. Pumping application:
        1) Diluted thermally hydrolyzed solids.
        2) Maximum temperature of solids: 107 DegC (225 DegF).
        3) pH: 5.0 to 7.0.
        4) Dry solids concentration: 9 to 12 percent.
    c. Operation: Continuous.
    d. Design Condition: 170 gpm at 90 psig and maximum pump speed of 150 rpm.
    e. Minimum number of pump stages: 2.
    f. Pump Configuration: Counter-clockwise.
    g. Minimum nameplate drive horsepower: 25.
    h. Drive type: Variable speed, constant torque.
    i. Drive configuration: Direct drive, vertical motor configuration.
    j. Suction size: 8 IN, ANSI Class 150 LB flange
    k. Discharge size: 6 IN, ANSI Class 150 LB flange.

2.4 ACCESSORIES

A. See Specification Section 01 61 03 - Equipment - Basic Requirements.

B. Supplier shall provide over-pressurization protection by furnishing and installing an adjustable pressure switch at the pump discharge. The pressure switch shall have single and multiple switching capabilities and the pump shall stop on low or high discharge pressure. See Specification 40 79 00 – Miscellaneous Instruments and Appurtenances.

C. Removable jacket insulation on pump:
1. Type: Lace-up or Velcro closure.

2. Construction:
    a. Weatherproof for outdoor installation.
    b. Re-usable fiberglass type with PTFE-coated water-resistant cloth covers and liner.

2.5 FABRICATION

A. Base:
1. Design to support weight of drive, shafting and pump.
2. Comply with HI vibration limitations.
3. Mount horizontal pump, gearbox, motor, and coupling on a single piece of drip lip type baseplate.
4. Fabricate to withstand all operating loads transmitted from the pump and drive.
5. Lifting eye bolts or lugs.

B. Pump Body:
1. All cast parts shall be free of sand holes, blow-holes and other defects.
2. Provide body containing two (2) inspection ports 180 degrees apart.
3. Cradle mount pump to permit suction port to be rotated at 90 degree increments perpendicular to pump centerline.
4. Lifting eye bolts or lugs.
5. Fittings for properly adding any flushing lubricant.
6. Pressure relief fittings for any grease lubrication.

C. Rotor:
1. Rotor shall be single helix design.
2. Harden steel to minimum Rockwell C-57 and plated with a minimum thickness of 250 µm of hard chromium nitride to a minimum hardness of Rockwell C-70.

D. Stator:
1. Construct by bonding rubber-type material to inside of a steel tube.
2. Double helix configuration.
3. The elastomer shall be bonded to the stator sleeve ends forming a collar preventing any liquid contact with the tube or the bonding agent.
4. Minimum 60 durometer hardness (Shore A).
5. Minimum performance guarantee on service life: 5,000 hours operating continuously.

E. Drive Train:
1. Include crown gear-type or pin-type universal joints, seals, connecting rod, driveshaft, and shaft bearings.
2. Connect rotor drive shaft by a connecting rod equipped with two (2) crowned gear-type or pin-type factory grease lubricated and positively sealed universal joints.
    c. Joint unconditionally guaranteed by manufacturer to meet 10,000 hours operation at the required performance conditions.
3. Use universal joints to transmit thrust and torque while allowing the rotor to move through an eccentric path.
4. Joint shall be positively sealed and encased in a series 300 stainless steel cover to protect it from tramp metal and glass.
5. The shaft shall be solid through the stuffing box area, but of a two-part design which allows the mechanical seal and all other wetted rotating parts to be removed from the pump without disassembly of the pump or gear motor bearings.
    a. Shaft shall be coated with the same chrome plating used as the rotor coating.
    b. The stuffing box shall be provided with lantern rings and seal water flush connections for future use if required or retrofitted. The lantern ring shall be split for convenient removal. The stuffing box housing shall be drilled and tapped for water flush connections.

6. Bearings:
    a. Provided with oil lubricated thrust and radial bearings, located in the gear motor, designed for all loads imposed by the specified service.
    b. Mount drive shaft in two (2) ball or tapered roller bearings.
    c. Bearing ABMA L-10 life: 100,000 HRS at design operating conditions specified.

F. Provide fittings for grease or oil lubrication of bearings.

G. Anti-reversal Holdback:
1. Each main pump gearbox shall be fitted with a differential friction-type holdback designed to prevent reversal of flow when the pump is not in operation. The holdback shall be fitted as an integral component of the main pump gear drive and the unit will be adequately protected against the entrance of dust, dirt and moisture. Anti-reversal holdbacks shall be adequately sized for the specified service.

H. Motor:
1. See Specification Section 01 61 03 - Equipment - Basic Requirements.
2. Maximum nameplate driver horsepower shall be capable of operating throughout the entire published limits of the pump curve without operating in the 60 Hz service factor.

I. Gear Box and Reducer:
1. See Specification Section 01 61 03 - Equipment - Basic Requirements.

J. Control:
1. All control logic for the pumps will reside in remote hardware that is part of the THP System Local Control Panel (LCP) and Programmable Logic controller (PLC).

K. Assembly
1. Mount pump, motor, and gearbox on common base plate.

L. Paint and protective coatings:
1. Pump shall be shop primed and finish coated prior to shipment from the factory in accordance with the Specification Section 09 96 00 - High Performance Industrial Coatings.

2.6 SOURCE QUALITY CONTROL

A. Verification of all design conditions.

B. Factory hydrostatic test all pumps at 150 percent of shut-off head for a minimum of 5 minutes.

C. Testing:
1. Head (psi) versus flow (gpm) pump curves:
    a. Brake horsepower along each curve.
    b. Results certified by a registered professional engineer.
2. Perform Level I test for each pump as defined by HI standards to assure conformance to manufacturer's commercial performance criteria. Furnish results to the Owner.
3. Perform Level II test for each pump to assure conformance with specified pump speed, outlet pressure, inlet pressure, and liquid characteristics. Furnish results to the Owner.
4. Perform hydrostatic test for each pump in compliance with HI standards. Furnish results to the Owner.

2.7 MAINTENANCE MATERIALS

A. Furnish Owner one complete shelf spare pump for each type and size of pump.

B. Furnish Owner the following extra parts per pump:
1. One (1) shaft sleeve.
2. One (1) rotor.
3. Two (2) stators.
4. One (1) set of connecting rod joint assemblies.
5. One (1) set of mechanical seals.

6. One (1) pump cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 01 61 03 - Equipment - Basic Requirements.

B. Floor or Pad-Mounted Units:
   1. Align vertically and horizontally level, wedge and plumb units to match piping interfaces.
   2. Assure no unnecessary stresses are transmitted to equipment flanges.
   3. Tighten flange bolts at uniform rate and manufacturer's recommended torque for uniform gasket compression.
   4. Support and match flange faces to uniform contact over entire face area prior to bolting pipe flange and equipment.
   5. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
   6. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
   7. Assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened.
      a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
      b. Realign as necessary, install flange bolts and make equipment connection.
   8. Provide pressure gauge, visible from grade or operating floor, on suction and discharge piping of all pumps.

3.2 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer’s field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise pre-start adjustments and installation checks.
   3. Conduct initial start-up of equipment and perform operational checks.
   4. Provide training of Owner’s personnel as specified in Specification Section 01 75 00 – Facility and System Start-up.

END OF SECTION

SECTION 43 39 01
PROGRESSIVE CAVITY PUMPS FOR PRE-DEWATERED SOLIDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material, design, fabrication and installation requirements for progressing cavity pumps for pre-dewatered solids (cake), complete with electric motors and other appurtenances as specified in this specification.
   2. Progressing cavity pumps:
      a. Pulper Feed Pumps.
      b. Boundary Layer Injection Pumps.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Division 26 - Electrical.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 40 79 00 - Primary Elements and Transmitters.
   5. Section 46 34 50 - Pre-Engineered, Fabricated Thermal Hydrolysis Process System.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer shall have experience in manufacturing progressing cavity pumping equipment of similar size and configuration to the equipment specified herein. For a manufacturer to be determined acceptable for providing the progressing cavity pumps on this project, they must show evidence of a minimum of five installations and five years of experience in the design and manufacturing of progressing cavity pump equipment of similar size and type as specified herein.

B. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
      a. AGMA 6010-E-88, Spur, Helical, Herringbone, and Bevel Enclosed Drive.
      b. AGMA 6019-E-89, Gear Motors Using Spur, Helical, Herringbone, Straight Bevel, or Spiral Bevel Gears.
      c. AGMA 6023-A88, Design Manual for Enclosed Epicyclic Gear Drives.
   3. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   4. American National Standards Institute (ANSI).
   5. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
   6. Hydraulic Institute (HI).
   7. National Electrical Manufacturers Association (NEMA).
   8. Steel Structures Painting Council, American National Standards Institute (SSPC).

C. Coordinate all mechanical seal systems specified to ensure pump and seal compatibility.

D. Pump/motor and VFD coordination: See Specification Section 01 61 03 - Equipment - Basic Requirements.

1.3 DEFINITIONS

A. The abbreviations used in this section are defined as follows:
   1. NPSH3: Net Positive Suction Head for 3 percent head loss.

2. VFD: Variable Frequency Drive.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Requirements in Specification Section 01 61 03 - Equipment - Basic Requirements.
   3. Product technical data including:
      a. Performance data and curve with flow (gpm), head (psi), horsepower, hydraulic efficiency, pump rotating speed (rpm), and NPSH3 requirements.
      b. Pump accessory data.
      c. Bearing supports, shafting details and lubrication provisions.
      d. Bearing life calculations.
      e. Solids passage information.
      f. Gearbox sizing calculations.
   4. Mill certifications confirming hardness of rotor.
   5. Performance guarantee for minimum stator service life of 5,000 hours when operating continuously.
   6. Source quality control test reports.
   7. Written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Progressing cavity pumps:
      a. Moyno.
      b. Seepex.
   2. Mechanical seals:
      a. EagleBurgmann.
      b. Or approved equal.
   3. Removable insulation:
      a. Advanced Thermal Corp.
      b. Or approved equal.

B. No like, equivalent or "or-equal" item or substitution is permitted unless stated otherwise.

2.2 MATERIALS

A. Progressing Cavity Pre-dewatered Solids (Cake) Pumps:
   1. Pump body: Cast iron, ASTM A48 Class 25 or 35B.
   2. Rotor: Tool steel, AISI D6, with chrome plating.
   3. Coupling rod: 420 Stainless steel.
   4. Joint sleeve material: EPDM.
   5. Stator: Urethane.
   6. Auger shaft and flights: Carbon Steel, ASTM A284, Grade C or ASTM A53.
   7. Base plate: Fabricated steel.

8. Seal: Elastomer bellows seal, single acting mechanical seal, unbalanced type and independent of direction of rotation.
    a. Springs: Hastelloy C-4.
    b. Seal face: Tungsten carbide.
    c. Seat face: Tungsten carbide.
    d. Elastomers: Viton.

B. Progressing Cavity Boundary Layer Injection Pumps:
1. Pump body: 316 stainless steel.
2. Rotor: 316 stainless steel.
3. Coupling rod: 316 stainless steel.
4. Joint sleeve material: Viton.
5. Stator: Viton.
6. Seal: Elastomer bellows seal, single acting mechanical seal, unbalanced type and independent of direction of rotation.
    a. Springs: Hastelloy C-4.
    b. Seal face: Tungsten carbide.
    c. Seat face: Tungsten carbide.
    d. Elastomers: Viton.

C. Boundary Layer Injection Rings:
1. Flange material: 316 Stainless Steel.
2. Minimum flange size: 10 IN.
    a. Coordinate actual flange diameter size with future Contract Drawings.
3. Minimum flange class rating: ANSI Class 300 LB.
4. Hose material: 316 stainless steel braided hose.

D. Manufacturer's standard assembly and anchor bolts, nuts, and washers: 316 stainless steel.

2.3 EQUIPMENT

A. Performance and Configuration Requirements:
1. Quantity: Four (4) Pulper Feed Pump Nos. 1 - 4.
    a. Location: Indoors, located underneath cake storage bins.
    b. Cake storage bins will store solids at a dry solids concentration of 20 to 25 percent.
        1) Solids density: 60 - 80 LB/FT^3.
        2) Maximum suction head on pump: 32 FT.
    c. Pumping application:
        1) Pre-dewatered municipal wastewater solids with grit.
        2) Primary solids to waste activated solids ratio (PS:WAS):
            a) Average: 65:35.
            b) Range 40:60 to 80:20.
        3) pH: 5.0 – 9.0.
        4) Dry solids concentration: 15 to 20 percent.
            a) Solids will be diluted inside the pump suction housing using plant utility water.
    d. Operation: Continuous, 24 hours per day.
    e. Design conditions:
        1) Maximum: 100 gpm at 212 psig, and maximum pump speed of 80 rpm.
        2) Average: 41 gpm at 212 psig, and maximum pump speed of 50 rpm.
        3) Minimum: 20 gpm at 150 psig.
    f. Minimum number of pump stages: 4, no exceptions.
    g. Pump configuration: Counter-clockwise.
    h. Minimum nameplate drive horsepower: 50.
    i. Drive type: Variable speed, constant torque.
    j. Drive configuration: Direct drive, horizontal motor configuration.

k. Suction chute:
    1) Minimum length: 4.9 FT.
    2) Minimum width: 23.5 IN.
l. Minimum discharge size: 8 IN, ANSI Class 300 LB flange.

2. Boundary Layer Injection Pump Nos. 1 - 4.
    a. Location: Outdoors.
    b. Pumping application:
        1) Plant utility water.
        2) pH: 5.0 – 8.0.
        3) Used to reduce the pressure in the cake piping line by pumping water into boundary layer injection ring.
    c. Operation: Continuous, 24 hours per day.
    d. Design conditions: 0.05 to 0.75 gpm at 212 psig, and maximum pump speed of 600 rpm.
    e. Minimum number of pump stages: 4, no exceptions.
    f. Pump configuration: Counter-clockwise.
    g. Minimum nameplate drive horsepower: 1.
    h. Drive type: AC motor, fixed reduction variable speed, constant torque.
    i. Drive configuration: Direct drive, horizontal motor configuration.
    j. Minimum suction size: 1 IN NPT.
    k. Minimum discharge size: 0.75 IN NPT.
3. Boundary Layer Injection Rings:
    a. Quantity: 4, one per boundary layer injection pump.
    b. Minimum thickness: 1.5 IN.
    c. Minimum number of equally spaced injection points: 4.
        1) Piping shall manifold to one connection upstream of injection points.
    d. Injection opening size: 0.5 IN NPT.
    e. Machined such that the inside area of each injection opening is notched with a 0.25 IN lip to protect the opening from the upstream solids flow. Downstream side of the opening shall be beveled at a 45 degree angle to allow for smooth injection of water.

2.4 ACCESSORIES

A. See Specification Section 01 61 03 - Equipment - Basic Requirements.

B. Provide protection against run dry by monitoring the pump's stator temperature. The stator shall be fitted with a sensor sleeve and thermistor sensor. Manufacturer shall provide a controller to be installed by the Contractor. The controller shall monitor the stator temperature and activate a shutdown and alarm sequence if the stator temperature reaches the adjustable limit on the controller. The controller shall include a manual local and remote reset function and shall be supplied in a NEMA 4X stainless steel enclosure.

C. Additional protection against run dry and over-pressurization shall be furnished by installing an adjustable pressure switch at the pump discharge. The pressure switch shall have single and multiple switching capabilities and the pump shall stop on low or high discharge pressure. Pressure switch shall be provided and installed by the Contractor.

D. Removable jacket insulation on pump:
1. Type: Lace-up or Velcro closure.
2. Construction:
    a. Weatherproof for outdoor installation.
    b. Re-usable fiberglass type with PTFE-coated water-resistant cloth covers and liner.

2.5 FABRICATION

A. Base:
   1. Design to support weight of drive, shafting and pump.
   2. Comply with HI vibration limitations.
   3. Mount horizontal pump, gearbox, motor, and coupling on a single piece of drip lip type baseplate.
   4. Fabricate to withstand all operating loads transmitted from the pump and drive.
   5. Lifting eye bolts or lugs.

B. Pump Body:
   1. All cast parts shall be free of sand holes, blow-holes and other defects.
   2. Provide body containing two (2) inspection ports 180 degrees apart.
   3. Cradle mount pump to permit suction port to be rotated at 90 degree increments perpendicular to pump centerline.
   4. One (1) 4 IN flange flushing connection located on one side of the suction chute and three (3) 2 IN flanged, equally spaced connections on the opposite side of the suction chute for dilution water.

C. Rotor:
   1. Rotor shall be single helix design.
   2. Harden steel to minimum Rockwell C-57 and plated with a minimum thickness of 250 µm of hard chromium nitride to a minimum hardness of Rockwell C-70.

D. Stator:
   1. Construct by bonding rubber-type material to inside of a steel tube.
   2. Double helix configuration.
   3. The elastomer shall be bonded to the stator sleeve ends forming a collar preventing any liquid contact with the tube or the bonding agent.

E. Drive Train:
   1. Include crown gear-type or pin-type universal joints, seals, connecting rod, driveshaft, and shaft bearings.
   2. Connect rotor drive shaft by a connecting rod equipped with two (2) crowned gear-type or pin-type factory grease lubricated and positively sealed universal joints.
      a. Joint unconditionally guaranteed by manufacturer to meet 10,000 hour operation at the required performance conditions.
   3. Use universal joints to transmit thrust and torque while allowing the rotor to move through an eccentric path.
   4. Joint shall be positively sealed and encased in a series 300 stainless steel cover to protect it from tramp metal and glass.
   5. The shaft shall be solid through the stuffing box area, but of a two part design which allows the mechanical seal and all other wetted rotating parts to be removed from the pump without disassembly of the pump or gear motor bearings.
      a. Shaft shall be coated with the same chrome plating used as the rotor coating.
      b. The stuffing box shall be provided with lantern rings and seal water flush connections for future use if required or retrofitted. The lantern ring shall be split for convenient removal. The stuffing box housing shall be drilled and tapped for water flush connections.
   6. Bearings
      a. Provided with oil lubricated thrust and radial bearings, located in the gear motor, designed for all loads imposed by the specified service.
      b. Mount drive shaft in two (2) ball or tapered roller bearings.
      c. Bearing ABMA L-10 life: 100,000 HRS at design operating conditions specified.
      d. Provide fittings for grease or oil lubrication of bearings.

F. Feed Auger:
   1. Running the entire length of the suction housing and designed to transport dewatered solids or cake from the suction housing to the pump cavity at the rotor.
   2. Single helix ribbon type auger.

G. Anti-reversal Holdback:
   1. Each main pump gearbox shall be fitted with a differential friction-type holdback designed to prevent reversal of flow when the pump is not in operation. The holdback shall be fitted as an integral component of the main pump gear drive and the unit will be adequately protected against the entrance of dust, dirt and moisture. Anti-reversal holdbacks shall be adequately sized for the specified service.

H. Motor:
   1. See Specification Section 01 61 03 - Equipment - Basic Requirements.

I. Gear Box and Reducer:
   1. See Specification Section 01 61 03 - Equipment - Basic Requirements.

J. Assembly
   1. Mount pump and motor on common base plate.
   2. Furnish base plate with drip lip to mount motor and pump.

K. Paint and protective coatings:
   1. Pump shall be shop primed and finish coated prior to shipment from the factory in accordance with Specification Section 09 96 00 - High Performance Industrial Coatings.

2.6 SOURCE QUALITY CONTROL

A. Verification of all design conditions.

B. Factory hydrostatic test all pumps at 150 percent of shut-off head for a minimum of 5 minutes.

C. Testing:
   1. Head (psi) versus flow (gpm) pump curves:
      a. Brake horsepower along each curve.
      b. Results certified by a registered professional engineer.
   2. Perform Level I test for each pump as defined by HI standards to assure conformance to manufacturer's commercial performance criteria.
   3. Perform Level II test for each pump to assure conformance with specified pump speed, outlet pressure, inlet pressure, and liquid characteristics. Furnish results to the Owner.
   4. Perform hydrostatic test for each pump in compliance with HI standards.

2.7 MAINTENANCE MATERIALS

A. Furnish Owner one complete shelf spare pump for each type of pump.

B. Furnish Owner the following extra parts per pre-dewatering solids (cake) pump:
   1. One (1) shaft sleeve.
   2. One (1) rotor.
   3. One (1) stator.
   4. One (1) set of connecting rod joint assemblies.
   5. One (1) set of mechanical seals.

C. Furnish Owner the following extra parts per boundary layer injection pump:
   1. One (1) shaft sleeve.
   2. One (1) rotor.
   3. One (1) stator.
   4. One (1) set of connecting rod joint assemblies.
   5. One (1) set of mechanical seals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 01 61 03 - Equipment - Basic Requirements.

B. Floor or Pad-Mounted Units:
   1. Align vertically and horizontally level, wedge and plumb units to match piping interfaces.
   2. Assure no unnecessary stresses are transmitted to equipment flanges.
   3. Tighten flange bolts at uniform rate and manufacturer's recommended torque for uniform gasket compression.
   4. Support and match flange faces to uniform contact over entire face area prior to bolting pipe flange and equipment.
   5. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
   6. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
   7. Assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened.
      a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
      b. Realign as necessary, install flange bolts and make equipment connection.
   8. Provide pressure gage, visible from grade or operating floor, on suction and discharge piping of all pumps.

3.2 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer’s field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise pre-start adjustments and installation checks.
   3. Conduct initial start-up of equipment and perform operational checks.
   4. Provide training of Owner’s personnel as specified in Specification Section 01 75 00 – Facility and System Start-up.

END OF SECTION

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SECTION 46 34 50
PRE-ENGINEERED, FABRICATED THERMAL HYDROLYSIS PROCESS SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Material, design, fabrication, shop testing, delivery, installation assistance, start-up, and testing requirements for equipment, materials and services to supply the components necessary for a complete and fully functional Thermal Hydrolysis Process (THP) system, and Services as defined in Specification Section 01 11 00 – Summary of Work.

B. The specifications and drawings depict the THP configuration of a single manufacturer (Cambi U.S. subsidiary of Cambi AS of Norway). Final specifications and drawings will be developed based on the selected supplier from those pre-qualified by Arlington County.

C. Equipment, materials and services include, but are not limited to:
   1. One (1) THP train with two Pulpers, two Flash tanks and a Process Gas Unit:
      a. Four (4) Pulper Recirculation/Reactor Feed Pumps, Two (2) Digester Feed Pumps.
   2. One (1) Programmable Logic Controller (PLC) with panel-mounted HMI.
   3. One (1) remote HMI.
   4. Four (4) Pulper Feed Pumps.
   5. Two (2) THS Flow Control Valves.
   6. Two (2) THS Flow Meters.
   7. Two (2) THS pressure transmitters for flow control manifold.
   8. One (1) Spare parts Package.
   9. Two (2) years Operations and Maintenance Assistance Contract, as specified in Specification Section 01 11 00 – Summary of Work.

D. In addition to the requirements specified in this Section, Supplier's scope of work and supply of equipment and services is further described in Specification Section 01 11 00 – Summary of Work and is shown on the Drawings.

E. Refer to all specifications for requirements of the equipment to be provided by the Supplier, in addition to the requirements specified in this Section.

F. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Division 05 - Metals.
   3. Division 09 - Finishes.
   4. Division 10 - Specialties.
   5. Division 26 - Electrical.
   6. Division 40 - Process Interconnections.
   7. Division 43 - Process Gas and Liquid Handling, Purification and Storage Equipment.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
      a. B16.5, Pipe Flanges and Flanged Fittings.
      b. B16.11, Forged Fittings, Socket-Welding and Threaded.
      c. B36.19, Stainless Steel Pipe.

2. American Society of Mechanical Engineers (ASME).
    a. B31.3, Process Piping.
    b. Section VIII, Divisions 1 and 2 of Boiler and Pressure Vessel Code.
3. American Society for Testing and Materials (ASTM).
    a. A182/A182M, Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
    b. A193/A193M, Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
    c. A194/A194M, Carbon and Alloy Steel Nuts for Bolts for High Pressure and High-Temperature Service.
    d. A312/312M, Seamless and Welded Austenitic Stainless Steel Pipes.
    e. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure Containing Parts.
    f. A403/A403M, Wrought Austenitic Stainless Steel Piping Fittings.
    g. A774/A774M, As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
4. American Welding Society (AWS).
    a. D1.1, Structural Welding Code – Steel.
5. Institute of Electrical and Electronics Engineers (IEEE).
6. National Electric Code, (NEC).
7. National Electrical Manufacturers Association (NEMA).
8. Occupational Safety and Health Administration (OSHA).
9. Underwriter's Laboratories, Inc. (UL).

B. System Responsibility:
    1. Supplier shall coordinate with Contractor's system integrator to integrate the THP PLC with the Owner's Process Control System (PCS).

1.3 CLASS A PATHOGEN REDUCTION

A. The system shall meet all requirements for producing a Class A, pathogen free product as defined by the United States Environmental Protection Agency (U.S.E.P.A.) as defined in 40 CFR, part 503.

B. Supplier shall provide evidence to support that the THP system specified and provided for this Project meets or exceeds all requirements of 40 CFR 503.32(a)(3) including the following.
    1. Fecal coliform densities shall be below 1,000 MPN per gram of total solids (dry weight basis) or Salmonella sp. bacteria shall be below detection limits (3 MPN per 4 grams total solids (dry weight basis).
        a. The required time-temperature regimes specified herein are met.
        b. The time-temperature criteria apply to every particle of biosolids processed. The system shall meet the requirements of the USEPA including the following specific criteria identified in Control of Pathogens and Vector Attraction in Sewage Sludge (Including Septage) Under 40 CFR Part 503 EPA/625/R-92/013 Revised July 2003].
            1) "It is important to note that it is mandatory for all sewage sludge particles to meet the time-temperature regime."
            2) "The time-temperature requirements apply to every particle of sewage sludge processed. Time at the desired temperature is readily determined for batch or plug flow operations, or even laminar flow in pipes."

C. Testing to demonstrate the system meets these requirements shall be as above and as specified in Paragraph 3.4.C.

1.4 WARRANTY

A. Supplier shall warrant to the Owner that all equipment and materials of construction are new and free from faults and defects.

B. Supplier shall warrant all equipment to the Owner for one year from THP acceptance.

1.5 SUBMITTALS

A. Submittals and Operations and Maintenance Manuals shall be provided in accordance with Specification Section 01 33 00.

B. The following submittals shall be submitted within 70 calendar days of the Contractor's receipt of Notice to Proceed from the Owner for Design Phase Services:
   1. Design criteria (criteria used to select the components for inclusion in the System including rated capacity, materials of construction, purpose/description) for:
      a. Major components of the assembled THP train including: Pulpers, reactors, flash tanks, pumps, and process gas unit.
      b. Pulper feed pumps, refer to Specification Section 43 39 01 – Progressive Cavity Pumps for Pre-Dewatered Solids.
      c. Pulper circulation/reactor feed pumps, refer to Specification Section 43 39 00 – Progressive Cavity Pumps for Hydrolyzed Solids.
      d. Digester feed pumps, refer to Specification Section 43 39 00 – Progressive Cavity Pumps for Hydrolyzed Solids.
      e. Digester control valves. Predicted performance showing flow rates, pressure drop, and percent open at minimum, average and maximum process conditions.
      f. Air compressor system, not to be installed on the assembled THP train but separately.
   2. Minimum and maximum steam demands for the minimum and maximum process solids loading conditions identified in Paragraph 2.3.C.
   3. Complete steam demand profile for a single reactor batch as well as for batch sequencing/timing for minimum and maximum process loading conditions identified in Paragraph 2.3.C.
   4. Water requirements for the THP system including pressures and flow rates.
   5. Assembled THP train including main components: Pulper, reactors, flash tank, pumps, air compressor system, and process gas cooler and skid with empty weight, operating weight, and dimensional information (Length x Width x Height).
   6. Structural design criteria:
      a. Foundation plan with located columns and equipment, including relative elevations.
      b. Anchoring requirements including diameter and material of the anchors for complete scope of supply.
      c. Equipment dynamic load resistance requirements (if applicable).
      d. Certification that manufactured units meet all design loads specified.
      e. Engineering design calculations:
         1) Indicate foundation design loads including dead, live, wind, seismic, snow, fluid, dynamic, thermal (if applicable).
         2) Sealed by a licensed professional engineer, registered in the Commonwealth of Virginia.
         3) Engineer will review for general compliance with Contract Documents.
   7. General arrangement drawing in AutoCAD and three-dimensional rendering in a 3D compatible software format with relevant information mechanical, electrical and structural interfaces to support design.
   8. Drawings to identify location, size, and requirements for all connections to the THP train and remote equipment, including, but not limited to:
      a. Solids to Pulper.
      b. Solids from Flash Tank.
      c. Dilution water connections.
      d. Process gas cooling water connections.
      e. Process gas unit condensate connection.
      f. Steam to steam header connection
   9. Process and instrumentation (P&ID) diagrams.
   10. Listing of all input and output (I/O) points.

11. Instrument list (primary elements, proposed manufacturer, model, and service condition).
12. Any exceptions to the requirements set forth in the Specifications and Drawings.

C. All remaining Design Phase Submittals shall be provided as scheduled in Specification Section 01 33 00:
   1. Equipment shop drawing submittals identified in Specification Section 01 61 03 - Equipment - Basic Requirements and as follows:
      a. Pulper feed pumps, refer to Specification Section 43 39 01 – Progressive Cavity Pumps for Pre-Dewatered Solids.
      b. Pulper circulation/reactor feed pumps, refer to Specification Section 43 39 00 – Progressive Cavity Pumps for Hydrolyzed Solids.
      c. Digester feed pumps, refer to Specification Section 43 39 00 – Progressive Cavity Pumps for Hydrolyzed Solids.
   2. Electrical and instrumentation.
      a. Refer to Division 26 specifications for submittal requirements.
      b. Single line diagrams for:
         1) 480V, 3 phase loads.
         2) 120V/24V loads and devices.
         3) Signal wiring and devices.
      c. Drawings showing the locations and elevations of every junction box to be wired. These drawings should also identify the spaces provided on the THP train for raceway routing.
      d. Assign an equipment tag number to each device and maintain consistency throughout.
      e. Termination schedule (connection diagrams for devices including controls).
      f. Electrical load list including heat trace load.
      g. Motor load list.
      h. List of motor equipment with device tag numbers that relate to the plan/elevation drawings. The list should identify the equipment, voltage and amp ratings, and control required (discrete start/stop or on/off, analog variable speed, etc.).
      i. List of valves with device tag numbers. The list should identify the equipment, voltage and amp ratings, and control devices on the equipment or separately mounted adjacent to the equipment.
      j. List of instruments with device tag numbers, voltage and wiring requirements.
      k. Any other miscellaneous devices with tag number, electrical ratings.
      l. Manufacturer's shop drawings or equipment cut sheets for each item listed above.
   3. Programmable Logic Controller (PLC) and Human Machine Interface (HMI):
      a. See Division 13 specifications for submittal requirements.
      b. Drawings include, but are not limited to, full bill of material, dimensions, front panel view, complete connection diagrams identifying field with device tag numbers used throughout, schematic diagrams, etc.
      c. Detailed functional description of operations for the control system.
      d. Copy of the PLC program and associated software.
      e. Information confirming interface requirements between programmable logic controller (PLC) and the plant PCS, including I/O mapping for replication/repeating on the plant PCS.
   4. Structural elements (support structure, grating, and railing):
      a. See to Division 05 specifications for submittal requirements.
      b. Materials of construction.
      c. Connection details unless already included in structural calculations.
      d. For record purposes only: Calculations and drawings signed and sealed by Professional Engineer(s) registered in the Commonwealth of Virginia for the design of the structural elements of the THP system in its entirety.
   5. Pressure Vessels:
      a. Submit product data, shop drawings, working drawings, certifications, test reports and service manuals appropriate for pressure vessels.

1) Test reports and certifications to be provided pursuant to requirements of applicable ASME codes.
2) After fabrication of the THP system, provide all documentation required in accordance with ASME including registration with the National Board of Boiler and Pressure Vessel Inspectors.

6. Coating and identification submittals, as specified in Specification Section 09 96 00 – High Performance Industrial Coatings and Specification Section 10 14 00 – Identification Devices.
7. Pipe insulation and cladding system product data and materials of construction.
8. Pipe materials and pressure class, service conditions, joints and fittings, and testing certifications following completion of testing per the guidance and standards of ASME.
9. Cambi THP B6-4 train installation instructions.

D. Construction Phase Submittals:
1. Typical annual preventative maintenance requirements, including spare parts (with range of typical replacement frequencies) and consumables required.
2. Complete spare parts list, with current pricing, valid for one year from THP Acceptance.
3. All start-up testing plans at least one month prior to the planned start of any testing.
4. Installation and Training Certification Forms in accordance with Specification Section 01 61 03 - Equipment - Basic Requirements and Specification Section 01 75 00 – Facility and System Start-up.
   a. Templates for the installation certification forms and the training certification forms will be provided by Owner.
   b. Separate installation forms and certification forms shall be provided by Supplier for each individual component of Supplier's scope of supply, including but not limited to Supplier's main equipment identified in Part 2.4.
5. Operations and Maintenance Manuals, in accordance with Specification Section 01 33 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturer is acceptable:
1. Cambi U.S. subsidiary of Cambi AS of Norway.

B. Or equal.

2.2 MATERIALS

A. Pressure Vessels:
1. Material including nozzles: 316 stainless steel.
2. Flanges: 316 stainless steel.
3. Gaskets: 316 stainless steel spiral wound gaskets.
4. Bolts for flanges: A4-80 Grade stainless steel bolts.

B. Process Gas Systems:
1. Process gas cooler:
   a. Material: 316 stainless steel pipe, ASTM A312 or alloy 254 SMO, ASTM A312.
2. Process gas module:
   a. Material: 316 stainless steel for all wetted pump parts.

C. Piping:
1. Refer to Part 2.5.

D. Valves:
1. Refer to Part 2.6.

2.3 PERFORMANCE REQUIREMENTS

A. General
   1. Site conditions:
      a. Outdoor installation, installed on concrete foundation.
      b. Air temperature range: -8 to 103 DegF.
      c. Humidity: up to 95 percent.
   2. Operation:
      a. Designed and built to operate continuously at maximum rated speed, 24 hours per day, seven days per week.
      b. Indigenous undigested primary solids (PS) and WAS will be dewatered, diluted and then fed to the THP system. All solids will be screened using solids screens with a maximum screen opening size of 5 mm.

B. THP System shall be designed and built to operate satisfactorily under the following solids feed conditions.

Parameter	Range
Dry solids concentration within the range.[1]	15.0 to 18.0%
PS:WAS Concentration (dry weight)	
Average	65:35
Range	40:60 to 80:20
Temperature	59 to 84 DegF
pH	5.0 to 7.0

1. All process guarantees are based on 16.5% DS average at 70 DegF.

C. Solids loading design criteria.

Design Condition	Solids Loading Rate Dry Tons Per Day
Start-up Condition (23 MGD)	
Minimum Day	10.7
Annual Average	30.7
Maximum Month	40.1
Peak Two-Week	43.7
Peak Week	46.3
Design Condition (30.8 MGD)	
Minimum Day	14.4
Annual Average	41.1
Maximum Month	53.7
Peak Two-Week	58.5
Peak Week	61.9
Future Condition (40 MGD)	
Minimum Day	18.8
Annual Average	53.5
Maximum Month	69.8
Peak Two-Week	76.0
Peak Week	80.6

D. Performance Criteria:

   1. Supplier shall Guaranteed Performance for the THP system as defined below. Satisfaction of the Performance Guarantees shall be fulfilled through the Acceptance testing specified in

Paragraph 3.4 C. Should the acceptance testing show that actual performance is below the guaranteed performance, despite remedies taken by the Supplier, the Owner may reject the equipment.

	Parameter	Requirement
THP PG-1	Solids Throughput	92 dtpd
THP PG-2	Reactor Time and Pressure	Minimum 87 psig for 20 minutes
THP PG-3	Class A Biosolids	Fecal coliform density less than 1000 MPN/gram dry solids or Salmonella less than 3 MPN per 4 grams total solids (dry weight basis)
THP PG-4	THS Flow Control	Flow split between flow control valves must be within ±5 percent.
THP PG-5	Steam Usage	1. Maximum of 1.0 tons per ton of dry solids processed at a maximum solids loading rate of 92 dtpd at 20 DegC. 2. Maximum instantaneous steam demand of 4.4 tons per hour

2.4 EQUIPMENT

A. THP train:
   1. Structural design will be in accordance with the following documents and standards:
      a. Building Code: 2018 Virginia Uniform Statewide Building Code (VUSBC)
      b. ASCE/SEI 7-10 Minimum Design Loads for Building and Other Structures.
      c. AISC 360-05 Steel Construction Manual and Specification for Structural Steel Buildings.
      d. Other codes as referenced by the Building Code.
   2. Design Loads:
      a. Stairs and Grating: 100 psf.
      b. Basic Wind Speed: 119 mph.
      c. Snow Load: Refer to the Building Code for complete derivation of these loads.
      d. Seismic Load: Refer to the Building Code for complete derivation of these loads.
   3. Steel structures including stairs, railing and elevated walkways, shall be provided to access the pressure vessels and equipment, and in accordance with Division 05. Design of structures shall comply with ASCE/SEI 7-10. Steel structures and grating shall be galvanized according to ASTM A123.
   4. All structural work shall be certified and sealed by a professional engineer licensed in the Commonwealth of Virginia.

B. Pressure Vessels:
   1. General:
      a. Provide six (6) pressure vessels in one (1) thermal hydrolysis train.
      b. Pressure vessels include two (2) Pulpers, four (4) Reactors and (2) Flash Tanks.
         1) Pulpers:
            a) Minimum design pressure: 72.5 psig.
            b) Minimum design temperature: 318 DegF (159 DegC).
         2) Reactors:
            a) Minimum design pressure: 180 psig.
            b) Minimum design temperature: 370 DegF (187 DegC).

3) Flash tanks:
a) Minimum design pressure: 72.5 psig.
b) Minimum design temperature: 318 DegF (158 DegC).

c. Pressure vessels shall be designed, fabricated, tested and Code stamped in accordance with the latest edition and the appropriate sections of the ASME Boiler and Pressure Vessel Code and addenda.

2. All vessels shall be manufactured by an ASME Certified Manufacturer for the Code and Class Vessels specified. The manufacture shall also be registered with the National Board of Boiler and Pressure Vessel Inspectors. The design, fabrication, testing and documentation for all pressure vessels shall comply with the ASME Boiler and Pressure Vessel Codes. The vessels shall be stamped with the ASME certification mark and "U" stamp.
3. Pressure vessels shall meet the following additional requirements.
   a. Vessels shall be designed for outdoor location with ambient temperature ranges stated in Paragraph 2.3.A.1.
   b. Flanges shall be designed according to ANSI B16.5.
   c. Spare flanges shall be equipped with properly installed blind flanges and securely tightened by means of gaskets and bolts.
   d. Welds shall be continuous. Partial welds will not be accepted unless deemed sufficient by Owner's Representative on a case by case evaluation.
   e. Welds shall be pickled and passivated according to applicable standards.
   f. Pressure vessels shall be provided with the following:
      1) Bottom skirt fitted with vent holes and access openings.
      2) Manway with davit and handle bars for easy removal of blind flange. Manway size shall be standard size supplied by Supplier, minimum 24 IN, and shall meet all applicable requirements by Codes.
      3) Lifting lugs or trunnions on the vessels or the skid modules for lifting and erecting.
      4) Foundation bolt holes designed to allow drilling of the concrete foundation with the vessel located in place. Anchors shall be adhesive anchors, provided and installed by the Contractor. Anchor design, including materials requirements, size and location shall be provided by Supplier.
      5) Jacking points each designed to bear 50 percent of vessel empty weight with ample extra margin.
      6) All vessels and pipes, requiring insulation, will be insulated and cladded in the factory. Loose blanket style insulation will be provided for all field connections by Supplier to be installed by the Contractor.
      7) Wall thickness for nozzles in top dishes to be minimum as required by ASME.
      8) Nozzles for all required process connections and maintenance cleaning connections.

C. Process Pumps:
   1. Pulper Feed Pumps:
      a. Furnish pulper feed pumps in accordance with Specification Section 43 39 01 – Progressive Cavity Pumps for Pre-Dewatered Solids.
   2. Pulper Circulation/Reactor and Digester Feed Pumps:
      a. Furnish pumps in accordance with Specification Section 43 39 00 – Progressive Cavity Pumps for Hydrolyzed Solids.

D. Process Gas Systems:
   1. Provide one process gas system with cooler and module.
      a. Process Gas Cooler:
         1) Cooler shall be tube-in-tube type exchanger designed to avoid clogging and minimize pressure loss.

2) Cooling media shall be disinfected chlorinated final effluent.
   a) Residual chlorine content: 1.0 – 2.0 mg/L.
   b) Temperature range: 40 DegF to 85 DegF.
3) Cooler shall meet requirements of ASME 31.3 and shall be designed for outdoor location with ambient temperature ranges stated in Paragraph 2.3.A.1.
4) Flange connections shall be designed according to ANSI B16.5, Class 150.

2. Process Gas Module:
   a. Provide one process gas module with one gas ejector, two water pumps, storage drum, and interconnecting piping, instruments and valves assembled as a complete system.
   b. Process gas module shall have a common skid and support frame assembly designed and manufactured to prevent process gas leakage.
   c. Ejectors shall be liquid jet gas compressor type, resistant to organic acids with pH ranging from 2.0 to 7.0.
   d. Water pumps shall be close coupled, seal-less, horizontal centrifugal type with magnetic drive.

E. Compressed Air System:
1. Design requirements:
   a. As required by Supplier.
   b. Compressed air system shall produce instrument air quality conforming to ANSI/ISA-7.01 (ISO 8573-1; Class 2.2.2).
2. Compressed air system shall be Kaeser Compressors Model SM 10, or equal.
3. Type: duplex compressed air system with two (2) parallel compressor units having duty plus 100 percent standby capacity, operating in duty/assist mode for air supply to pneumatic valve operators.
4. System shall be provided with all necessary components and accessories including filters, dryers, reservoirs, pressure regulators, oil and moisture separators, piping, valves, motors, motor starters, instruments and other equipment for a complete and operating system.
5. Compressors type: Screw centrifugal.
6. Entire compressed air system shall be installed and delivered in an acoustically insulated removable enclosure.
   a. Enclosure shall be steel with paint system rated for outdoor environment.
   b. Removable panels to facilitate all routine maintenance and major component replacement.
7. External connections to the container shall be limited to those for power, air outlets, drains, and communication.
8. Compressors shall be supported on anti-vibration mountings and be attached to piping using tied flexible bellows connectors.
9. Compressed air receiver shall meet the requirements of ASME Section VIII, Division 1 or 2 and bear an ASME inspector's stamp.
10. Air receiver shall be equipped with automatic condensate drain valve and pressure safety valves.
11. Controls shall be provided for full automatic operation. System controls shall include switching duty dryer on indication of high dew point or failed dew point transmitter. For each compressor and each dryer, signals shall be provided for connection to the control panel for the following conditions: running, available, and tripped/fault.
    a. Provide integral motor starters.
    b. The compressor package shall have a single point of connection for power.
    c. Provide NEMA 4X stainless steel enclosure for the starter and controls compartment.
    d. Assembly shall be rated a minimum 65,000 amperes symmetrical at 480V.

F. Motors and VFDs:
1. See Specification Section 01 61 03 - Equipment - Basic Requirements for motor requirements.
2. Contractor shall supply all VFDs.

2.5 PIPING

A. Piping shall be designed for minimal use of bellows. Pipe schedule, routing and supports shall be designed to accommodate thermal displacement. Pipe stress calculations shall be conducted on all heated pipes by Supplier.

B. Pipe materials and pressure class shall be as shown in the table below. Flange gaskets for stainless steel piping shall be Type 316 spiral wound.

Service Code	Service	Material	Pressure Class
CA	Compressed Air	304 stainless steel and PVC air tubing at connections	ANSI 150 LB
PG	Process Gas	316 stainless steel	ANSI 150 LB
FS	Flash Steam	316 stainless steel	ANSI 150 LB/ ANSI 300 LB
THS	Thermally Hydrolyzed Solids	316 stainless steel	ANSI 150 LB/ ANSI 300 LB
MPS	Medium Pressure Steam	316 stainless steel	ANSI 300 LB
CMP	Steam Condensate	304 stainless steel	ANSI 300 LB
UW	Utility Water	304 stainless steel	ANSI 150 LB

C. Pipe:
1. General:
   a. Supplier's scope shall include furnishing all piping, fittings, couplings, and appurtenances included within the THP train's perimeter. Piping beyond and between Supplier-provided components not within the THP train's perimeter will be furnished and installed by the Contractor.
   b. Pulper feed pump discharge piping, fittings, couplings, valves and instruments shall be provided and installed by the Contractor.
2. Type: Seamless or welded annealed austenitic stainless steel.
3. Material: ASTM A312, Grade TP 304, 304L, 316 or 316L, full finish.
4. Dimensional: ANSI B36.19.
5. Joints and Fittings:
   a. Flanged Joints:
      1) References: ASTM A182, ANSI B16.5, slip-on or lap joint with 1/16 IN raised face.
      2) Bolts and Nuts: ASTM A354, Type 316 stainless steel.
   b. Threaded (where provided for small diameter piping):
      1) Taper threads.
      2) References: ANSI B1.20.1, ASTM A403.
      3) Joint Preparation: Provide soft-setting sealant.
   c. Fittings:
      1) Provide fittings conforming to ASTM A403.
      2) Fitting and flange class shall coincide with pipe pressure conditions and resulting static and dynamic loads.
6. Taps:
   a. Provide taps where required for small pipe connections and other purposes.
   b. Provide a boss or pipe saddle where pipe or fitting wall thickness is inadequate to provide required minimum number of threads. Provide boss or pipe saddle for all taps over 2 IN size.
7. Pipe adapters: Provide necessary adapters to join pipe of different types. All adapters shall be restrained.

8. Pipe couplings/unions: Provide couplings, unions, and connections at equipment as appropriate to allow for the disconnection of piping and to facilitate the disassembly and reassembly of skid components. All couplings and unions shall be restrained.
9. Pipe Supports:
    a. Supplier is responsible for all pipe support design within the THP train.
    b. Supplier shall select pipe hangers and supports as appropriate to withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected.
    c. As a minimum, consideration shall be given to the following conditions:
        1) Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.
        2) Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.
        3) Reaction forces due to the operation of safety or relief valves.
        4) Wind, snow or ice loadings on outdoor piping.
    d. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where required, the outside diameter of insulation.
    e. Hangers for the suspension of size 2 1/2 IN and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.
    f. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.
    g. Stock hanger and support components shall be used wherever practical.

2.6 VALVES AND APPURTENANCES

A. General:
1. Supplier shall provide all valves required for a complete and functional system within the THP train perimeter and the THS flow control valves.
2. Actuators for automatic valves mounted at the THP train shall be pneumatically operated and shall be provided by the valve manufacturer.
3. Actuators for automatic valves mounted remotely from the THP train shall be electrically operated and shall be provided by the valve manufacturer.
4. Materials of construction shall be as per specification below. Where material of construction is not specified it shall be chosen suitable for the applicable service, temperature and pressure as determined by Supplier.
5. To reduce amount of specific valve types and spare parts, a limited variety of valves shall be procured as far as practically possible.
6. Install vacuum breakers on all steam equipment and piping which have the potential to condense steam in a closed vessel.
7. Provide air release valves at the following as a minimum:
    a. On the MPS steam main header on the riser piping.
    b. As required per Code and per good engineering practice.
8. Provide steam safety relief and pressure safety relief valves as required by ASME pressure vessel code and good engineering practice.

B. Eccentric Plug Valves (THS Flow Control Valves):
1. Type: Non-lubricated eccentric plug with resilient plug faces.
    a. Service: Hydrolyzed solids control and drain.
        1) Thermally Hydrolyzed Solids (THS) feed control.
    b. Design criteria: Supplier is responsible for sizing THS flow control valves to ensure they operate between 20 percent and 80 percent open for the solids feed conditions and all solids loading design criteria conditions specified in Paragraphs 2.3.B and 2.3 C, respectively.
    c. Material:
        1) Body material: 316 stainless steel.
        2) Plug, shaft, seats: 316 stainless steel.

3) Bearings: 316 stainless steel.
4) Packing: PTFE.
5) Bonnet Screws: 18-8 stainless steel

d. Ends: Flanged, ANSI Class 150.
e. Actuator: Electric actuator.

C. Air Release Valves:
1. Type: Float.
2. Service: Air release, process gas cooling water.
3. Material: Brownall Type A.

D. Ball Valves:
1. Type: Threaded full port, 2-piece design:
a. Service: Flush/drain/vent valves, and water and air isolation.
b. Material:
1) Body and ball: Stainless steel, ASTM A351 Grade CF8M.
2) Body seal: RPTFE.
3) Seat: RPTFE.
4) Stem: 316 stainless steel.
5) Stem Packing: Reinforced PTFE.
6) Handle, nut, and locking lever: 304 stainless steel.

c. End connection: Threaded, 1000 psi WOG.
d. Actuator: Lever.
2. Type: Flanged full port, two-piece design:
a. Service: Pulper dilution water supply, Pulper vacuum break, low pressure steam to Pulper (heat recovery), flash steam from Reactors to Pulper, and Process Gas Unit.
b. Material:
1) Body and ball: Stainless steel, ASTM A351 Grade CF8M.
2) Body seal: Spiral wound (316 SS/graphite).
3) Seat: Carbon/graphite filled TFM.
4) Stem: 316 stainless steel.
5) Stem Packing: Reinforced PTFE/graphite.
6) Handle, nut, and locking lever (non-actuated valves): 304 stainless steel.

c. End connections: ANSI Class 150 LB RF Flanges.
d. Actuator: Lever, 1/4 turn pneumatic actuator.
3. Type: V-port, two-piece design:
a. Service: Steam to Reactors.
b. Material:
1) Body and ball: Stainless steel, ASTM A351 Grade CF8M.
2) Body seal: Spiral wound (316 SS/graphite).
3) Seat: Carbon/graphite filled TFM.
4) Stem: 316 stainless steel.
5) Stem Packing: Reinforced PTFE/graphite.

c. End connection: ANSI Class 300 LB RF Flanges.
d. Actuator: Double acting, 1/4 turn pneumatic actuator.

E. Check Valves:
1. Type: Tilting disc.
a. Service: Process Gas Pump Nos. 1 and 2 discharge, process gas skid discharge to digester, and steam header to Reactors.
b. Material:
1) Body: Stainless steel ASTM A182 grade F316 (2 IN valves) and ASTM A351 Grade CF8M (3 to 24 IN valves).
2) Disc: Stainless Steel ASTM A240 Grade 329 or ASTM A487 Grade CA6NM.
3) Seat: Metal.
4) Spring: Stainless steel, ASTM A564 Type 635.

c. End connection: Wafer.
d. Pressure class: ANSI 150 LB for process gas services and ANSI 300 LB for steam services.

2. Type: Spring disc.
a. Service: Steam condensate, utility water supply to Process Gas Unit, utility water supply to Pulper circulation, and dilution water at flash tank (discharge).
b. Material:
1) Body: Stainless steel ASTM A351 Grade CF8M
2) Disc: 316 stainless steel.
3) Seat: Metal.
4) Plug: Stainless steel, ASTM A182 F316 L.
c. End connection: Wafer.
d. Pressure class: ANSI 150 LB.

F. Globe Valves
1. Type: Flanged, straight through design:
a. Service: Steam, steam condensate, and cooling water:
b. Material:
1) Body: Cast carbon steel, ASTM A216 WCB.
2) Seat: Stainless steel, E347-16.
3) Plug: Stainless steel, Grade 420.
4) Bellows seal: 316 stainless steel.
5) Stem: Stainless steel, Grade 420.
6) Packing: Graphite.
7) Hand wheel: Carbon steel.
c. End connection: ANSI 150 LB flange for steam condensate and cooling water services, and ANSI 300 LB flange for steam supply.
d. Actuator: Hand wheel.

G. Knife Gate Valves:
1. Type: Knife gate valves, high performance:
a. Service: Hydrolyzed solids control and drain.
b. General: Knife gate valves shall be designed for in situ seal tightening and replacement and for full bi-directional free end pressure and shall be shrouded/guarded with in open position.
c. Material:
1) Body: Cast 316L stainless steel, ASTM A216 WCC.
2) Gate: 316L stainless steel.
3) Stem: Stainless steel, Grade 2320.
4) Seat: PTFE.
5) Packing: PTFE.
6) Hand wheel (non-actuating valves): Carbon steel.
d. End connection: Lugged, ANSI 150 LB and ANSI 300 LB depending on service.
e. Actuator: Handwheel or piston actuator with limit switches.

2. Type: Knife gate valves, high performance, Ni-Hard insert:
a. Service: Hydrolyzed solids discharge from Reactors.
b. General: Knife gate valves shall be designed for in situ seal tightening and replacement and for full bi-directional free end pressure and shall be shrouded/guarded with in open position.
c. Material:
1) Body: Cast 316L stainless steel.
2) Gate: 304 stainless steel.
3) Spindle: Stainless steel.
4) Stem: Stainless steel, Grade 2320.

5) Seat: Seal cord, AFLAS.
6) Packing: PTFE.
d. End connection: Lugged, ANSI 300 LB.
e. Actuator: Piston actuator with limit switches.

H. Pressure Safety Valves:
1. Type: Direct acting, full lift safety relief valve.
a. Service: Process gas drum over pressure protection.
b. Material:
1) Body: Stainless steel.
2) Spring: Stainless steel.
c. Ends: Flanged, Class 150.
d. Set point: 150 psig.
e. Design capacity: 239.9 lbs/h.
f. Size: 1/2 IN inlet, 1 IN outlet.
2. Type: Direct acting, full lift safety relief valve:
a. Service: Process gas skid water circulation pipework over pressure protection.
b. Material:
1) Body: Stainless steel.
2) Spring: Stainless steel.
c. Ends: Flanged, Class 150.
d. Set point: 225.5 psig.
e. Design capacity: 239.9 lbs/h.
f. Size: 1/2 IN inlet, 1 IN outlet.
3. Type: Direct acting, full lift safety relief valve:
a. Service: Process gas cooler over pressure protection.
b. Material:
1) Body: Stainless steel.
2) Spring: Stainless steel.
c. Ends: Threaded or flanged, Class 150.
d. Set point: 130 psig.
e. Design capacity: 346 lbs/h.
f. Size: 1/2 IN inlet, 1 IN outlet.
4. Type: Enclosed spring type ASME steam safety valves with external lifting levers:
a. Service: Pressure relief for Pulpers, Reactor, and Flash tanks.
b. Material:
1) Body: Stainless Steel.
2) Seat: Stainless Steel.
3) Spring: Alloy Steel.
c. Ends: Flanged, Class 300.
d. Set point:
1) Pulper and Flashtank: 73 psig.
2) Reactor: 181 psig.
e. Pressure Relief Rating:
1) Pulper: 8,800 lbs/h saturated steam at 73 psig.
2) Flashtank: 8,800 lbs/h saturated steam at 73 psig.
3) Reactor: 19,665 lbs/h saturated steam at 181 psig.
f. Size: 2 IN inlet, 3 IN outlet.
g. Provide steam safety relief valves with drip pan elbows.

I. Limit Switches:
1. Limit switches for modulating control valves.
a. Type: Integral limit switches built into the positioner (in addition to continuous position feedback).
b. Model: 6DR4004-8K for Siemens Sipart SP2, or equal.

2. Limit switches for on/off ball valves:
    a. Type: Top mounted compact type with visual indicators.
    b. Model: APL-210N, or equal.
3. Limit switches for on/off knife gate valves:
    a. Type: Magnetic reed proximity indicators with LED lamp.
    b. Model: Festo SME-8-K-LED-230, or equal.
4. Provide PLC and panel equipment to monitor equipment and devices designated by the Owner during the submittal process. These devices shall also be configured and included in Supplier's configuration screens.
    a. Owner's standards for motor operated valves:
        1) Valve fully closed: Closed limit switch is made and Opened limit switch is not made.
        2) Valve traveling from Fully Closed to Fully Opened: Both limit switches are made.
        3) Valve fully open: Opened limit switch is made and Closed limit switch is not made.
        4) Reverse requirements when valve traveling in opposite direction.
5. PLC screen presentation shall show both the closed and open valve indicating lights ON during mid-travel.

J. Actuators for valves on THP train:
1. For automatic shutoff service, actuators shall be single acting, quarter-turn pneumatic type with limit switches, and spring return.
2. For control service, actuators shall be double acting, quarter-turn pneumatic type with positioner, position feedback and limit switches.

K. Electric actuators for THS flow control valves:
1. General:
    a. Counter clockwise opening as viewed from the top.
    b. Direction of opening and the word OPEN to be cast in handwheel or valve bonnet.
    c. Size actuator to produce required torque with a maximum pull of 80 LB at the maximum pressure rating of the valve provided and withstand without damage a pull of 200 LB on handwheel or chainwheel or 300 foot-pounds torque on the operating nut.

L. Electric Actuators (480 V, 3 PH):
1. Manufacturers:
    a. Rotork.
    b. Limitorque.
2. Actuator motor starter type:
    a. For open/close service provide electro-mechanical starters.
    b. For modulating service provide solid-state starters.
3. Conform to AWWA C542.
4. Provide electric valve actuators with integral control devices and a remote pushbutton station.
5. Furnish electric actuator integral with valve consisting of:
    a. Motor.
    b. Gearing.
    c. Handwheel.
    d. Limit and torque switches.
    e. Lubricants.
    f. Heating elements.
    g. Wiring.
    h. Terminals for motor power and controls.
    i. Drive nut.
6. Housing/Enclosure:
    a. Provide cast iron gear housing and cast iron load bearing enclosure.
    b. Non load bearing enclosure and housing: Aluminum or cast iron.

c. Rated for area classification shown on Drawings.
d. Provide O-ring seals for covers and entries.
e. Terminal and limit switch compartment covers are to be fastened to gear housing by stainless steel fasteners with capture device to prevent loss.

7. Motors:
   a. Provide motors that are totally enclosed, high torque design made expressly for valve actuator service and capable of operating the valve under full differential pressure for complete open-close and reverse cycle of travel at least five (5) times in immediate succession without overheating.
   b. Design motors in accordance with NEMA MG 1 standards, with Class B insulation, and to operate successfully at any voltage within 10 percent above or below rated voltage.
   c. Provide positive method to ensure motor bearings are permanently lubricated.
   d. Provide three (3) thermal switches imbedded in windings:
      1) 120 degrees apart.
      2) Provide motor shutdown at high temperature.
   e. Motor housing:
      1) Aluminum or cast iron.
      2) Totally enclosed nonventilated with cooling fins.
   f. Provide motor capable of operating in any position.
   g. Provide motor sealed from gearcase to allow any mounting position.
   h. Provide motors suitable for 480 V, 3 PH, 60 Hz.
8. Gearing:
   a. Provide power gearing consisting of heat treated steel helical gears, carburized and hardened alloy steel worm, and alloy bronze worm gear, all grease or oil bath lubricated, designed for 100 percent overload, and effectively sealed against entrance of foreign matter.
   b. Provide gearing mechanism constructed to permit field changes of reduction gear ratio.
   c. Design actuators so that motor comes up to speed before stem load is encountered in either opening or closing operation.
   d. Limit switch gearings and feedback device reduction gearing:
      1) Steel or bronze.
   e. Support rotating shafts with anti-friction bearings.
   f. Provide separate drive nut/thrust bearing assembly:
      1) Mounted to base of actuator.
      2) High tensile bronze.
      3) Quarter turn actuator: Provide 90 degree mounting intervals.
      4) Provide grease fitting on drive assembly.
9. Handwheel:
   a. Permanently attached for manual operation.
   b. Positive declutch mechanism to engage and disengage handwheel.
   c. Handwheel shall not rotate during motor operation.
   d. Inoperable motor shall not prevent manual operation.
10. Limit torque and thrust loads in both closing and opening directions by torque limit switches.
   a. Provide torque switches with micrometer adjustment and reference setting indicator.
      1) Assure adjustment variation of approximately 40 percent in torque setting.
   b. Provide switches having rating of not less than 6 A at 120 Vac and 2.2 A at 115 Vdc.
   c. Limit and torque switches shall have totally sealed contacts.
11. Furnish electric actuator with two (2) geared limit switch assemblies with each switch assembly having four (4) separate limit switches. See Owner's standards for monitoring of valve position at the PLC as specified in this Section.
   a. Assure each limit switch assembly is geared to driving mechanism and is independently adjustable to trip at any point at and between the fully open and fully closed valve position.

b. Provide minimum of two (2) normally open contacts and two (2) normally closed contacts at each end of valve travel.
c. Provide switches with inductive contact rating of not less than 6 A at 120 Vac, 3 A at 240 Vac, 1.5 A at 480 Vac, 2.2 A at 115 Vdc and 1.1 A at 230 Vdc.
d. Limit switches shall be fully adjustable when power is applied to actuator.

12. Provide space heating elements sized to prevent condensation in both motor and geared limit switch compartment(s).
    a. Furnish heating elements rated at 120 Vac with heaters continuously energized.
13. Additional requirements for modulating valve actuators:
    a. Proportional position servo-amplifier mounted integral with the actuator control compartment.
    b. Positioning of valve shall be proportional to a 4-20 mA signal input to the position servo-amplifier when remote control has been selected.
    c. Servo-amplifier adjustments shall include zero, span, gain, and dead-band.
    d. Provide 4-20 mA signal position control that interfaces with the position control/position feedback instrumentation wiring to and from THP PLC.

M. Appurtenances:
1. Rupture Discs:
    a. Construction: Disc and holder, 316 stainless steel with Teflon coating.
    b. Set point: 10 percent below upstream pressure safety valve set point.
2. Strainers:
    a. Type: Y-Strainers for process gas.
    b. Construction:
        1) Body: Cast 316 stainless steel.
        2) Perforated screen: 316 stainless steel, 40 mesh.
        3) Ends: Flanged, Class 150.

2.7 INSULATION AND CLADDING

A. The vessels and pipes shall be insulated with mineral/ceramic insulation. Insulation shall be sized to maintain a maximum temperature on the exterior of the cladding below 120 DegF (55 DegC) and shall maintain insulating properties when wet.

B. Cladding shall be provided to cover all insulated pipes and vessels. The cladding shall be made from a blend of aluminum, zinc and silicon. Cladding shall be securely fastened, with no sharp edges. Velcro attached insulated blankets shall be provided where access to pumps, pipe flanges, valves and instruments is required for easy removal and replacement without damage to cladding. Cladding shall be shipped loose and furnished to allow for addition to the piping at the site.

C. Heat tracing shall be provided by Supplier to eliminate the potential for freezing of any lines or instruments furnished herein. Specification for heat tracing system and materials of construction shall be in accordance with Specification Section 40 41 13 – Heat Tracing Cable.

2.8 INSTRUMENTATION AND CONTROLS

A. General:
1. Instruments and control devices shall be provided in accordance with Specification Sections 40 61 13 – Process Control System General Requirements, 40 79 00 – Primary Elements and Transmitters, 40 78 00 – Control Auxiliaries, 40 67 00 – Control System Equipment Panels and Racks, 40 61 43 – Surge Protection Devices for Instrumentation and Control Equipment, 40 63 43 – Programmable Logic Controllers, and 40 62 05 – Computer System hardware and Ancillaries.
2. Provide instruments as required for the proper operation of the THP system, to complement the control system, and to provide feedback to operators on condition of the THP system.
3. Instruments shall be chosen to suit the applicable service and duty.

4. Instrument input/output (I/O) signals shall be gathered in one Programmable Logic Controller (PLC) cabinet.

B. Pressure Transmitters:
   1. Provided for pressure indication and level monitoring.
   2. Provide local display and install as follows:
      a. Steam and air service:
         1) Install with 1/2 IN threaded connection and 1/2 IN double block-and-bleed isolation valves between main line and transmitter. All pressure transmitters on steam and flash steam pipes shall be installed in a hanging position to ensure a liquid phase towards the membrane.
      b. Flash steam service:
         1) Install with 2 IN flanged connection and 2 IN double block-and-bleed isolation valves between main line and transmitter. All pressure transmitters on steam and flash steam pipes shall be installed in a hanging position to ensure a liquid phase towards the membrane.
      c. Solids service:
         1) Install with a 2 IN flanged connection with remote seal and 2 IN isolation valve between the main line and transmitter. Provide Onyx style bladder isolator ring for pressure transmitters in solids service.
      d. Water service:
         1) Install with 2 IN flanged connection and remote seal with 2 IN double block-and-bleed isolation valves between the main line and transmitter.

C. Vessel level monitoring service:
   1. Differential pressure transmitters for level monitoring shall be provided with capillary tube and local display and shall be installed with a 3 IN flanged connection to the vessel.
   2. A flushing ring shall be provided for membrane flushing on liquid side connection.

D. Pressure switches shall be provided between rupture discs and safety relief valves.
   1. Switches shall be installed with a 1/2 IN threaded connection.
   2. Local display and isolation valve will not be provided.

E. Level switches:
   1. Overfill protection: Capacitive/vibrating type level switches will be provided for overfill protection of pulper and flashtank vessels. Level switches shall be installed with 4 IN flanged connections on the vessels. Length of probe shall be equal for both vessels to facilitate interchangeability and provide switching point around upper tan level of vessels.

F. Temperature transmitters shall be provided.
   1. Thermowell shall be provided for installation of temperature transmitters and shall be Type 316 stainless steel.
   2. For temperature transmitters installed in odorous media, thermowells shall have 1 IN flanged connection.
   3. For temperature transmitters installed in other services, thermowells shall have 1/2 IN threaded connection.
   4. Temperature transmitters shall be installed pointing in the direction of the flow, preferably in a bend. If installation in a bend is not possible, the probe shall penetrate into the middle of the pipe for most accurate reading.

G. Flow meters for solids and water shall be electromagnetic type, shall have indication of flow direction (reverse flow digital contact).) Connections shall be flanged for all applications.

H. Electrical Control System:
   1. General: Electrical control system devices shall be provided in accordance with Specification Sections 40 61 13 – Process Control System General Requirements, 40 67 00 – Control System Equipment Panels and Racks, 40 63 43 – Programmable Logic

Controllers and as specified herein. PLC cabinets shall be provided in accordance with the applicable sections of Division 40.

2. The THP Control Panel shall be provided to monitor instruments and control motors, valves, and provide interlocks with other process equipment related to the operation of the THP.
3. Control Panel shall be assembled, tested, approved, and labelled in accordance with UL requirements.
4. The power source to the THP Control Panel shall be 120 volt, single phase. Number of circuits and amperage defined during design.
5. The control panel shall be remotely installed by the Contractor in a nearby electrical room that is conditioned.

I. PLC:
1. PLC and associated devices shall be provided in accordance with Specification Section 40 67 00 – Control System Equipment Panels and Racks, 40 63 43 – Programmable Logic Controllers, and as specified herein.
2. A stand-alone PLC system shall be provided and installed in the THP Control Panel to operate the THP system. The PLC will interface with existing Owner's PCS via Ethernet/IP communication protocol. The PCS will be programmed by the Owner, or by a Contractor selected by the Owner. The PCS shall monitor the PLC and functionality.
3. The data interface between the THP control system and the PCS via Ethernet shall allow the PCS access to all parameters and signals necessary to provide historical data logging, PCS graphical interface development, provide supervisory control, and to provide the ability to adjust supervisory setpoints from the PCS to the PLC. The intent is that the PCS will mirror the graphical interface provided at the PLC control panel. Additionally the PCS will be the long-term data store for THP historical information.
4. The Supplier will be responsible for providing assistance to the Owner's Process Control Group to complete the interface of the THP PLC with the plant PCS. These services are described in Specification Section 01 11 00 – Summary of Work.
    a. The Supplier shall assist the Owner in the integration of the PLC database information into the PCS by supplying a Register Mapping Table of all holding register information after the factory acceptance testing and prior to shipment.
        1) Provide unique tag names for each I/O point. Repeat tag names are not permitted. This shall apply to similar I/O for identical process trains.
        2) Provide electronic spreadsheets for I/O points, instrumentation, and valves.

2.9 ELECTRICAL

A. Cable Tray Systems:
1. Provide tray systems in accordance with Division 26 specifications.
2. Provide cable tray systems for Supplier's cabling requirements on the THP train.
3. Provide the cable trays to the limits of the THP train. These include:
    a. Control and instrumentation cabling from the Supplier's terminal junction boxes.
    b. 480 volt cabling to the equipment on the THP train.
        1) Size the power cable tray in accordance with NFPA 70 (NEC).
    c. 120 volt cabling to control devices associated with the 480 volt equipment.
        1) Size cable tray system to accommodate a 12-conductor No. 14 AWG multi-conductor control cable for each motor location (for local control station, motor space heater, motor temperature switch, etc.). Further coordination during the submittals stage will refine this requirement.

B. Cabling on the THP Train:
1. Provide cabling in accordance with Division 16 specifications.
2. Provide multi-conductor cables for connection of control and instrumentation devices provided by Supplier and located on the THP train to the junction terminal boxes.

C. Terminal Junction Boxes:
1. Provide junction terminal boxes in accordance with Division 16 specifications.

2. Locate junction terminal boxes in readily accessible locations.

D. Heat Tracing Controllers:
   1. Provide the quantity of heat tracing controllers needed for piping with heat trace requirements. Locate controllers in a readily accessible space and in accordance with NFPA 70 (NEC).
   2. Identify heat tracing controller locations in the submittals.

2.10 SERVICES NOT INCLUDED IN SUPPLIER'S SCOPE OF WORK

A. The Contractor shall be responsible for coordination, installation, furnishing all labor, materials, and incidentals shown or inferred, to install, and assistance with complete testing and commissioning of the THP System.

2.11 MAINTENANCE MATERIALS:

A. Furnish Owner the following spare parts:
   1. Pulper feed pumps, pulper circulation/reactor feed pumps, and digester feed pumps, as specified in each narrow scope pump section.
   2. Cambi THP B6-4 Train valves:
      a. One of each steam inlet valve and steam inlet valve repair kit.
      b. One complete valve and actuator of each type and size for automatic valves.
      c. One of each type and size for manual knife gate valves.
      d. One complete set of pressure relief and vacuum breaker valves.
      e. One of each type of positioner for actuated valves.
      f. One of each type and size of limit switch for pneumatic valves.
   3. Valves not mounted directly on the THP Train:
      a. One complete valve and actuator of each type and size for automatic valves.
      b. One repair kit for each type and size.
      c. Pressure transmitter on THS manifold.
   4. Vessel Equipment:
      a. One complete set of rupture discs.
      b. Two of each size of manway gaskets.
      c. Two each of Flash Tank wear nozzles.
      d. One complete set of steam lances for one reactor
   5. Removable Insulation
      a. One insulation blanket of each size provided for flanges, instruments, and pumps.
   6. Instruments and Appurtenances:
      a. One complete instrument per type.
   7. Process Gas Skid:
      a. One gas ejector.

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Equipment shall be delivered and stored in accordance with the Delivery and Storage requirements set forth in Specification Section 01 65 00 – Product Delivery Requirements.

B. Supplier shall be responsible for all costs associated with shipping and delivery of the THP System to the project site. Unloading of equipment at the project site is the responsibility of the Contractor.

C. Prior to shipment, all large shipping modules are to be stretch (shrink) wrapped and sealed using TufCoat. Smaller items are to be fully crated.
   1. PLC, control panels, and instruments, shall be shipped in specially marked and customized containers to protect the sensitive and delicate nature of these devices.
      a. Store in conditioned space.

D. Inspection of the THP system and components will be made by the Supplier, Contractor as well as the Owner's Representative after delivery. Materials shall be subject to rejection at any time for failure to meet any of the specification requirements. Materials rejected after delivery shall be identified and shall be immediately removed from the jobsite or storage facility.

E. Contractor shall store all THP equipment at the Owner's designated area at their respective treatment plant until the equipment is ready to be installed. Means of storage shall be coordinated with the Supplier to ensure continued warranty of the equipment and all associated appurtenances. All costs associated with coordination, receiving and off-loading the THP equipment, and storage to the Owner's designated location at their respective plant shall be included in Contractor's cost.

F. Supplier shall conduct a field inspection to verify the equipment pad foundations and other preparations are complete and ready for the installation of THP train.

3.2 INSTALLATION

A. Installation of the THP train shall be by the Contractor under the supervision of Supplier's qualified factory representative, and in accordance with the Supplier's written installation instructions, having been previously submitted, reviewed and approved by the Owner and Contractor.

B. Supplier's qualified factory representative shall inspect the final installation and supervise the field acceptance tests of the equipment. At a minimum the representative shall complete the following:
   1. Supervise unloading and storage of the THP train equipment and appurtenances.
   2. Inspect installation and make mechanical checks all equipment provided by Supplier.
   3. Submit installation inspection report for completed installation and certify in writing that the systems are properly installed, adjusted, and ready for start-up and testing.

3.3 FACTORY TESTING

A. Control System Factory Acceptance Test (FAT):
   1. FAT shall be conducted for the THP control system.
   2. Testing shall be completed by Supplier and witnessed by the Owner or Owner's Representative and Contractor, prior to shipment of the control panel.
   3. Prior to the shipment of the panel, the factory acceptance test report and preliminary operations and maintenance manuals must be submitted and approved.
   4. Factory Testing: Supplier shall burden all costs for travel and hotel accommodations for the Owner's 2 (two) representatives for factory witnessed acceptance tests.
   5. Submit FAT test plans for approval prior to scheduling the FAT.
      a. Coordinate location and logistics of the FAT with the Owner, and Contractor a minimum of 60 days prior to the date of the FAT.

B. Refer to Specification Section 01 75 00 – Facility and System Start-up for additional requirements for Facility and System Start-up.

3.4 COMMISSIONING AND FIELD TESTING

A. Mechanical Completion Period:
   1. Refer to Specification Section 01 75 00 – Facility and System Start-up for additional requirements of the Mechanical Completion Period.

2. Mechanical Testing:
    a. The following mechanical items must be completed by Supplier and the Contractor prior to preliminary testing on water with steam.
        1) Mechanical and electrical installation checkout.
        2) Supervision of, and participation in, lubricant filling and planning of start-up.
        3) Full check of the THP train before any process fluids are introduced.
        4) Complete hydrostatic testing of all tanks and piping systems.
        5) Verify mechanical components and all instruments are properly installed and configured.
        6) Verify functionality of all control loops.
        7) Work manually through the THP process until ready for automatic operation.
        8) Check all alarm and safety functions.
        9) Supervise and adjust settings for automatic operation.
        10) Work with Contractor's system integrator and Owner Process Control Group to verify all interfaces between the Owner's PCS and THP PLC are in place and functional.
        11) Work with the Contractor's system integrator to complete the Project's field testing requirements.
    b. Mechanical Testing shall be conducted twice: once with the primary Pulper and Flash Tank and associated Pulper Recirculation/Reactor Feed Pumps, and then a second time with the redundant Pulper, Flash Tank and associated Pulper Recirculation/Reactor Feed Pumps.
3. Preliminary Testing with Water and Steam:
    a. Supplier shall coordinate all work with the Contractor.
    b. Testing shall be conducted with steam and disinfected effluent water.
    c. Demonstrate to the Owner the following:
        1) The THP train can process water using steam.
        2) Proper sequence of operation.
        3) All alarms and shutdown functions.
        4) Control loops have been tuned, and that PLC control, functionality, and automatic operation have been achieved.
    d. Preliminary testing with Water and Steam shall be conducted twice: once with the primary Pulper and Flash Tank and associated Pulper Recirculation/Reactor Feed Pumps, and then a second time with the redundant Pulper, Flash Tank and associated Pulper Recirculation/Reactor Feed Pumps.
4. Satisfactory completion of the requirements herein, as demonstrated to the satisfaction of the Owner constitutes Mechanical Completion.

B. Commissioning on Solids Period:
1. Refer to Specification Section 01 75 00 – Facility and System Start-Up for additional requirements of the Commissioning on Solids Period.
2. Commissioning on Solids Period, including functional tests shall be conducted twice: once with the primary Pulper and Flash Tank and associated Pulper Recirculation/Reactor Feed Pumps, and then a second time with the redundant Pulper, Flash Tank and associated Pulper Recirculation/Reactor Feed Pumps.
3. During the Commissioning on Solids period, Supplier shall coordinate all testing on solids in accordance with the following:
    a. Introduce solids feed and steam to the THP.
    b. Introduce solids feed to all reactors in sequence.
    c. Adjust auto operation on solids process feed and steam.
    d. Start up and monitoring during thermally-hydrolyzed solids pumping, feeding and introduction to digesters.
    e. Follow-up and responsible operation during commissioning and first weeks/months of operation.

4. Functional Tests shall be completed during Commissioning on Solids and after Supplier and the Contractor complete all tuning of control loops with process fluids. The tuning that is completed under the functional testing period shall be checked and adjusted while actual process fluids are being used.
    a. Functional tests shall be conducted for at least seven consecutive days.
    b. Process fluids include wastewater solids, steam, process gas streams, and other process fluids moving through the system at flow rates and concentrations that are typical of full-scale operation and current ATP solids production rates.
    c. Supplier will optimize control loops, including dilution loops.
5. During this Commissioning period, Supplier is responsible for all THP system operational controls and adjustments, unless otherwise directed by Owner in writing.
6. During functional testing, the THP system shall be operated in Automatic mode.
7. Once demonstrated to the satisfaction of the Owner and Program Manager, as agreed to in writing by the Owner upon request by the Contractor, Commissioning on Solids shall be considered complete and acceptance testing for the purposes of proving achievement of Performance Guarantees may begin.

C. Acceptance Testing for demonstrating Performance Guarantees:
1. Refer to Specification Section 01 75 00 – Facility and System Start-up for additional requirements of the THP Acceptance Test Period for demonstrating performance guarantees.
2. Performance Guarantees: Supplier and the Contractor shall complete acceptance testing to prove that contractual Performance Guarantees have been achieved. After the Performance Guarantees are achieved, the Contractor and Supplier may request THP Acceptance from the Owner via written request. Should THP Acceptance not be provided, the Owner will provide written notice to the Contractor with the reasons for rejection of the request for THP Acceptance, any required remedies, and a required schedule for completion of the remedies. The Performance Guarantees required for the THP system to achieve THP Acceptance, and corresponding remedies for not achieving the guarantees are identified as follows:
3. General:
    a. Testing shall utilize data collected by the PLC along with separate and independent field-collected (or separately collected) information. If there are discrepancies between data shown in the PLC and separately collected information for the THP systems, Supplier shall reconcile said discrepancies.
    b. Supplier shall either directly collect all data required for the test or confirm that valid data and information is collected by the Owner.
    c. Supplier is responsible to determine that all data and information is collected for each test is properly documented and reported for review. Owner may take duplicate samples at any location for quality control purposes.
    d. Tests shall occur only after digesters are in stable full-time operation with one hundred percent of the Owner's indigenous solids production following being processed through the THP system.
4. THP Peak Solids Throughput (THP PG-1):
    a. Purpose: Demonstrate that the entire THP system can handle and process design capacity solids throughput and flow rates.
    b. Testing for this condition can only be completed for short periods of several hours at a time because the Owner does not normally produce the quantity of solids to operate at this condition at the WPCP.
    c. The THP Peak Solids Throughput test requires two testing periods of time, each 24-hour minimum in duration unless shorter duration is approved by Owner for this full THP throughput guarantee demonstration.
    d. During each test period, Supplier shall show that the THP achieves solids throughput of at least 92.0 dry US tons per day (dtpd).
    e. Prior to each test period, the Owner will dewater a quantity of solids sufficient to fill the Pre-dewatered Cake Storage Bins for the purposes of running the THP Peak Solids

Throughput acceptance testing to demonstrate compliance. The dry solids concentration of the pre-dewatered solids fed to the THP system shall be between 15–18 percent solids, with an average of 16.5 percent solids. The variation in feed solids shall not exceed plus or minus 2 percentage points per hour for the duration of the test period.

f. Supplier shall operate the pulper feed pumps and THP system to complete the acceptance test. Only one pulper feed pump may be operated at a time to demonstrate throughput capacity, with each pump being operated in sequence over the course of the test. Each pulper feed pump shall be operated for at least two hours during the test to demonstrate the pumping capability of each pump.
g. Supplier shall test the THP at the maximum throughput rate for as long as there is available pre-dewatered cake from the bins. The acceptance test shall be run until the pre-dewatered cake storage bin solids levels reach the low level.
h. The Owner may continue solids handling and pre-dewatering activities during the test to continue to fill the pre-dewatered cake bins.
i. Testing duration is contingent on the availability of pre-dewatered solids but shall not exceed 24 hours.
j. Measurement of THP system throughput shall be as defined below.
    1) Throughput quantity will be measured via composite samples of the cake feed material to the THP along with volume processed through the THP reactors, as determined by the quantity of reactor cycles completed during the test and the confirmed working volumes of each reactor.
    2) Supplier shall show that there is no significant storage of solids within the THP during the test, which could affect the throughput calculations, via pressure and flow measurements conducted during the test.
    3) The THP throughput test will show that the required quantity of solids (92 dtpd minimum) is being fed through the pulper feed pumps, THP train, digester feed pumps, and digester feed control valves.
    4) If actual peak throughput cannot be proven (due to inadequate quantity of feedstock), a calculation method can be used by Supplier to confirm system's ability to achieve the peak throughput.
k. This test shall be completed two times to satisfy the requirements.
l. If Supplier fails to meet this THP Throughput performance guarantee, and when the pre-dewatered solids feed available to the THP system meets the required quantity and quality as defined above (hopper full and solids concentration as indicated), the test shall be terminated and Supplier shall be required to recommence the test from the beginning, once the required solids volume is available, and demonstrate the performance guarantees in accordance with these requirements.
m. If, after three attempts at the test, the Supplier is unable to demonstrate the performance guarantee of 92 dtpd, the Supplier shall provide compensation to the Owner of $250,000 for each dry ton of solids up to 92 dtpd not proven processed through the THP.

5. Reactor Time and Pressure (THP PG-2):
    a. This performance guarantee requires that Supplier show that a system is in place for collecting and storing data on every THP reactor batch cycle and show that this system is operating as specified. The data collected for each and every reactor batch cycle shall include as a minimum the following:
        1) Pressure measurement as required during each batch cycle. The pressure shall be a minimum of 87 psi (6 bar) for at least the entire 20-minute minimum time of the retention step in the reactor.
        2) Correlations of pressure with temperature can be used to determine the temperature within the solids that are being processed within the reactor.

b. If the Supplier is unable to demonstrate the performance guarantee, the supplier shall make the necessary modifications to the system and repeat the testing to demonstrate performance guarantees.

6. Class A Pathogen Reduction (THP PG-3):
   a. This performance guarantee requires that the Supplier show that the fecal coliform density in THS discharge is below the Class A biosolids requirement, which is 1000 MPN/gram dry solids or less than 3 Salmonella sp. per 4 grams of total solids (dry weight basis), and as specified in Paragraph 1.3.
   b. Each fecal coliform test is comprised of seven discrete samples, according to EPA requirements, and the geometric mean is taken of the seven samples for reporting the result from each test.
   c. Fecal coliform density samples shall be taken from the THS sample port downstream of the digester feed pumps, after dilution of the THS.
   d. The test shall be completed twice during the testing period. Both such results shall be in compliance to meet this performance guarantee.
   e. Sampling and testing protocol shall take into account for the needs for sampling pathogen-free materials.
   f. If the Supplier is unable to demonstrate the performance guarantee, the supplier shall make the necessary modifications to the system and repeat the testing to demonstrate performance guarantees.
7. THS Flow Control (THP PG-4):
   a. This performance guarantee requires that the Supplier show that the THS flow control valves (FCVs) and flow meters are accurately calibrated and controlled to provide the manually-input flow split between the in-service valves. Demonstrated accuracy between the valves must be within ±5 percent, as shown on the THS flow meters.
   b. When the percent feed to the valves in service are changed in the THP PLC, the THP PLC will automatically adjust the THS feed flow split accordingly and shall demonstrate the desired split is stably maintained for a minimum duration of one hour between changes in percent feed.
   c. Demonstrate that the required flow split is maintained through changes in the total solids throughput through the THP system. Minimum time required to demonstrate stable flow split is one hour between changes in flow split.
   d. The readout from the installed THS flow meters will be used to demonstrate the accuracy of the flow split. Prior to the testing, the THS flow meters will be independently tested and calibrated at the Supplier's expense. Certification of calibration shall be provided to Owner prior to testing.
   e. The duration of this test will be eight hours, with up to six changes in the flow split between the flow control valves.
   f. If, at the time of the test, the demonstrated accuracy is not within the guaranteed value, the test shall be terminated and Supplier shall be required to recommence the test from the beginning, and demonstrate the performance guarantees in accordance with these requirements.
   g. If, after three attempts at the test, the Supplier is unable to demonstrate the Performance Guarantee, the Supplier shall make the necessary modifications to the system controls up to and including the replacement of the flow control valves and/or actuators and resume the testing to demonstrate performance guarantees.
8. Steam Usage (THP PG-5):
   a. The test procedure for the steam consumption guarantee is detailed in the "Cambi Steam Consumption Guarantee" document, included as Appendix A.
   b. A condition of this guarantee and test is that the feed solids to the THP must have a dry solids concentration 15-18 percent, with an average of 16.5 percent solids.
   c. This performance guarantee requires that Supplier show that steam usage per ton of dry solids throughput will not exceed the pre-determined guarantee values defined in the

table below, as determined by the testing and analyses defined in the "Cambi Steam Consumption Guarantee."

Solids Temperature (DegC)	Kg steam per m^3 pulper feed[1]	Tons steam per ton of dry solids[1]
10	182	1.10
15	174	1.05
20	164	1.00

1. THP dry solids concentration is 15-18 percent, with an average of 16.5 percent solids.

d. Supplier shall guarantee a not-to-exceed instantaneous steam demand of 4.4 tons per hour.
e. The duration of this test shall be a minimum of four hours and shall not exceed 24 hours.
f. If, at the time of the test, the steam demand exceeds the guaranteed value, the test shall be terminated and Supplier shall be required to recommence the test from the beginning, and demonstrate the Performance Guarantees in accordance with these requirements.
g. If, after three attempts at the test, the Supplier is unable to demonstrate the performance guarantee of 1.0 tons steam consumed per ton of dry solids throughput at 20 DegC as shown in the table above, the supplier shall provide compensation to the Owner of $400,000 for each 0.1 tons of steam per dry ton of solids.

3.5 FIELD QUALITY CONTROL

A. Comply with requirements of Specification Section 01 75 00 – Facility and System Start-up and Specification Section 01 61 03 - Equipment - Basic Requirements.

B. Supplier shall provide a qualified field service technician to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise pre-start adjustments and installation checks.
   3. Conduct initial start-up of equipment and perform operational checks.
   4. Provide training of Owner's personnel as specified in Specification Section 01 75 00 – Facility and System Start-up.

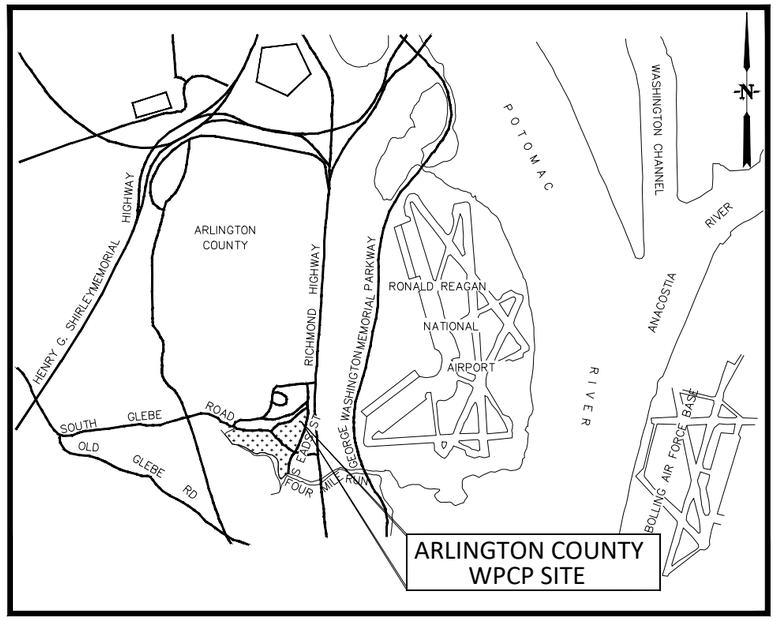
END OF SECTION

ARLINGTON COUNTY, VIRGINIA
WATER POLLUTION CONTROL PLANT

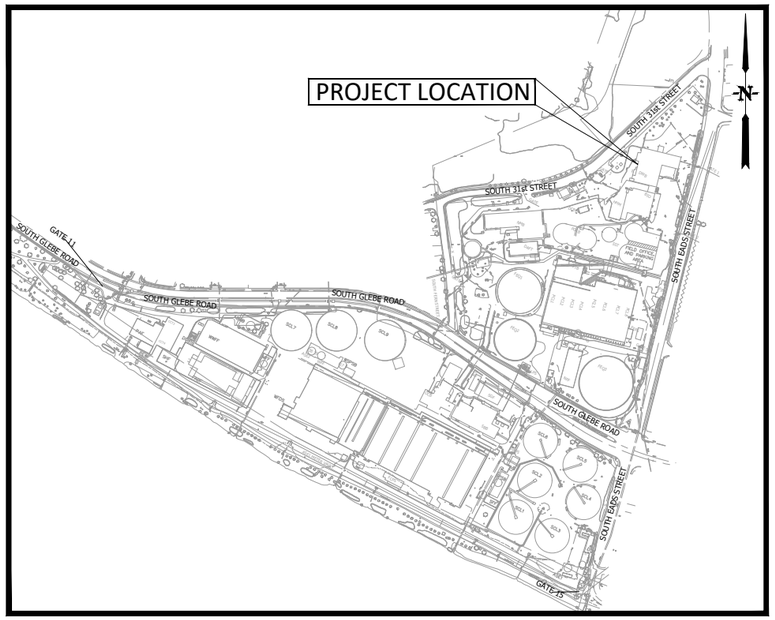
ARLINGTON WATER POLLUTION CONTROL PLANT
PHASE 10B
BIOSOLIDS UPGRADES
THERMAL HYDROLYSIS PROCESS EQUIPMENT PRE-QUALIFICATION

VOLUME 2 OF 2

SEPTEMBER 2023



VICINITY MAP



LOCATION PLAN

DRAWING LIST

DRAWING 1	COVER SHEET
DRAWING 2	GENERAL LEGEND AND SYMBOLS
DRAWING 3	OVERALL PROCESS FLOW DIAGRAM 1
DRAWING 4	OVERALL PROCESS FLOW DIAGRAM 2
DRAWING 5	THP PROCESS FLOW DIAGRAM 1
DRAWING 6	THP PROCESS FLOW DIAGRAM 2
DRAWING 7	RENOVATE DEWATERING BUILDING - SITE PLAN
DRAWING 8	DECOMMISSION DEWATERING BUILDING SITE PLAN
DRAWING 9	DECOMMISSION DEWATERING BUILDING-SOLIDS PROCESSING BUILDING PLAN AT EL 24.00
DRAWING 10	DECOMMISSION DEWATERING BUILDING SECTION 1
DRAWING 11	DECOMMISSION DEWATERING BUILDING SECTION 2
DRAWING 12	THERMAL HYDROLYSIS PROCESS PLAN

OWNER:

ARLINGTON COUNTY WPCP
3402 S. GLEBE ROAD
ARLINGTON, VA 22202

GENERAL SYMBOLOGY

ARROW INDICATES DIRECTION OF TRUE/PLAN NORTH

N

PLAN

1/4" = 1'-0"

PLAN TITLE

SECTION LETTER

FLAG INDICATES DIRECTION OF SECTION CUT

X"
XXX

SHEET WHERE SECTION IS LOCATED

SECTION CUT MARKER

SECTION LETTER

X
XXX

SECTION

3" = 1'-0"

SHEET WHERE DETAIL WAS CALLED OUT *

SECTION TITLE

DETAIL NUMBER

#
XXX

SHEET WHERE DETAIL IS LOCATED *

DETAIL MARKER

FOR REFERENCING DETAILS INCLUDED IN DRAWING SET.

XXXXXXXXX

DETAIL MARKER

FOR REFERENCING DETAILS BOUND IN SPECIFICATIONS OR SEPARATE VOLUME.

DETAIL NUMBER

X
XXX

DETAIL

3" = 1'-0"

SHEET WHERE DETAIL WAS CALLED OUT *

DETAIL TITLE

ELEVATION NUMBER

X
XXX

ARROW INDICATES POINT OF VIEW

SHEET WHERE ELEVATION IS LOCATED *

SINGLE ELEVATION OR PHOTO MARKER

ELEVATION NUMBER

A
D
X
XXX
B
C

ARROW INDICATES POINT OF VIEW ELEVATION

INDICATES SHEET WHERE ELEVATION IS LOCATED

MULTIPLE ELEVATION OR PHOTO MARKER

ELEVATION IDENTIFICATION NUMBER

X
XXX

ELEVATION

3" = 1'-0"

SHEET WHERE POINT OF VIEW MARKER CAN BE FOUND *

ELEVATION TITLE

* EXCEPTIONS WHERE THE SHEET NUMBER IS REPLACED BY A DASH (-).

1) FOR COMMON DETAILS, SECTIONS, ELEVATIONS OR DETAILS THAT ARE CUT OR CALLED OUT ON MULTIPLE SHEETS.
2) SECTIONS, ELEVATIONS OR DETAILS THAT ARE LOCATED ON THE SAME SHEET THEY ARE CUT OR CALLED OUT ON.

GENERAL LEGEND AND SYMBOLS NOTES:

1. THIS SHEET IS A STANDARD SHEET SHOWING COMMON SYMBOLOGY. NOT ALL SYMBOLS ARE NECESSARILY USED ON THIS PROJECT.
2. SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE-EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK. REFER TO CONTEXT OF EACH SHEET FOR USAGE.

TARGET ELEVATION

ARCHITECTURAL

ROOM NAME
XX-XX — ROOM NUMBER

XXX — DOOR NUMBER

A — COLUMN GRID LINE

X — WALL TYPE

KEY NOTE DESIGNATION

KEY NOTE NUMBER

#

EQUIPMENT SYMBOLOGY

ARCHIMEDES SCREW

CENTRIFUGE

CENTRIFUGAL PUMP

CHEMICAL FEED PUMP

COMPRESSOR

DOUBLE DISC POSITIVE DISPLACEMENT PUMP

GRINDER

HEAT EXCHANGER

RADIATOR

U-TUBE HEAT EXCHANGER

TUBE IN TUBE HEAT EXCHANGER

MIXER - PROPELLER TYPE

M OR M — MOTOR

PLATE TYPE HEAT EXCHANGER

PROGRESSING CAVITY PUMP

EQUIPMENT SYMBOLOGY

ROTARY LOBE PUMP

POSITIVE DISPLACEMENT PUMP

INCLINED BELT CONVEYOR

SCREW CONVEYOR

SHELL AND TUBE TYPE HEAT EXCHANGER

SLUDGE GATE / WEIR GATE

M — VERTICAL TURBINE CAN PUMP

EDUCTOR

SOLIDS SCREEN

POSITIVE DISPLACEMENT BLOWER

PIPING AND VALVE SYMBOLOGY

BALL VALVE (NORMALLY OPEN)

BALL VALVE (NORMALLY CLOSED)

BUTTERFLY VALVE

DIAPHRAGM VALVE

GATE VALVE

GLOBE VALVE

KNIFE GATE VALVE

NEEDLE VALVE

PINCH VALVE

PLUG VALVE

THREE WAY BALL VALVE

THREE WAY PLUG VALVE

BALL CHECK VALVE

CHECK VALVE

DOUBLE DISK CHECK VALVE

CONE VALVE

OR — PRESSURE RELIEF VALVE

PRESSURE REDUCING VALVE

X — AIR RELEASE VACUUM VALVE
A = AIR RELEASE
V = VACUUM

AIR RELEASE VALVE

PRESSURE REGULATING VALVE

BACK PRESSURE VALVE

S — SOLENOID VALVE

PIPING AND VALVE SYMBOLOGY

36"-RWI — TYPICAL PIPE LINE CALLOUT

OA DAMPER

BACKFLOW PREVENTER

M — FLOW METER

NGM — NATURAL GAS METER

UNION

WYE-STRAINER

FLEXIBLE HOSE OR TUBING

FLEXIBLE PIPING CONNECTION

LINE SIZE CHANGE

LINE TURNING DOWN

LINE TURNING UP

BLIND FLANGE

PIPE BREAK

V-PORT BALL VALVE

THREE-WAY CONTROL VALVE

3-WAY VALVE

4-WAY VALVE

CALIBRATION POT

BASKET STRAINER

QUICK CONNECT

PNEUMATIC ACTUATOR

SUCTION DIFFUSER-STRAINER

PUMP DISCHARGE (TRIPLE DUTY) VALVE

THERMOSTATIC MIXING VALVE

INJECTION RING

PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)

PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)

PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)

PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)

PIPE JOINT (SEE SPECIFICATIONS FOR REQUIREMENTS)

COMPRESSION SLEEVE TYPE COUPLING

FLANGED COUPLING ADAPTER (FCA)

FLEXIBLE CONNECTION

HARNESSED MECHANICAL COUPLING

EXPANSION COUPLING/JOINT

PRESSURE GAUGE (WITH COCK)

TRAP

QUICK DISCONNECT CAM & GROOVE COUPLING

CAP OR PLUG

CO — INTERIOR CLEANOUT

HOSE BIBB -1

HOSE BIBB -2

HR — HOSE REEL

FD-X — FLOOR DRAIN

X = TYPE DESIGNATED IN SPECIFICATIONS

PIPE IN SECTION

BU — BELL UP (PLAN)

BU — BELL UP (SECTION OR SCHEMATIC)

D — DRAIN (SECTION OR SCHEMATIC)

RUPTURE DISK

SPRING-OPPOSED SINGLE-ACTING PNEUMATIC CYLINDER

NOTE:
1. VALVES SHOWN AS BLACK /SOLID ARE TO INDICATE NORMALLY CLOSED VALVES.

ABBREVIATIONS

AS	AIR SUPPLY
APPROX	APPROXIMATELY
BBD	BOILER BLOWDOWN
BCT	BOILER CHEMICAL TREATMENT
BFP	BELT FILTER PRESS
BFW	BOILER FEED WATER
BM	BENCHMARK, BEAM
BMP	BEST MANAGEMENT PRACTICES
BYP	BYPASS
CA	COMPRESSED AIR
℄	CENTERLINE
CCK	CAKE
CCT	CENTRATE
CHEX	COOLING HEAT EXCHANGER
CHH	COMMUNICATION OR CONTROL HANDHOLE
CHP	COMBINED HEAT AND POWER
CIP	CAST-IN-PLACE
CIRC	CIRCULATION, CIRCULAR
CKT	CIRCUIT
CL	CENTERLINE, CLASS, CLOSE
CONC	CONCENTRATION, CONCENTRATED, CONCRETE
COND	CONDENSATE
COW	COUNTY WATER
CUYD	CUBIC YARD
CWR	COOLING WATER RETURN
CWS	COOLING WATER SUPPLY
DEG	DEGREE
DEG C	DEGREE CENTIGRADE
DEG F	DEGREE FAHRENHEIT
Ø	DIAMETER
DG	DIGESTER GAS
DN	DOWN
DR	DRAIN
DS	DIGESTED SLUDGE
DSR	DIGESTED SLUDGE RECYCLE
DSRF	DIGESTED SLUDGE RECYCLE PLUS FEED
DTON	DRY TON
DW	DILUTION WATER
EH	ENGINE EXHAUST
EL	ELEVATION
EX, EXIST	EXISTING
EXH	EXHAUST
F	DEGREES FAHRENHEIT
FA	FOUL AIR
FAD	FOUL AIR DUCT
FFE	FINISHED FLOOR ELEVATION
FG	FINISHED GRADE
FH	FIRE HYDRANT
FIT	FLOW INDICATING TRANSMITTER
FL	FLOOR
FLA	FULL LOAD AMPERES
FLT	FILTRATE
FM	FLOW METER, FORCE MAIN
FS	FLASH STEAM
GEN	GENERAL, GENERATOR
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
GTI	GRAVITY THICKENER INFLUENT
GTO	GRAVITY THICKENER OVERFLOW
HB	HOSE BIB
HDG	HIGH PRESSURE DIGESTER GAS
HEX	HEXAGONAL, HEAT EXCHANGER
HOA	HAND/OFF/AUTO
HOR	HAND/OFF/REMOTE
HT - LOOP	HIGH TEMPERATURE LOOP (JACKET WATER)
IN	INCH
INF	INFLUENT
IN WC	INCHES WATER COLUMN
LB/D	POUNDS PER DAY
LBVS	POUND OF VOLATILE SOLIDS
LE	LEVEL ELEMENT
LIT	LEVEL INDICATING TRANSMITTER
LO	LOADOUT
LOD	LIMITS OF DISTURBANCE
LS	LEVEL SWITCH, LIMIT SWITCH
LSH	LEVEL SWITCH
L-STOP	LOCAL STOP
LSL	LEVEL SWITCH LOW
LT - LOOP	LOW TEMPERATURE LOOP (AFTER COOLER)
MCC	MOTOR CONTROL CENTER
MFR	MANUFACTURER
MG	MILLION GALLONS
mg/L	MILLIGRAMS PER LITER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE, METAL HALIDE, MOUNTING HEIGHT
MIN	MINIMUM
MISC	MISCELLANEOUS
MOV	MOTOR OPERATED VALVE
MPC	MEDIUM PRESSURE CONDENSATE
MPS	MEDIUM PRESSURE STEAM
MW	MAKE UP WATER
N/A	NOT APPLICABLE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NG	NATURAL GAS (NG)
NGM	NATURAL GAS METER
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN, NUMBER
NOS	NUMBERS
NTS	NOT TO SCALE
NaOH	SODIUM HYDROXIDE
OA	ODOROUS AIR
OCS	ODOR CONTROL STATION
OFLW	OVERFLOW
ORP	OXIDATION REDUCTION POTENTIAL
OVRF	OVERFLOW
PD	PLANT DRAIN
PDS	DIFFERENTIAL PRESSURE SWITCH
PDSH	DIFFERENTIAL PRESSURE SWITCH HIGH
PDSL	DIFFERENTIAL PRESSURE SWITCH LOW
PEW	PLANT EFFLUENT WATER
PG	PROCESS GAS
PGCON	PROCESS GAS CONDENSATE
PGU	PROCESS GAS UNIT
PIT	PRESSURE INDICATING TRANSMITTER
PL	PROPERTY LINE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PMP	PUMP
PNL	PANEL
POLY	POLYMER
POLYS	POLYMER SOLUTION
PS	PIPE SUPPORT, PRESSURE SWITCH, PUMP STATION, PRIMARY SLUDGE
PSH	PRESSURE SWITCH HIGH
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSIG	POUNDS PER SQUARE INCH GAGE
PSL	PRESSURE SWITCH LOW
PW	POTABLE WATER
Q	RATE OF FLOW
QTY	QUANTITY
RAS	RETURN ACTIVATED SLUDGE
RG	RAW GAS
RNG	RENEWABLE NATURAL GAS
RDB	RENOVATE DEWATERING BUILDING
SCE	SECONDARY CLARIFIER EFFLUENT
SC	SCUM
SCFM	STANDARD CUBIC FEET PER MINUTE
SDS	STORED DIGESTED SOLIDS
SEPT	SEPTAGE
SHC	SODIUM HYPOCHLORITE
SL	SLUDGE
SST	STAINLESS STEEL
STD	STANDARD
STL	STEEL
STS	SCREENED THICKENED SLUDGE
TBD	TO BE DETERMINED
T/GRADE	TOP OF GRADE
THP	THERMAL HYDROLYSIS PROCESS
THPF	THERMAL HYDROLYSIS FEED (SOLIDS CAKE)
THS	THERMALLY HYDROLYZED SLUDGE
THSR	THERMALLY HYDROLYZED SOLIDS RECYCLE
TIT	TEMPERATURE INDICATING TRANSMITTER
	THICKENED SOLIDS, TEMPERATURE SWITCH
TPS	THICKENED PRIMARY SLUDGE
TSH	TEMPERATURE SWITCH HIGH
TSL	TEMPERATURE SWITCH LOW
TS	THICKENED SLUDGE
TSS	TOTAL SUSPENDED SOLIDS
TWAS	THICKENED WASTE ACTIVATED SLUDGE
TYP	TYPICAL
UG	UNDERGROUND
UNO	UNLESS NOTED OTHERWISE
UON	UNLESS OTHERWISE NOTED
W/O	WITHOUT
WAS	WASTE ACTIVATED SLUDGE
WSE	WATER SURFACE ELEVATION
YH	YARD HYDRANT

ABBREVIATION NOTES:

1. THESE ABBREVIATIONS APPLY TO THE ENTIRE SET OF DRAWINGS.
2. LISTING OF ABBREVIATIONS DOES NOT IMPLY THAT ALL ABBREVIATIONS ARE USED IN THE DRAWINGS.

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

THERMAL HYDROLYSIS
PROCESS EQUIPMENT
PRE-QUALIFICATION
NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

GENERAL LEGEND AND SYMBOLS

0 — 1" — 2"

FILENAME: Drawing 2.dwg
SCALE: NOT TO SCALE

SHEET
DRAWING 2

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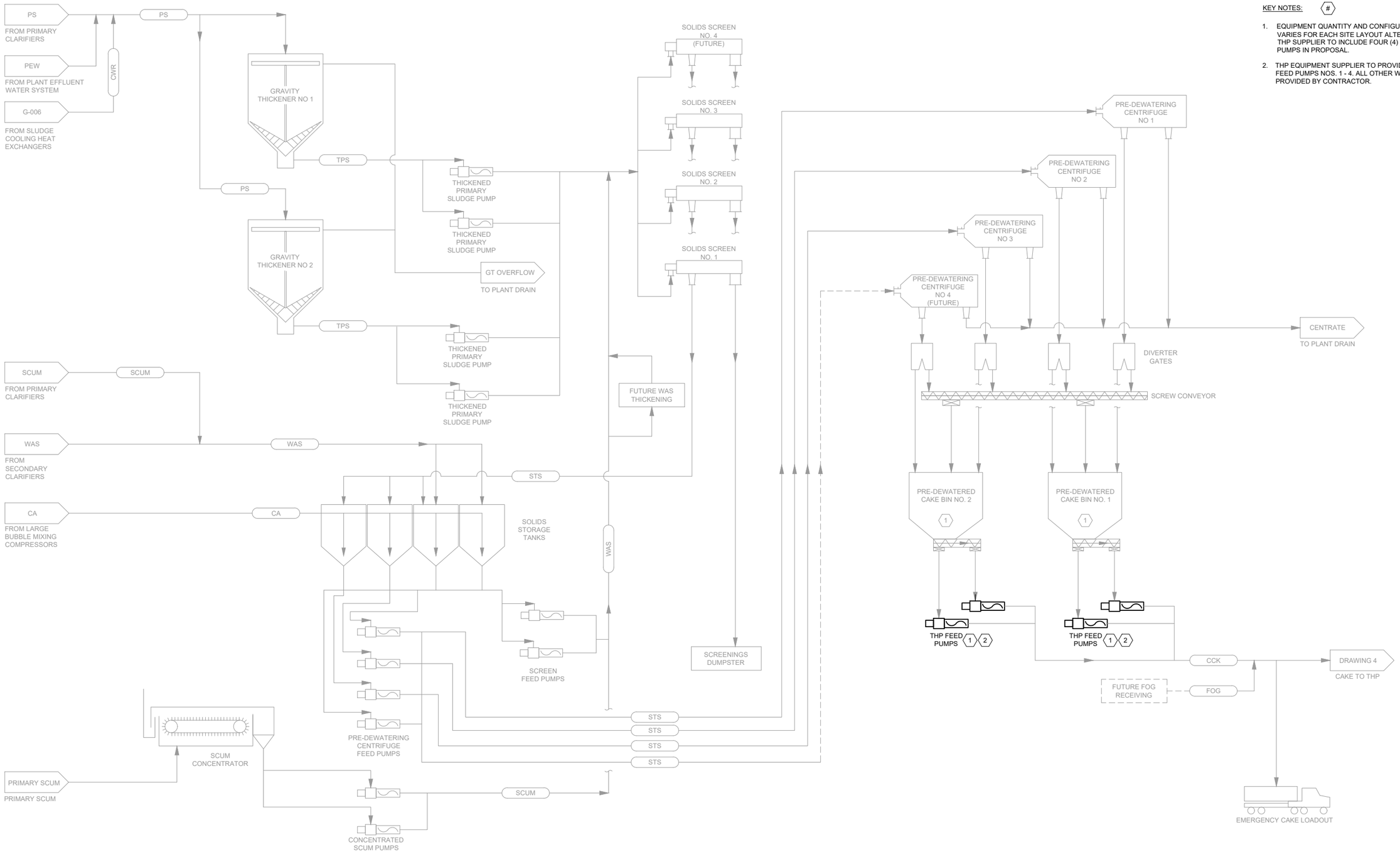

KEY NOTES: (#)

1. EQUIPMENT QUANTITY AND CONFIGURATION VARIES FOR EACH SITE LAYOUT ALTERNATIVE. THP SUPPLIER TO INCLUDE FOUR (4) THP FEED PUMPS IN PROPOSAL.
2. THP EQUIPMENT SUPPLIER TO PROVIDE THP FEED PUMPS NOS. 1 - 4. ALL OTHER WORK TO BE PROVIDED BY CONTRACTOR.

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THERMAL HYDROLYSIS PROCESS EQUIPMENT PRE-QUALIFICATION NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

OVERALL PROCESS FLOW DIAGRAM 1

0 1" 2"

FILENAME Drawing 3.dwg

SCALE NOT TO SCALE

SHEET **DRAWING 3**

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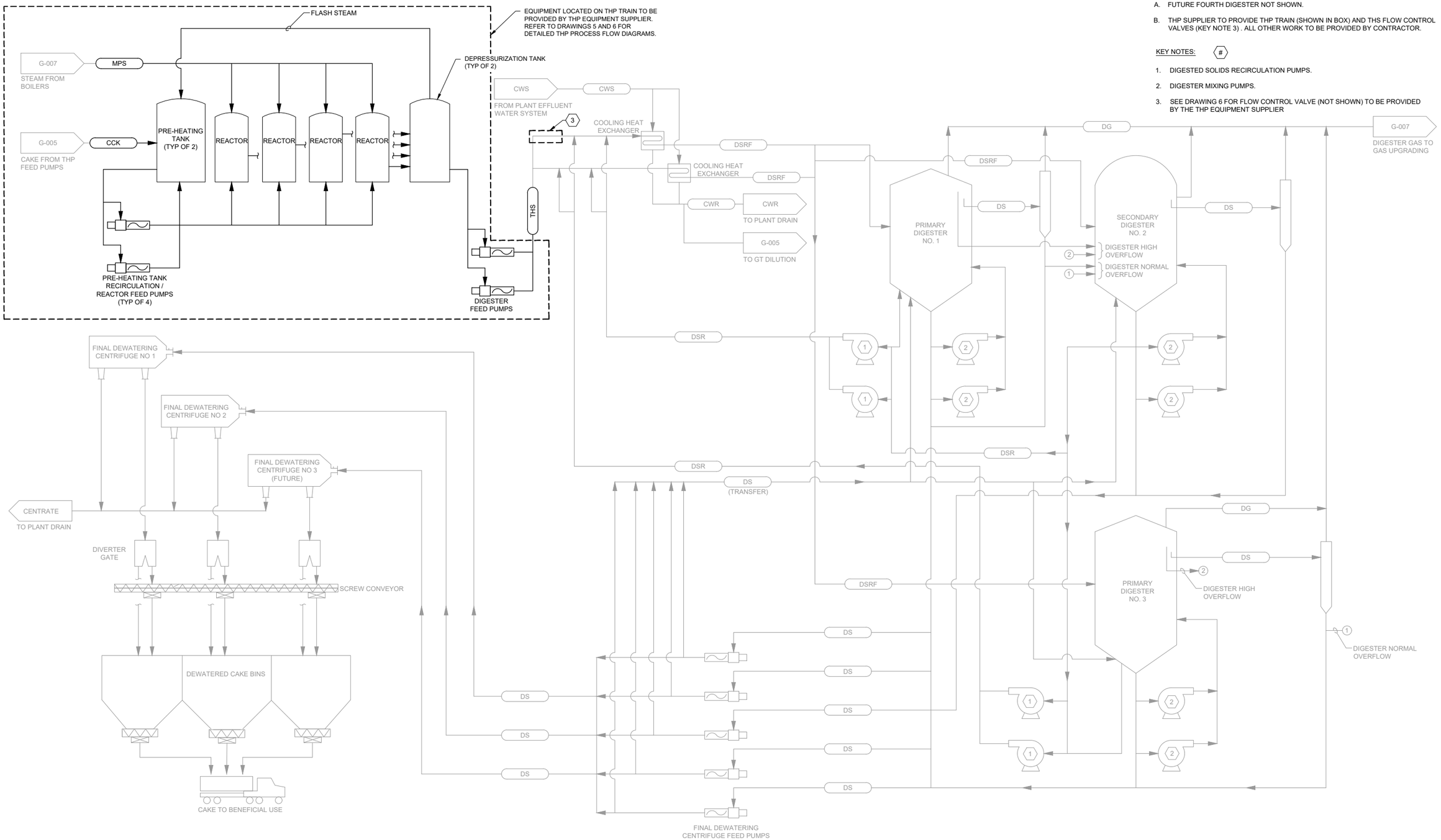
GENERAL NOTES:

A. FUTURE FOURTH DIGESTER NOT SHOWN.

B. THP SUPPLIER TO PROVIDE THP TRAIN (SHOWN IN BOX) AND THS FLOW CONTROL VALVES (KEY NOTE 3) . ALL OTHER WORK TO BE PROVIDED BY CONTRACTOR.

KEY NOTES: (#)

1. DIGESTED SOLIDS RECIRCULATION PUMPS.
2. DIGESTER MIXING PUMPS.
3. SEE DRAWING 6 FOR FLOW CONTROL VALVE (NOT SHOWN) TO BE PROVIDED BY THE THP EQUIPMENT SUPPLIER



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THERMAL HYDROLYSIS PROCESS EQUIPMENT PRE-QUALIFICATION NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

OVERALL SOLIDS PROCESS FLOW DIAGRAM 2

0 1" 2"

FILENAME Drawing 4.dwg

SCALE NOT TO SCALE

SHEET **DRAWING 4**

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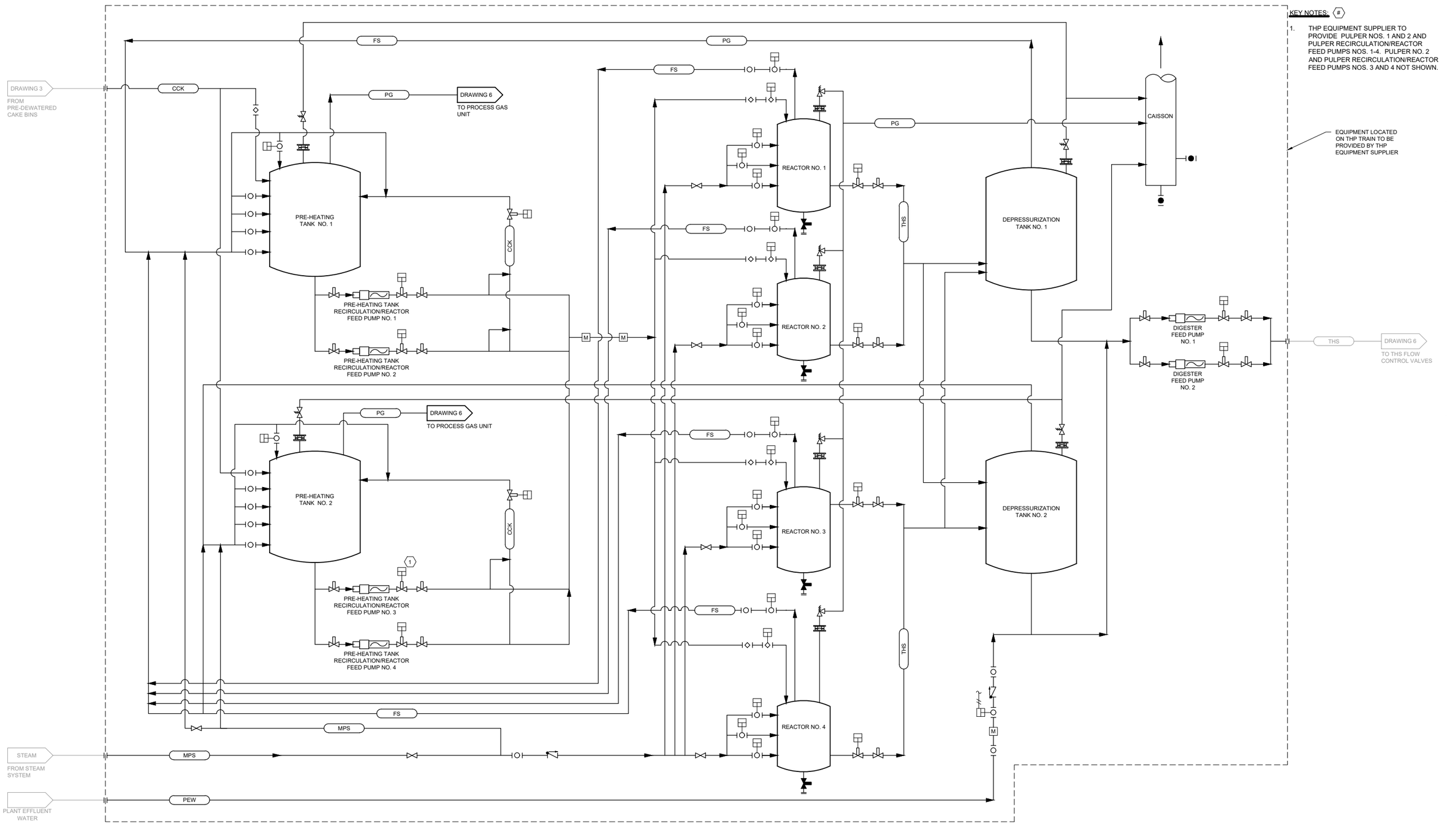

PROJECT MANAGER	BALCHUNAS, BRIAN		
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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

THP PROCESS FLOW DIAGRAM 1

0 1" 2"

FILENAME Drawing 5.dwg

SCALE NOT TO SCALE

SHEET **DRAWING 5**

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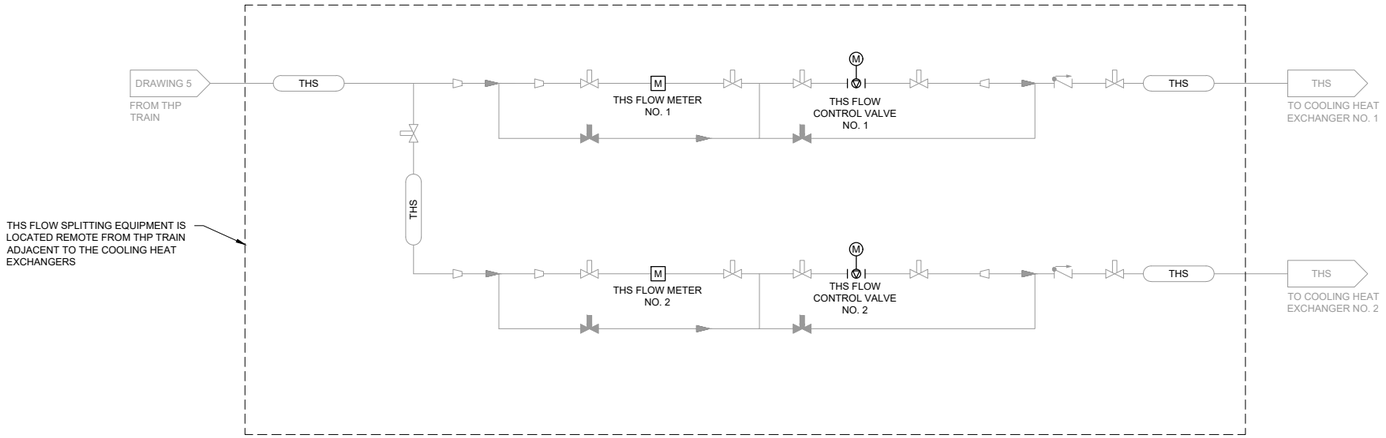
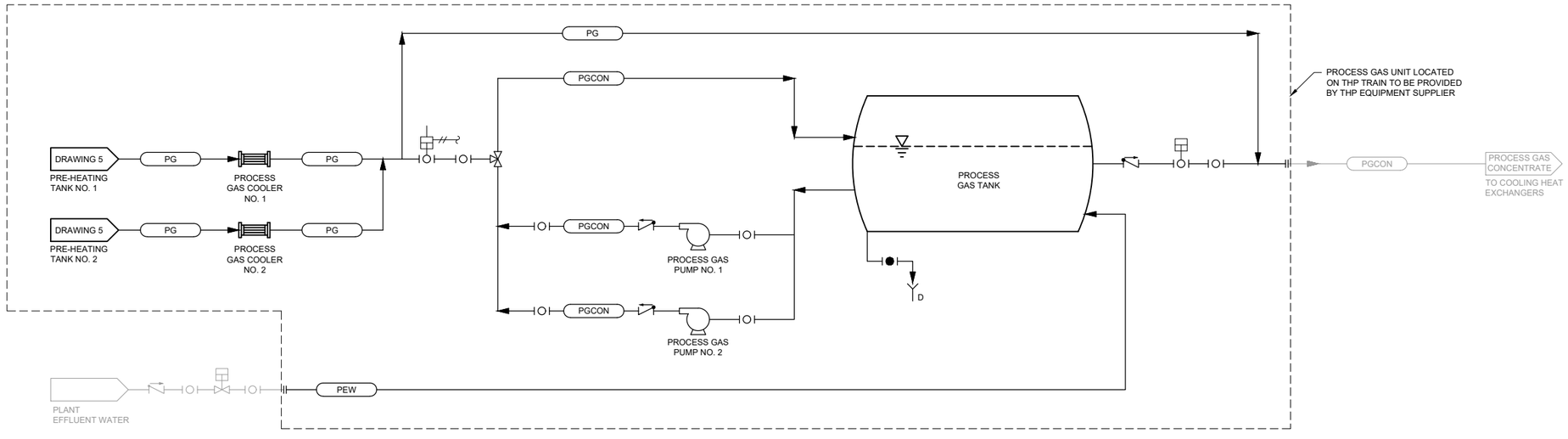


GENERAL NOTES:

1. THS FLOW METER NOS. 1 AND 2 AND THS FLOW CONTROL VALVE NOS. 1 AND 2 TO BE PROVIDED BY THP EQUIPMENT SUPPLIER. ALL OTHER ASSOCIATED PIPING AND VALVES TO BE SUPPLIED BY THE CONTRACTOR.



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THERMAL HYDROLYSIS PROCESS EQUIPMENT PRE-QUALIFICATION NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

THP PROCESS FLOW DIAGRAM 2

0 1" 2"

FILENAME Drawing 6.dwg

SCALE NOT TO SCALE

SHEET

DRAWING 6

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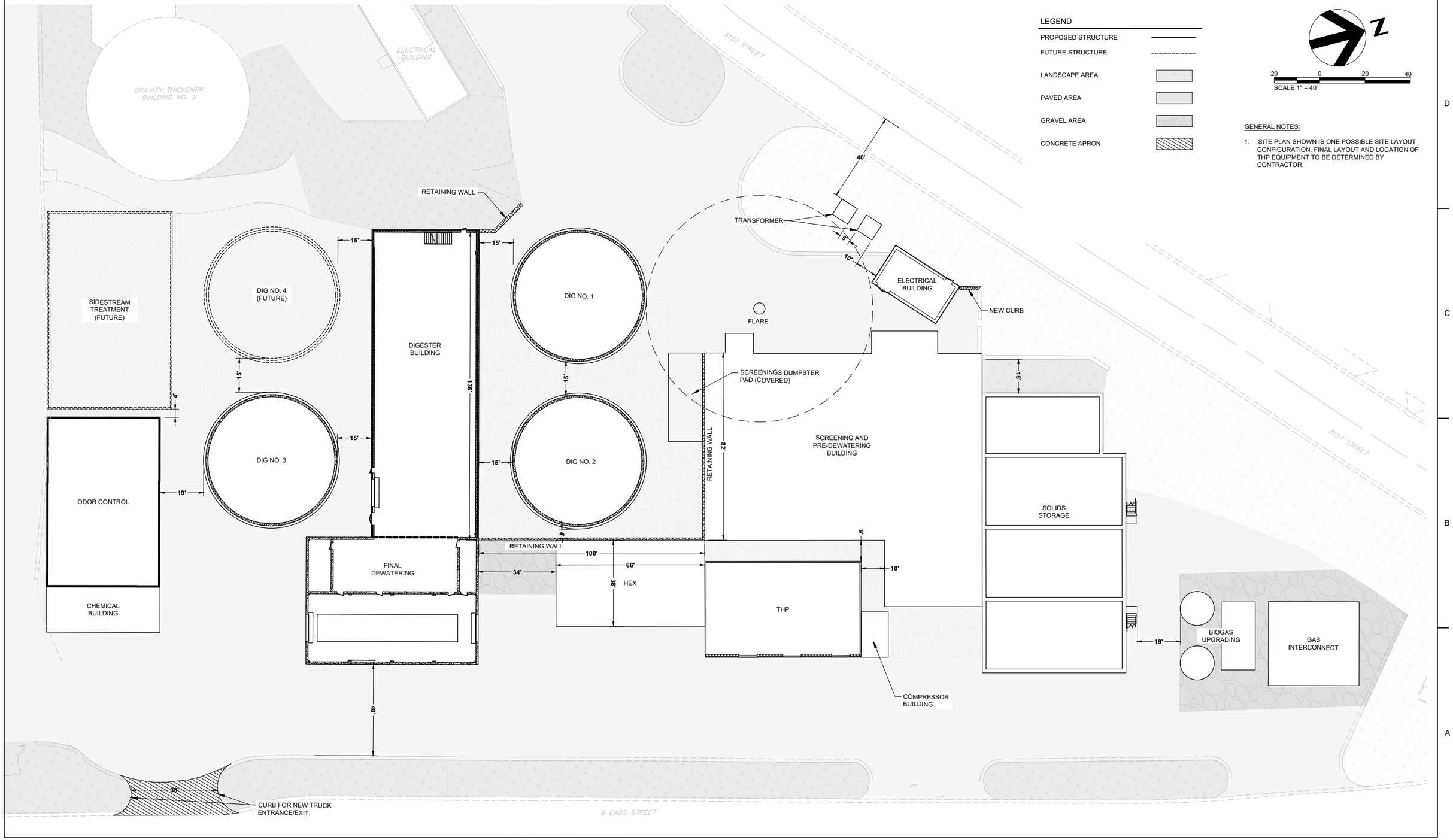

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ISSUE DATE DESCRIPTION

THERMAL HYDROLYSIS PROCESS EQUIPMENT PRE-QUALIFICATION NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

RENOVATE DEWATERING BUILDING SITE PLAN

0 1" 2"

FILENAME Drawing 7.dwg

SCALE 1"=40'

SHEET **DRAWING 7**

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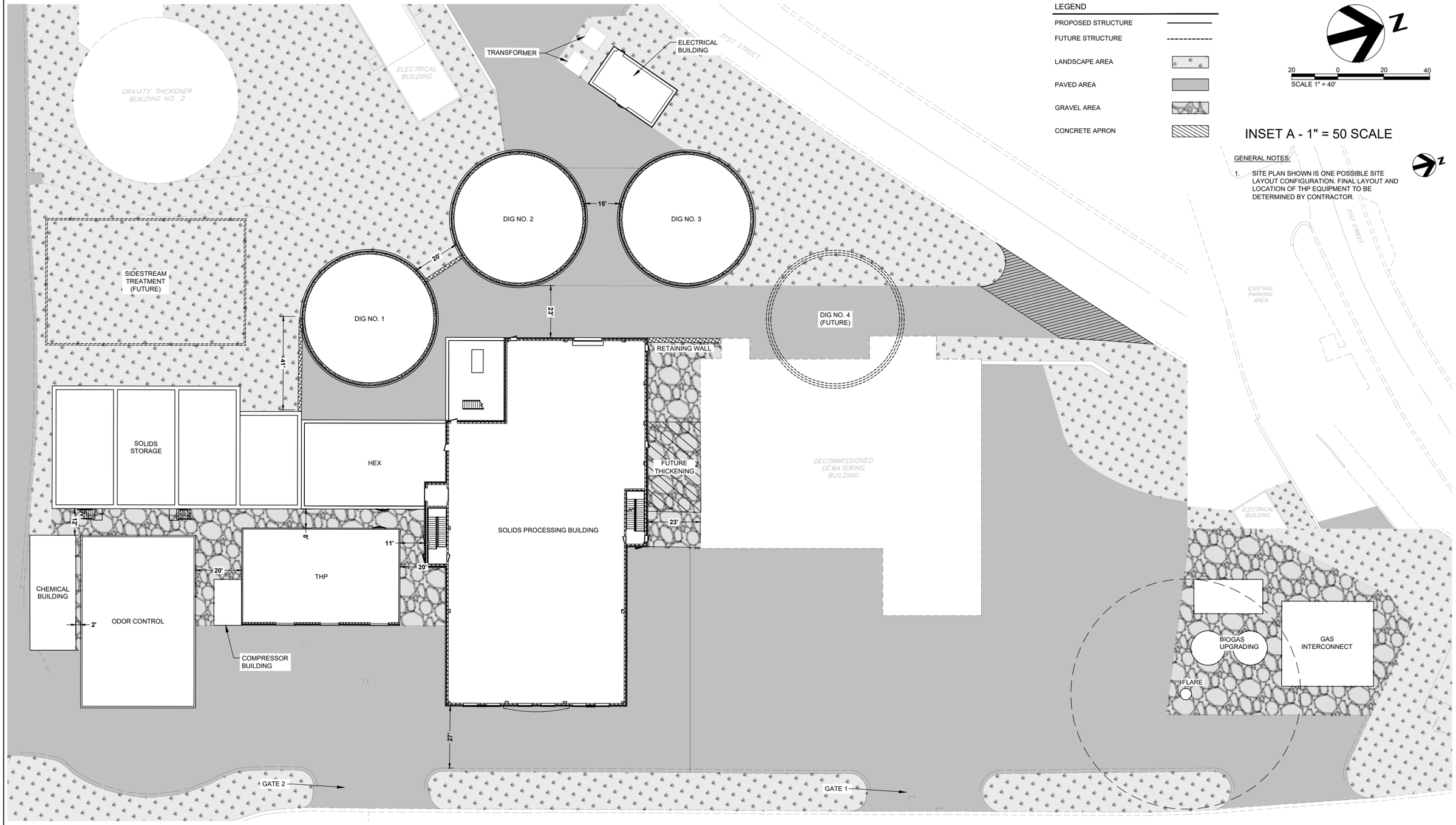

PROJECT MANAGER	BALCHUNAS, BRIAN	
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ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

DECOMMISSION DEWATERING BUILDING SITE PLAN

0 1" 2"

FILENAME	Drawing 8.dwg
SCALE	1"=40'

SHEET
DRAWING 8

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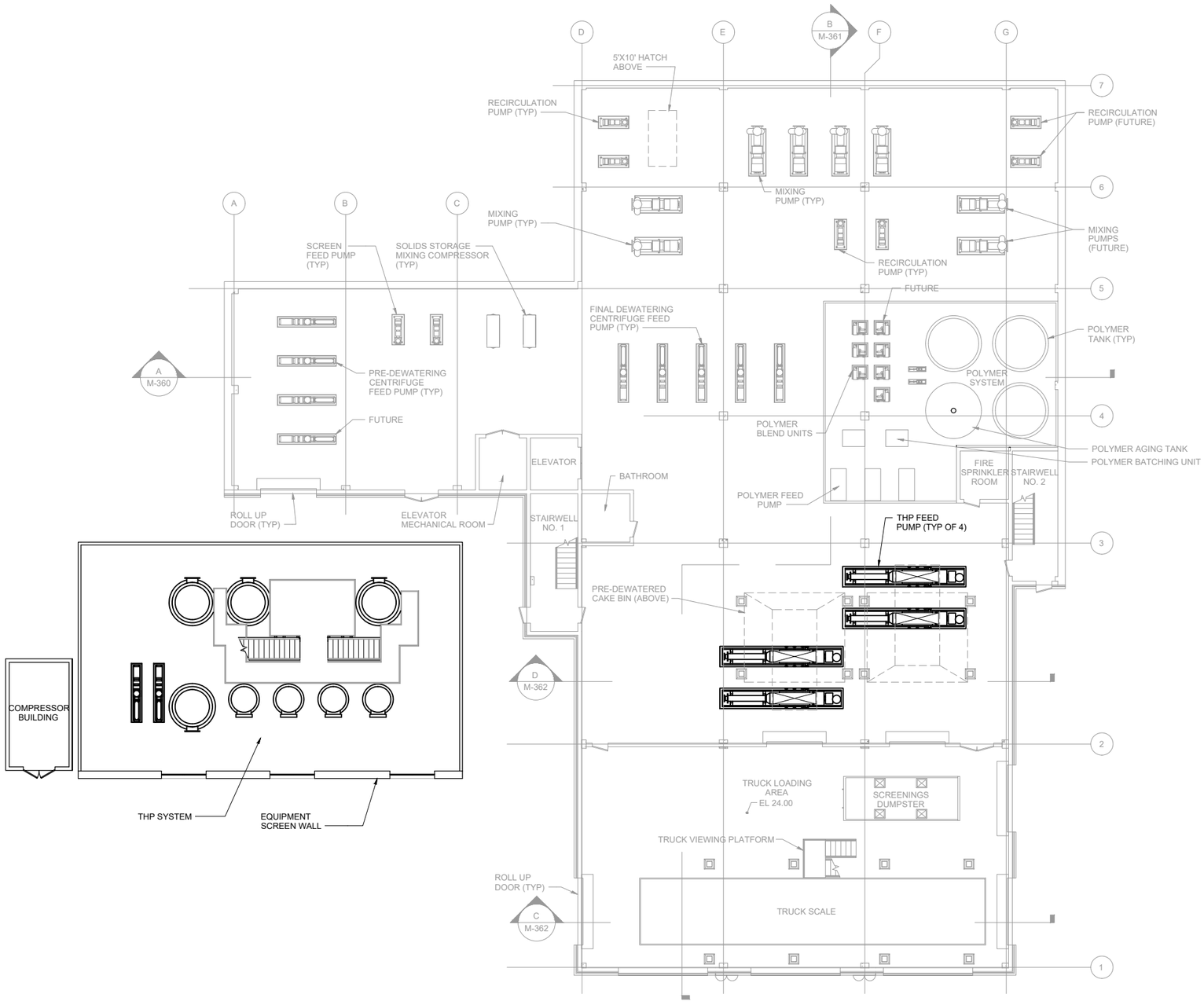


PLAN AT EL 24.00

3/32" = 1'-0"

GENERAL NOTES:

1. EQUIPMENT LAYOUT SHOWN IS ONE POSSIBLE CONFIGURATION. FINAL LAYOUT AND LOCATION OF THP SYSTEM AND THP FEED PUMPS TO BE DETERMINED BY CONTRACTOR.
2. THP FEED PUMP NOS. 1-4 AND THP SYSTEM TO BE PROVIDED BY THP EQUIPMENT SUPPLIER. ALL OTHER WORK TO BE PROVIDED BY CONTRACTOR.

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

THERMAL HYDROLYSIS
PROCESS EQUIPMENT
PRE-QUALIFICATION
NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

DECOMMISSION DEWATERING BUILDING
SOLIDS PROCESSING BUILDING
PLAN AT EL 24.00

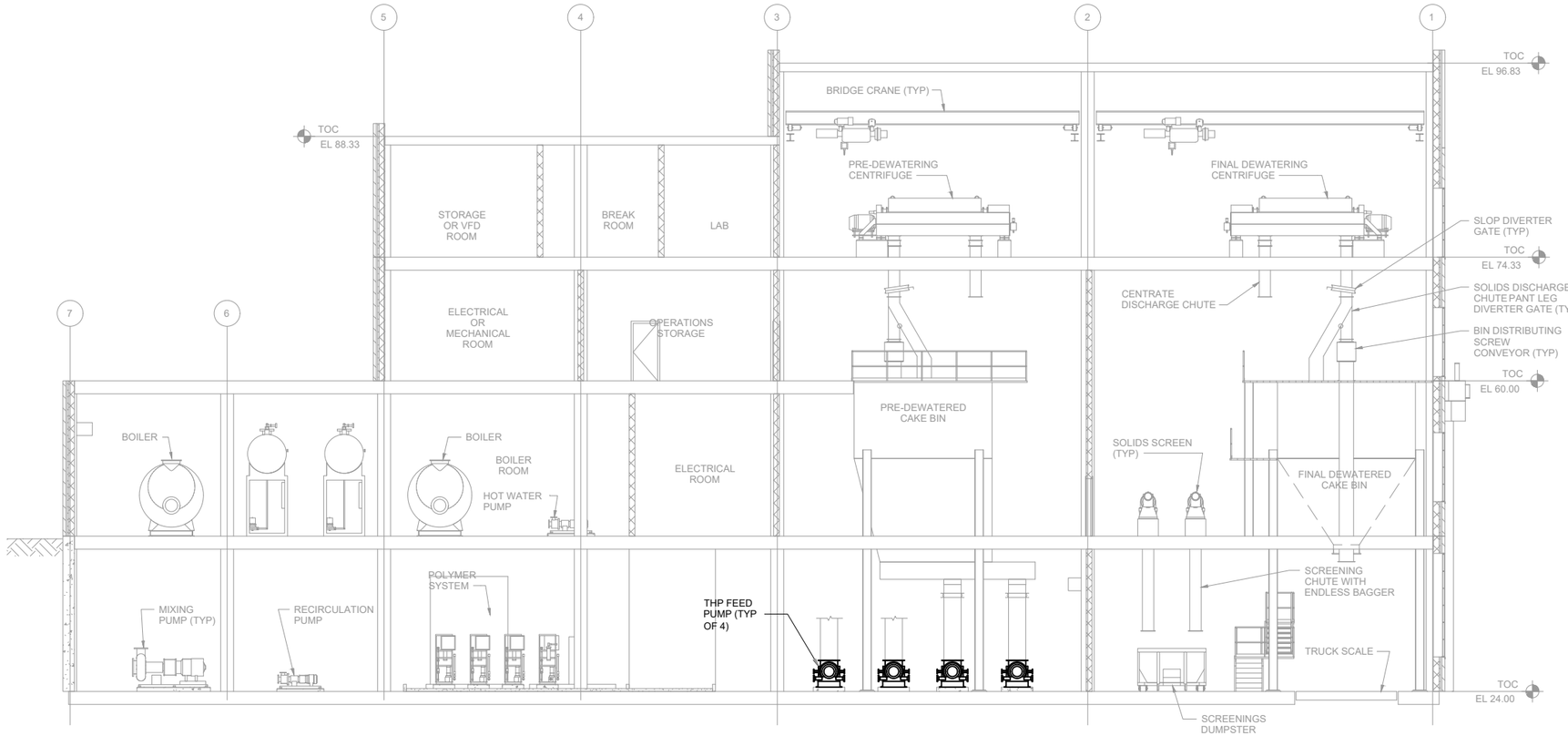
0 1" 2"

FILENAME Drawing 9.dwg
SCALE 3/32" = 1'-0"

SHEET
DRAWING 9

GENERAL NOTES:

1. EQUIPMENT LAYOUT SHOWN IS ONE POSSIBLE CONFIGURATION. FINAL LAYOUT AND LOCATION OF THP SYSTEM AND THP FEED PUMPS TO BE DETERMINED BY CONTRACTOR.
2. THP FEED PUMP NOS. 1-4 TO BE PROVIDED BY THP EQUIPMENT SUPPLIER. ALL OTHER WORK TO BE PROVIDED BY CONTRACTOR.



B / - SECTION
1/8" = 1'-0"

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

THERMAL HYDROLYSIS
PROCESS EQUIPMENT
PRE-QUALIFICATION
NOT FOR CONSTRUCTION

ARLINGTON
VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

DECOMMISSION DEWATERING BUILDING
SECTION 1

0 1" 2"

FILENAME Drawing 10.dwg
SCALE 1/8" = 1'-0"

SHEET
DRAWING 10

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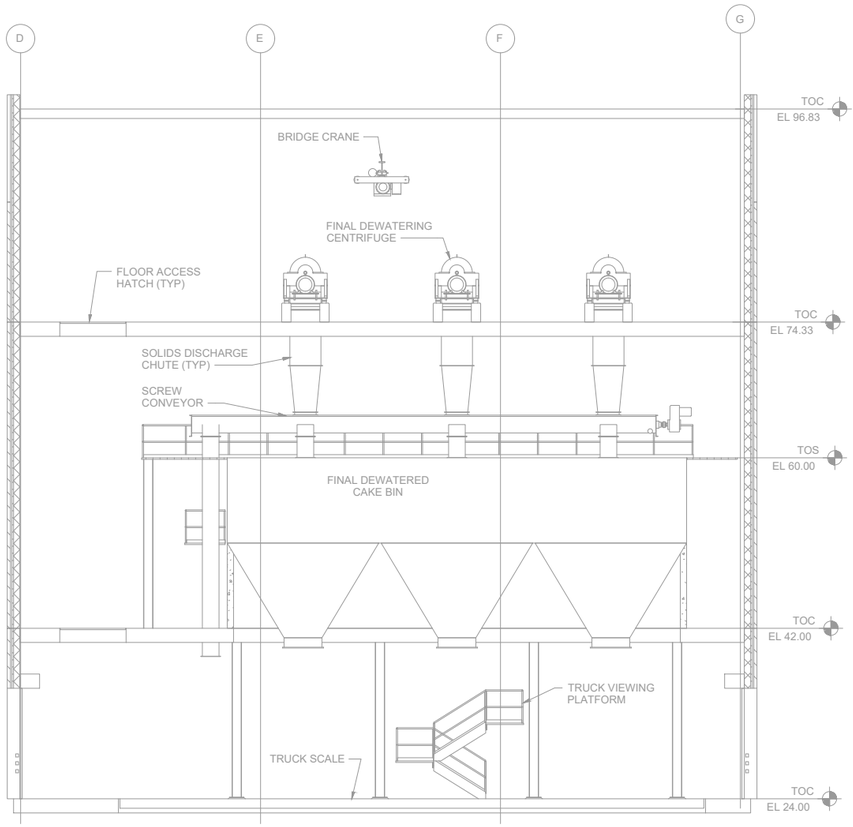
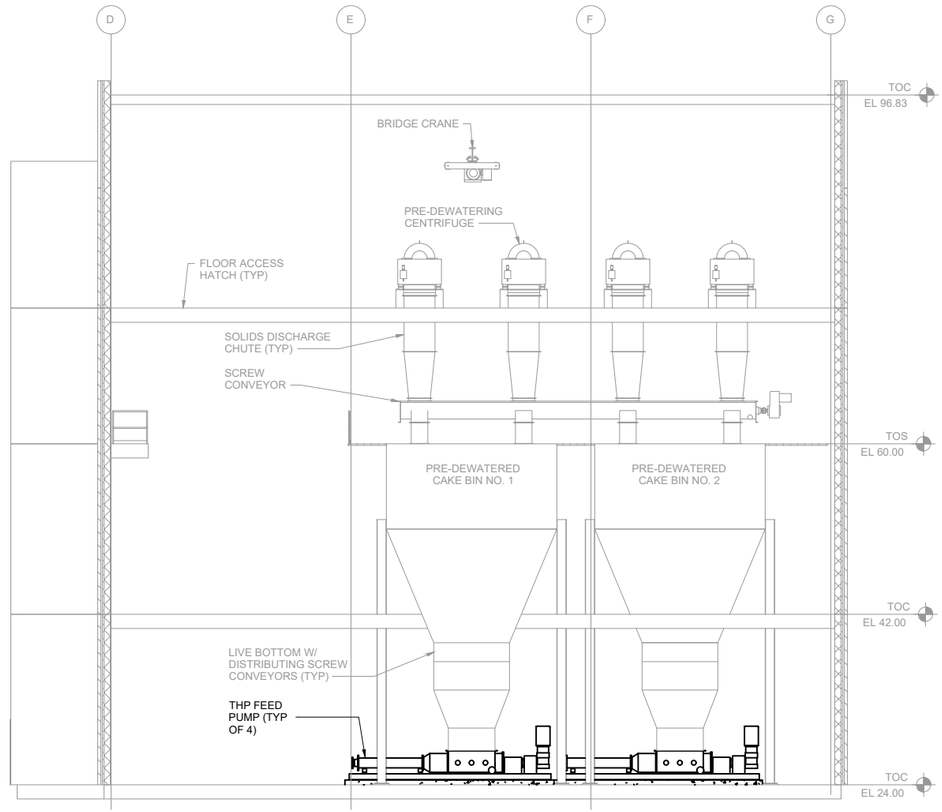
GENERAL NOTES:

1. EQUIPMENT LAYOUT SHOWN IS ONE POSSIBLE CONFIGURATION. FINAL LAYOUT AND LOCATION OF THP SYSTEM AND THP FEED PUMPS TO BE DETERMINED BY CONTRACTOR.
2. THP FEED PUMP NOS. 1-4 TO BE PROVIDED BY THP EQUIPMENT SUPPLIER. ALL OTHER WORK TO BE PROVIDED BY CONTRACTOR.



C SECTION
1/8" = 1'-0"



D SECTION
1/8" = 1'-0"

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

THERMAL HYDROLYSIS
PROCESS EQUIPMENT
PRE-QUALIFICATION
NOT FOR CONSTRUCTION

ARLINGTON
VIRGINIA

ARLINGTON COUNTY
WPCP
RE-GEN

DECOMMISSION DEWATERING BUILDING
SECTIONS 2

0 1" 2"

FILENAME Drawing 11.dwg
SCALE 1/8" = 1'-0"

SHEET
DRAWING 11

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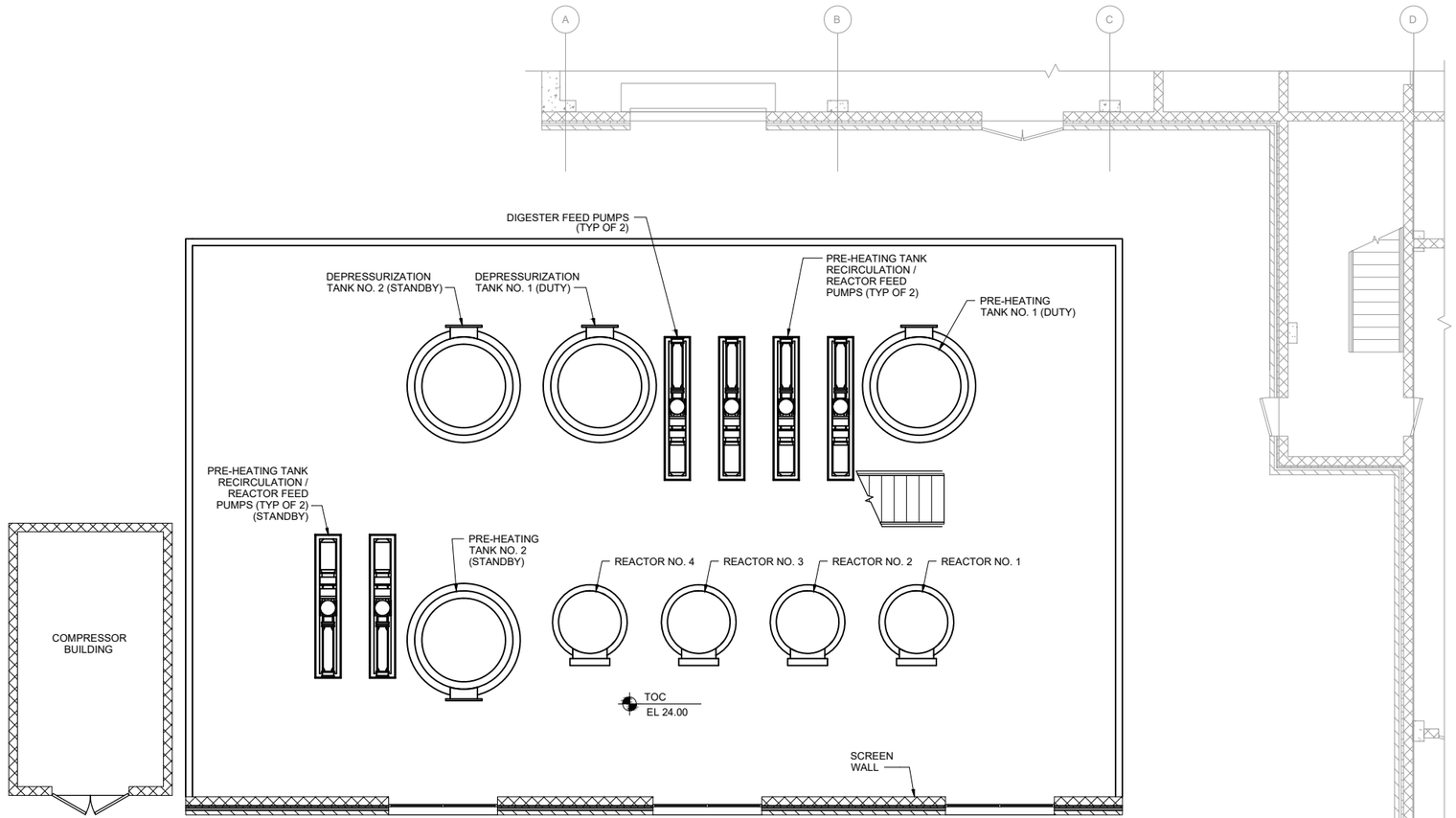

PLAN AT EL 24.00

3/16" = 1'-0"

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	BALCHUNAS, BRIAN
CIVIL	A. CALTON
STRUCTURAL	H. ANTSHEL
ARCHITECTURAL	J. REDDRICK
PROCESS	S. SPALDING
MECHANICAL	C. MOLINE
ELECTRICAL	B. CUNNINGHAM
INSTRUMENTATION	
PROJECT NUMBER	10263882

THERMAL HYDROLYSIS PROCESS EQUIPMENT PRE-QUALIFICATION NOT FOR CONSTRUCTION

ARLINGTON VIRGINIA

ARLINGTON COUNTY WPCP RE-GEN

THERMAL HYDROLYSIS PROCESS PLAN

0 1" 2"

FILENAME Drawing 12.dwg

SCALE 3/16" = 1'-0"

SHEET **DRAWING 12**

C:\PWWORKING\eastd1\d3304334\Drawing 12.dwg, 9/20/2023 3:14:27 PM, TLOKEY