

**CONTRACT DOCUMENTS
AND
SPECIFICATIONS
FOR
PROJECT NO. TMUA-W 24-03
MOHAWK WTP CHEMICAL
TANK REPLACEMENT**

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

PREPARED BY:
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WATER AND SEWER
Engineering Design

ERIC LEE, DIRECTOR

Account Numbers: 2631W00006.WaterOps.Water.7400.70003301-541101

Public Works Department
175 East 2nd Street, Suite 261
Tulsa, Oklahoma 74103
(918) 596-9637

CONTRACT DOCUMENTS

TULSA METROPOLITAN UTILITY AUTHORITY
PROJECT NO. TMUA-W 24-03
MOHAWK WTP CHEMICAL
TANK REPLACEMENT

WATER AND SEWER DEPARTMENT

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SPECIFICATIONS

CITY OF TULSA ENGINEERING SERVICES CONSTRUCTION
SPECIFICATIONS – March 2022

TECH SPECS – VOLUME II

1-496

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**NOTICE TO BIDDERS
SEALED BIDS FOR
TULSA METROPOLITAN UTILITY AUTHORITY
PROJECT NO. TMUA-W 24-03**

Notice is hereby given that pursuant to an order by the Tulsa Metropolitan Utility Authority, a Public Trust, sealed bids will be received in Room 260 of the Office of the City Clerk, City of Tulsa, 175 E. 2nd Street, Tulsa, Oklahoma 74103 until **8:30 a.m., 10th day of July, 2026** for furnishing all tools, materials and labor and performing the work necessary to be done in the construction of the following:

**PROJECT NO. TMUA-W 24-03 MOHAWK WTP CHEMICAL
TANK REPLACEMENT**

The entire cost of the improvement shall be paid from Account No. 2631W00006.WaterOps.Water.7400.70003301-541101

A **MANDATORY** Pre-Bid Conference is scheduled for **Tuesday, June 9th, 2026 at 9:00 a.m.** and will be held through video conferencing with Microsoft Teams, invitation presented on the City of Tulsa's website at this link:
<https://www.cityoftulsa.org/government/departments/engineering-services/construction-bids/>

Attendance at the Pre-Bid Conference is MANDATORY. Bids will not be received from contractors who did not attend the Pre-Bid Conference.

Bids will be accepted by the City Clerk from the holder of valid pre-qualification certificates from the City of Tulsa in one or more of the following classifications: **A or D**

Drawings, specifications and contract documents for construction of said public improvements of the said project have been adopted by the Mayor of said City. Copies of same may be obtained at the Office of Contract Administration, 175 E. 2nd St., 13th Floor, Tulsa, OK 74103 for a non-refundable fee in the amount of **\$50.00** made payable to the Tulsa Metropolitan Utility Authority by check or money order.

Contract requirements shall include compliance as required by law pertaining to the practice of non-discrimination in employment.

Attention is called to Resolution No. 18145 of August 23, 1988, requiring bidders to commit to the goal of employing on the project at least fifty percent bona fide residents of the City of Tulsa and/or MSA in each employment classification.

Attention is called to Resolution 7404 of November 8, 2006, requiring bidders, their subcontractors and their lower-tier subcontractors to hire only citizens of the United States.

The Authority, acting on behalf of the City of Tulsa, is exempt from the payment of any sales or use taxes, and pursuant to Title 68 O.S. Section 1356(10), direct vendors to the Authority are also exempt from those taxes. A bidder may exclude from his bid appropriate sales taxes which he will not have to pay while acting for and on behalf of the Tulsa Metropolitan Utility Authority. See Contract Article IIB.

A Certified or Cashier's Check or Bidder's Surety Bond, in the sum of 5% of the amount of the bid will be required from each bidder to be retained as liquidated damages in the event the successful bidder fails, neglects or refuses to enter into said contract for the construction of said public improvements for said project and furnish the necessary bonds within thirty days from and after the date the award is made.

The bidder to whom a contract is awarded will be required to furnish public liability and workmen's compensation insurance; Performance, Statutory, and Maintenance bonds acceptable to the Authority, in conformity with the requirements of the proposed contract documents. The Performance, Statutory, and Maintenance bonds shall be for one hundred percent (100%) of the contract price.

The bidding for this project is subject to a local preference law as defined in Oklahoma Statutes, Title 61, Section 103. For purposes of Section 103 a "local bid" means a bid submitted by a business entity that is authorized to do business in the State of Oklahoma and maintains its primary office or principal place of business within the State of Oklahoma. If the conditions outlined in Title 61 are met, The City of Tulsa must select the second lowest bid if within 5% of the lowest bid and the second lowest bid is a local bid and the lowest bid is not a local bid (i.e. non-local/out of state). Accordingly, when the local bid is required to be selected under the State law, the local bidder must agree to do the work at the lowest bid price to be awarded the project.

All bids will be opened and considered by the Bid Committee of said City at a meeting of said Committee to be held in the City Council Room of City Hall, 175 E. 2nd Street, in said City at 9:00 a.m. on the 10th day of July, 2026.

Dated at Tulsa, Oklahoma, this 29th day of May, 2026.

(SEAL)

Lou Reynolds
Tulsa Metropolitan Utility Authority

INSTRUCTIONS TO BIDDERS

B-1. BIDS

Each bid Proposal shall be completed, signed, and submitted. No alterations, additions, or erasures shall be made on the Proposal. Erroneous entries shall be lined out, initialed by the bidder, and the correct entry inserted. The unit price bid must cover all expense for furnishing the labor, materials, tools, equipment, and apparatus of every description to construct, erect, and furnish all work required by and in conformance with the Drawings and Specifications.

Each bid shall be enclosed in a sealed envelope addressed to the Tulsa Metropolitan Utility Authority, 175 E. 2nd Street, Room 260, City Hall, Tulsa, Oklahoma, identified on the outside with the words:

PROJECT NO. TMUA-W 24-03 MOHAWK WTP CHEMICAL TANK REPLACEMENT

Pre-qualification Certificate Number _____.

And shall be filed with the City Clerk in Room 260, City Hall.

All addenda to the contract documents should be denoted on the last page of the Proposal in the space provided.

B-2. BID SECURITY

Each bid shall be accompanied by a cashier's check, a certified check, or bidder's bond, in the amount of five percent (5%) of the total amount bid.

The bid security shall be made payable, without condition, to the Tulsa Metropolitan Utility Authority, Oklahoma. The bid security may be retained by and shall be forfeited to the Authority as liquidated damages if the bid is accepted, a contract based thereon is awarded, and the bidder fails to enter into a contract in the form prescribed, with legally responsible sureties, within thirty (30) days after such award is made by the Authority.

B-3 RETURN OF BID SECURITY

The bid security of each unsuccessful bidder will be returned when his bid is rejected. The bid security of the bidder to whom the contract is awarded will be returned when he executes a contract and files satisfactory bonds. The bid security of the second lowest responsible bidder may be retained for a period of time not to exceed sixty (60) days pending the execution of the contract and bonds by the successful bidder.

B-4 WITHDRAWAL OF BIDS

No bidder may withdraw his bid for sixty (60) days after the date and hour set for the opening. A bidder may withdraw his bid any time prior to expiration of the period during which bids may be submitted by making a written request signed in the same manner and by the same person who signed the Proposal.

B-5 REJECTION OF BIDS

Bids received more than ninety-six (96) hours before the time set for opening bids, excluding Saturdays, Sundays, and holidays, as well as bids received after the time set for opening bids, will not be considered and will be returned unopened.

The Tulsa Metropolitan Utility Authority reserves the right to reject any and all bids when such rejection is in the best interest of the Tulsa Metropolitan Utility Authority. All bids are received subject to this stipulation and the Authority reserves the right to decide which bidder shall be deemed lowest responsible bidder.

A violation of any of the following provisions by a bidder shall be sufficient reason for rejecting bidder's bid, or shall make any contract between the Tulsa Metropolitan Utility Authority and the Contractor that is based on bidder's bid, null and void: divulging the information in said bid before the bids have been opened; submission of a bid which is incomplete, unbalanced, obscure, incorrect, or which has conditional clauses, additions, or irregularities of any kind not in the original proposal form, or which is not in compliance with the Instruction to Bidders and published Notice to Bidders, or which is made in collusion with another bidder. The Authority shall have the right to waive any immaterial defects or irregularities in any bid received.

B-6 DISQUALIFICATION OF BIDDERS

No contract will be awarded to any person or persons, firm, partnership, company, or corporation which is in arrears to the Authority upon any debt of contract, or in default as surety or otherwise upon any obligation to the Authority.

B-7 SIGNATURE OF BIDDERS

Each bid shall be properly signed with the full name of the company or individual submitting the bid, the bidder's address, and the name and title of all persons signing printed below their signature lines. Bids by partnerships shall be signed with the partnership name followed by the signature and title of one of the partners. Bids by corporations shall be signed with the name of the corporation followed by the signature and title of the president, vice president, chairman, or vice chairman of the Board of Directors with attestation by the corporate secretary or assistant corporate secretary. Bids by joint ventures shall be signed by each participant in the joint venture. Bids by limited liability companies shall be signed with the name of the limited liability company followed by the signature and title of the Manager or Managing Member. Bid by limited partnerships shall

be signed with the name of the limited partnership followed by the signature of the general partner. Note: The signature requirements listed above are for Oklahoma entities; entities organized in other states must follow the law of the state in which they are organized.

A bid by a person who affixes to his signature the word "President", "Manager", "General Partner", "Agent", or other title, without disclosing the name of the company for which he is signing, may be held to be the bid of the individual signing.

B-8 INTERPRETATION OF CONTRACT DOCUMENTS

If any bidder who contemplates submitting a bid is in doubt as to the true meaning of any part of the drawing, specifications, or other proposed contract documents, bidder may submit to Contract Administration and the Engineer a written request for interpretation thereof. The person submitting the request shall be responsible for its prompt delivery. Interpretation of the proposed contract documents will be made only by addendum. The addendum will be posted on the Tulsa Metropolitan Utility Authority website and emailed to all the pre-bid attendees. The Authority will not be responsible for any other explanations or interpretations of the proposed contract documents.

B-9 LOCAL CONDITIONS AFFECTING WORK

Each bidder shall visit the site of the work and shall completely inform himself relative to construction hazards and procedure, labor, and all other conditions and factors, local and otherwise, which would affect prosecution and completion of the work and its cost. Such considerations shall include the arrangement and condition of existing structures and facilities, the procedure necessary for maintenance of uninterrupted operation of existing structures and facilities, the availability and cost for labor, and facilities for transportation, handling, and storage of materials and equipment. All such factors shall be properly investigated and considered in the preparation of the bid. There will be no subsequent financial adjustment for lack of such prior information.

B-10 TIME OF COMPLETION

The time of completion is an essential part of the contract and it will be necessary for each bidder to satisfy the Authority of his ability to complete the work within the allowable time set forth in the Bid Form. For all projects that will impact the public, a public meeting is required before any work is done. In this connection, attention is directed to the provisions of the General Conditions and Special Conditions relative to delays, extension of time, and liquidated damages.

B-11 QUALIFICATION OF BIDDERS

No bid will be received and filed by the City Clerk of the Tulsa Metropolitan Utility Authority unless the person submitting the bid has been pre-qualified as provided

by ordinance, and is the holder of a current certificate of Pre-qualification in force and effect on the date such bid is to be submitted and filed.

B-12 TAXES AND PERMITS

Attention is directed to the requirements of the General Conditions regarding payment of taxes and obtaining permits. Contractor shall comply with all zoning ordinances of the City, as provided in the Tulsa Zoning Code, Title 42 Tulsa Revised Ordinances and conform with all zoning requirements established by the Tulsa Metropolitan Area Planning Commission and the Board of Adjustment. Contractor can call the Indian Nations Council of Governments (INCOG) at (918) 584-7526, to determine if any zoning requirements must be met.

B-13 OKLAHOMA LEGAL REQUIREMENTS

The Contractor must comply with the Oklahoma Scaffolding Law, 40 Oklahoma Statutes, Sections 174 - 177, which cover erection and use of scaffolds, hoists, cranes, stays, ladders, supports, or other mechanical contrivances.

In accordance with Oklahoma Statutes, Title 68, Section 1701-1707, before commencing any work pursuant to this contract, any nonresident contractor shall give written notice by certified mail, return receipt requested, to the Oklahoma Tax Commission, the Oklahoma Employment Security Commission, the Workers Compensation Court, and the county assessor of each county in which work will be performed. The notices shall comply with the requirements set forth in said statute.

B-14 BONDS

The bidder to whom a contract is awarded will be required to furnish bonds as follows:

- a. Performance Bond – A Performance Bond to the Authority in an amount equal to one hundred percent (100%) of the Contract price.
- b. Statutory Bond – A Statutory Bond to the State of Oklahoma in an amount equal to one hundred percent (100%) of the contract price.
- c. Maintenance Bond – A Maintenance Bond to the Authority in an amount equal to one hundred percent (100%) of the contract price.

The bonds shall be executed on the forms included in the contract documents by a surety company authorized to do business in the State of Oklahoma and acceptable as Surety to the Tulsa Metropolitan Utility Authority.

Accompanying the bonds shall be a "Power-of-Attorney" authorizing the attorney-in-fact to bind the Surety Company and certified to include the dates of the bonds.

B-15 BOUND COPY OF CONTRACT DOCUMENTS

Bound contract documents are no longer required.

B-16 EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENTS

Each bidder agrees to comply with the terms of Title 5, Chapter 1, Section 111, of the Tulsa Revised Ordinances relating to Non-Discrimination.

B-17 BASIS FOR AWARD OF CONTRACT

The basis for award of a contract shall be the total base bid submitted by the lowest responsible bidder unless otherwise directed in the form of proposal. The Tulsa Metropolitan Utility Authority reserves the right to withhold the awarding of a contract for a reasonable period of time from the date of opening of bids. The awarding of a contract upon a successful bid shall give the bidder no right or action or claim against the Tulsa Metropolitan Utility Authority upon such contract until the same shall have been reduced to writing and duly signed by the contracting parties. The award of a contract will not be completed until the contract is duly executed and the necessary bonds and insurance approved.

B-18 TIME FOR AWARDING OF CONTRACT

The awarding of a contract to the lowest responsible bidder will be made within thirty (30) days after the opening of bids unless the Tulsa Metropolitan Utility Authority by formal recorded action and for good cause shown, provides for a reasonable extension to that period, which extension period shall not in any event exceed fifteen (15) days where only state or local funds are involved, or not to exceed ninety (90) days on any award of contract for the construction of public improvements where funds are utilized which are furnished by an agency of the federal government.

B-19 SAFETY AND HEALTH REGULATIONS

Bidders should note that they are subject to "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926 and that compliance, review and enforcement are the responsibility of the U.S. Department of Labor.

The Contractor is fully responsible for the safety of the work site and is expected to train their employees in all applicable safety issues. This should include but not be limited to: trench safety, confined space entry, head protection, etc. In accordance with construction contracts with the City, Authority, Board, or Commission, all applicable Labor and OSHA safety regulations must be followed.

Work sites must be monitored by the Contractor and safety provisions enforced. Contractors are asked to ensure that all employees are properly informed and trained in construction, work site safety.

B-20 VENDORS AND SUBCONTRACTOR IDENTIFICATION

Where Vendor and Subcontractor Identification Questionnaires are included in the bid documents, each bidder shall submit the Questionnaire directly to the Engineer no later than 5:00 p.m. on the first working day following the bid opening. Failure to submit the questionnaire may render the bid unresponsive and not eligible for award. The award of the Contract will be subject to the acceptability of the vendors and subcontractors listed. If an award is made, the vendors and subcontractors listed on the questionnaire shall be used on the project. No changes in the vendor and subcontractor list will be permitted unless prior consent is obtained from the Engineer.

B-21 U.S. ENVIRONMENTAL PROTECTION AGENCY NPDES REQUIREMENTS FOR STORMWATER DISCHARGES

The bidder's attention is directed to U.S. Environmental Protection Agency (EPA) NPDES requirements for stormwater discharges. The Contractor shall be responsible for filing a Notice of Intent and development and implementation of a Stormwater Pollution Prevention Plan (PPP).

B-22 AMERICANS WITH DISABILITIES ACT

The Contractor shall take the necessary actions to ensure its facilities are in compliance with the requirements of the Americans with Disabilities Act (ADA). It is understood that the program of the Contractor is not a program or activity of the Tulsa Metropolitan Utility Authority. The Contractor agrees that its program or activity will comply with the requirements of the ADA. Any costs of such compliance will be the responsibility of the Contractor. Under no circumstances will the Contractor conduct any activity, which it deems non-compliant with the ADA.

RESOLUTION NO. 18145

A RESOLUTION REQUIRING THE INCLUSION IN PLANS AND SPECIFICATIONS FOR PUBLIC IMPROVEMENT CONTRACTS OF PROVISIONS PROVIDING FOR THE EMPLOYMENT OF BONA FIDE RESIDENTS OF THE CITY OF TULSA; AND/OR THE MSA; ALSO PROVIDING THAT AT LEAST OF FIFTY PERCENT (50%) OF EACH CLASS OF EMPLOYEES USED ON A PROJECT BE BONA FIDE RESIDENTS OF THE CITY OF TULSA AND/OR THE MSA; THAT THE DIRECTOR OF THE DEPARTMENT OF HUMAN RIGHTS IS CHARGED WITH ENSURING THAT ALL BIDS FOR PUBLIC CONSTRUCTION CONTRACTS COMPLY WITH THIS RESOLUTION; AND DECLARING AN EMERGENCY.

WHEREAS, City of Tulsa, Oklahoma, desires to achieve a goal of full employment.

WHEREAS, it is necessary for the protection of the health, safety and welfare of all residents of the City of Tulsa, Oklahoma, to accomplish this goal.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF COMMISSIONERS OF THE CITY OF TULSA, OKLAHOMA:

SECTION 1. The City of Tulsa is committed to the policy of achieving full employment of its citizens by encouraging the employment of bona fide Tulsa and MSA residents in public improvement contracts.

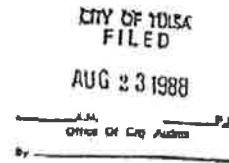
SECTION 2. Definitions. The definitions of certain terms used in this resolution are as follows:

a. "Bidding Documents" or "Bid" means the bid notice, plans and specifications, bidding form, bidding instructions, special provisions and all other written instruments prepared by or on behalf of an awarding public agency for use by prospective bidders on a public construction contract.

b. (i) "Bona Fide Residents" shall include only those persons who are either registered to vote in the City of Tulsa or who have resided within the city limits for at least six months, or who have purchased a permanent residence within the city limits or who have leased a residence for at least a six month term. Residency may be further determined by a valid Oklahoma driver's license, a current Oklahoma license tag, and a valid Oklahoma automobile inspection sticker. (ii) Bona fide residents of MSA shall include only those persons who are registered to vote in outlying MSA areas or who have resided within the outlying MSA area for at least six months, or who have purchased a permanent residence within the outlying MSA areas or who have leased a residence for at least a six month term. Residency may be further determined by a valid Oklahoma driver's license, a current Oklahoma license tag, and a valid Oklahoma automobile inspection sticker.

c. "Public Construction Contract" or "Contract" means any contract exceeding Seven Thousand Five Hundred Dollars (\$7,500.00) in amount, awarded by the City of Tulsa for the purpose of making any public improvements or constructing any public building or making repairs to the same.

d. "Public Improvement" means any beneficial or valuable change or addition, betterment, enhancement or amelioration of or upon any real property, or interest therein, belonging to the City of Tulsa, intended to enhance its value, beauty or utility or to adapt it to new or further purposes. The term does not include the direct purchase of materials, equipment or supplies by the City of Tulsa.



- e. "MSA". All of the land areas composed of Creek County, Osage County, Rogers County, Tulsa County and Wagoner County.

SECTION 3. Residency Requirements of Contractor's Employees. Every employee and/or agent of the City of Tulsa, Oklahoma, charged or involved with the preparation of plans and specifications for any public improvement funded in whole or in part with funds of the City of Tulsa, is hereby charged to include in said plans and specifications the following provisions which shall be binding upon the successful bidders:

- a. Each bid shall be accompanied by a sworn statement that the bidder is committed to the goal of employing at least 50% bona fide residents of the City of Tulsa and/or the MSA in each classification as determined by the Oklahoma Commissioner of Labor.
- b. The successful bidder will be responsible for having like requirements placed upon any subcontractor.
- c. The successful bidder will submit to the Director or his designated representative of the Department of Human Rights any compliance reports involving the bidder and its subcontractors required by Title 31, Chapter 1, Section 9, of the Tulsa Revised Ordinances. The reports shall include information about the residence of each employee in each laboring and trade class applicable to any City project.

SECTION 4. Unresponsive Bids. The failure to submit the documents required by Section 3 shall render a bid unresponsive. Said documents must be submitted prior to the opening of the bids. The Director of the Department of Human Rights Section of City Development is charged with ensuring that all bids comply with Section 3 prior to the bid opening date.

SECTION 5. Duty of Employees and/or Agents of the City of Tulsa. Any employee and/or agent of the City of Tulsa who fails to include the goals for residency requirements found in Section 3 in the plans and specifications for any public improvement may be subject to disciplinary action, including dismissal.

SECTION 6. Severability. The invalidity of any section, subsection, provision or clause or portion of this chapter, or the invalidity of the application thereof to any person or circumstance shall not affect the validity of the remainder of this chapter or the validity of its application to other persons or circumstances.

SECTION 7. Effect Date. This resolution shall take effect as of July 1, 1988.

SECTION 8. Emergency Clause. That an emergency exists for the preservation of the public peace, health and safety, by reason whereof this resolution shall take effect immediately upon its passage, approval and publication.

PASSED, with the emergency clause ruled upon separately and approved this 23rd day of August, 1988.

APPROVED, this 23rd day of August, 1988.

Rodger Randle

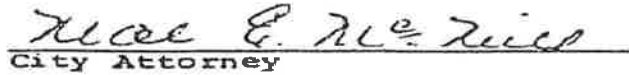


Mayor

ATTEST: Philip W. Wood

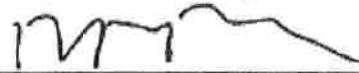

City Auditor

APPROVED: Neal E. McNeil


City Attorney

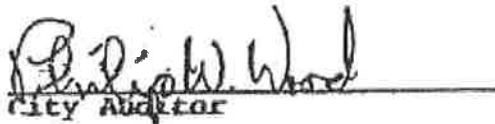
PASSED, with the emergency clause ruled upon
separately and approved this 23 day of August, 1988.

- APPROVED, this 23 day of August, 1988.



Mayor

ATTEST:


City Auditor

APPROVED:


City Attorney

CITY OF YOLIS
FILED

AUG 23 1988

Office of City Auditor
By _____

(Must be submitted at time of Bid)
CITY OF TULSA
RESOLUTION NO. 7404
AFFIDAVIT OF COMPLIANCE

_____, of lawful age, being first duly sworn, states that s(he) is the authorized agent of the Company set forth below.

Affiant further states that the Company, in compliance with City of Tulsa Resolution No. 7404, shall not hire or knowingly allow any of its subcontractors or lower tier subcontractors to hire anyone who is not a United States citizen or legal immigrant or anyone who does not have legal status as a temporary worker to perform work on any project which is the subject of a contract between the Company and the City of Tulsa.

Affiant further states that the Company shall not fail to comply with and shall not knowingly allow any of its subcontractors or lower tier subcontractors to fail to comply with all applicable laws including, but not limited to, labor, employment and taxation laws, in the performance of any work on any project which is the subject of a contract between the Company and the City of Tulsa.

Affiant further states that the Company shall make available to the City of Tulsa, at the City's request, sufficient information and/or affirmations to allow the City to confirm Company's compliance with Resolution No. 7404 relating to the performance of any contract between the Company and the City of Tulsa.

Company: _____

Signed: _____

Title

SUBSCRIBED and SWORN to before me, this ____ day of _____, 20__.

NOTARY PUBLIC

MY COMMISSION EXPIRES:

COMMISSION NO.:

(Must be submitted at time of Bid)
CITY OF TULSA
50% RESIDENT RESOLUTION
AFFIDAVIT FOR BID

STATE OF)
) ss:
COUNTY OF)

_____, of lawful age, being first duly sworn, states that s(he) is the agent authorized by the bidder to submit the attached bid. Affiant further states that the bidder, in compliance with City of Tulsa Resolution No. 18145, is committed to the goal of employing at least 50% bona fide residents of the City of Tulsa and/or the Metropolitan Statistical Area (composed of Creek, Okmulgee, Osage, Pawnee, Rogers, Tulsa, and Wagoner counties).

Affiant further states that bidder is responsible for having like requirements placed upon any of its subcontractors.

BIDDER (Company Name)

SIGNED

Title

SUBSCRIBED and SWORN to before me this ____ day of _____, 20__.

NOTARY PUBLIC

MY COMMISSION EXPIRES:

COMMISSION NO.:

(Must be submitted at time of bid)

NON-COLLUSION AFFIDAVIT

STATE OF _____)
) ss:
COUNTY OF _____)

_____, of lawful age, being first duly sworn, says that:

1. I am the duly authorized agent of the bidder submitting the competitive bid associated with this sworn statement for the purpose of certifying facts pertaining to the existence of collusion among bidders and between bidders and municipal officers or employees, as well as facts pertaining to the giving or offering of things of value to governmental personnel in return for special consideration in the letting of any contract pursuant to the bid;
2. I am fully aware of the facts and circumstances surrounding the making of the bid and have been personally and directly involved in the proceedings leading to the submission of such bid;
3. Neither the bidder nor anyone subject to the bidder's direction or control has been a party:
 - a. to any collusion among bidders in restraint of freedom of competition by agreement to bid at a fixed price or to refrain from bidding;
 - b. to any collusion with any municipal official or employee as to quantity, quality or price in the prospective contract, or as to any other terms of such prospective contract; nor
 - c. in any discussions between bidders and any municipal official concerning exchange of money or other things of value for special consideration in the letting of a contract.
4. If awarded the contract, neither the bidder nor anyone subject to the bidder's direction or control has paid, given or donated or agreed to pay, give or donate to any officer or employee of the City of Tulsa or of any public trust where the City of Tulsa is a beneficiary, any money or other thing of value, either directly or indirectly, in procuring the contract for which the bid is submitted.

BIDDER (Company Name)

Signed

Title

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

NOTARY PUBLIC

MY COMMISSION EXPIRES:

_____, ____ *
COMMISSION NO.:

(Must be submitted at time of bid)
BUSINESS RELATIONSHIP AFFIDAVIT

STATE OF)
) ss:
 COUNTY OF)

_____, of lawful age, being first duly sworn, says that s(he) is the agent authorized by the bidder to submit the attached bid. Affiant further states that the nature of any partnership, joint venture or other business relationship presently in effect or which existed within one (1) year prior to the date of this statement with the architect, engineer, or other party to the project is as follows:

Affiant further states that any such business relationship presently in effect or which existed within one (1) year prior to the date of this statement between any officer or director of the bidding company and any officer or director of the architectural or engineering firm or other party to the project is as follows:

Affiant further states that the names of all persons having any such business relationships and the positions they hold with their respective companies or firms are as follows:

(If none of the business relationships herein above mentioned exist, affiant should so state.)

Signed: _____

 BIDDER (Company Name)

 Title:

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

 NOTARY PUBLIC

MY COMMISSION EXPIRES:

 COMMISSION NO.:

(Must be submitted at time of bid)
INTEREST AFFIDAVIT

STATE OF _____)
)ss.
COUNTY OF _____)

I, _____, of lawful age, being first duly sworn, state that I am the agent authorized by Contractor, Engineer, Architect or provider of professional service [“Services Provider”] to submit the attached Agreement. Affiant further states that no officer or employee of the City of Tulsa either directly or indirectly owns a five percent (5%) interest or more in the Services Provider’s business or such a percentage that constitutes a controlling interest. Affiant further states that the following officers and/or employees of the City of Tulsa own an interest in the Services Provider’s business which is less than a controlling interest, either direct or indirect.

By _____
Signature

Title _____

Subscribed and sworn to before me this _____ day of _____, 20 ____.

Notary Public

My Commission Expires: _____

Notary Commission Number: _____

County & State Where Notarized: _____

The Affidavit must be signed by an authorized agent and notarized.

ELECTRONIC BID PROPOSAL INSTRUCTIONS - EXCEL SPREADSHEET
PROJECT NO. TMUA-W 24-03

Please read the following instructions carefully.

1. After opening this file re-save it as your company's name.
2. Open the BID FORM Sheet from the tabs below.
3. Input the unit price of the appropriate pay item in the cells highlighted in blue.
4. Review all data input and check calculations to ensure accuracy of Bid.
5. Print 1 hardcopy of the "PROPOSAL" tab, BID FORM and the "SIGNATURE PAGE" tab.
6. Complete and sign the "Signature Page" document.
6. Submit hardcopy and electronic disk with Contract Documents and Specifications for Bid opening date.

LEGEND

\$	1.00	Cells Requiring Data Input.
\$	1.00	Internal Data Transfer.
\$	2.00	Calculated Results.

AGREEMENT FOR USING ELECTRONIC BID PROPOSAL

By and Between: Garver, LLC (ENGINEER) and RECIPIENT. The enclosed electronic media is provided pursuant to your request and is for your limited use in connection with your submittal of Bid Proposal for Project No. TMUA-W 24-03. In no event shall the information be used for any other purpose or be released to third parties without the written consent of the ENGINEER. In the event of a discrepancy between the hard copy and this electronic media at delivery or in the future, the hard copy shall govern. ENGINEER hereby disclaims any and all liability for the consequences from use of the electronic media and makes no warranty or guarantee of accuracy. RECIPIENT shall assume full responsibility for the uses and consequences of the electronic media. It is agreed that ENGINEER has and retains ownership of the electronic media. ENGINEER does not warrant or guarantee that the electronic data is compatible with RECIPIENT'S computer hardware or software, and ENGINEER'S responsibility for the electronic media is limited to replacement of defective media for a period of thirty (30) days after delivery to RECIPIENT. !!! By opening and using this FILE, You AGREE to these TERMS AND CONDITIONS!!!

PROPOSAL
PROJECT NO: TMUA-W 24-03

TO: TULSA METROPOLITAN UTILITY AUTHORITY
CITY OF TULSA, OKLAHOMA

THE UNDERSIGNED BIDDER, having carefully examined the drawings, specifications, and other Contract Documents of the above project presently on file in the City Clerk, City of Tulsa Oklahoma:

CERTIFIES THAT he has inspected the site of the proposed work and has full knowledge of the extent and character of the work involved, construction difficulties that may be encountered, and materials necessary for construction, class and type of excavation, and all other factors affecting or which may be affected by the specified work; and

CERTIFIES THAT he has not entered into collusion with any other bidder or prospective bidder relative to the project and/or bid: and

HEREBY PROPOSES: to enter into a contract to provide all necessary labor, materials, equipment and tools to completely construct and finish all the work required by the Contract Documents hereto attached and other documents referred to therein: to complete said work within 270 calendar days after the work order is issued; and to accept in full payment therefore the amount set forth below for all work actually performed as computed by the Engineer as set forth in the Contract.

Basis of Award

IT SHOULD BE NOTED THAT THE LOWEST RESPONSIVE BID SHALL BE DETERMINED BY THE TOTAL BASE BID PLUS ADDITIVE ALTERNATES NO. 1. THE ITEMS IN ADDITIVE ALTERNATES 1 MAY OR MAY NOT BE INCLUDED IN THE CONTRACT AWARD AT THE SOLE DISCRETION OF TMUA. ANY PROPOSAL SUBMITTED WITH THE ADDITIVE ALTERNATE NO.1 INCOMPLETE SHALL BE CONSIDERED NON-RESPONSIVE.

Note: - Item numbers omitted are not a part of the Contract.

PROPOSAL
PROJECT NO. TMUA-W 24-03

BID ITEM	SPEC NO.	DESCRIPTION	UNIT	QTY	DATA INPUT UNIT PRICE	TOTAL EACH ITEM
BASE BID MOHAWK WTP CHEMICAL TANK REPLACEMENT						
1	SPECIAL	ALL WORK AS DEFINED IN THE CONTRACT DOCUMENTS, EXCEPT THOSE ITEMS LISTED SEPARATELY BELOW	EA	1		\$ -
2	02 41 00	DEMOLITION	EA	1		\$ -
3	43 41 45	18,900 GALLON 50% SODIUM HYDROXIDE FIBERGLASS REINFORCED PLASTIC TANKS	EA	3		\$ -
4	43 41 45	18,900 GALLON 50% ALUMINUM CHLOROHYDRATE FIBERGLASS REINFORCED PLASTIC TANKS	EA	3		\$ -
5	43 41 45	12,600 GALLON 25% HYDROFLUORSILICIC ACID FIBERGLASS REINFORCED PLASTIC TANKS	EA	1		\$ -
6	43 41 45	12,600 GALLON CATIONIC POLYMER FIBERGLASS REINFORCED PLASTIC TANKS	EA	1		\$ -
7	43 41 43	500 GALLON 50% SODIUM HYDROXIDE POLYETHYLENE UPRIGHT STORAGE TANK	EA	2		\$ -
8	40 72 23	RADAR LEVEL METERS	EA	8		\$ -
9	40 73 45	WEIGHT SCALE	EA	2		\$ -
10	43 42 56	SEALLESS MAGNETIC DRIVE CENTRIFUGAL PUMPS	EA	3		\$ -
11	SPECIAL	ELECTRICAL IMPROVEMENTS	EA	1		\$ -
12	40 68 63	DCS AND OWS PROGRAMMING	EA	1		\$ -
13	COT 303	MOBILIZATION/DEMOBILIZATION	EA	1		\$ -
14	01 20 00	CHEMICAL ALLOWANCE	ALLOW	1	\$245,000.00	\$ 245,000.00
15	SPECIAL	OWNER ALLOWANCE	ALLOW	1	\$125,000.00	\$ 125,000.00
BASE BID MOHAWK WTP CHEMICAL TANK REPLACEMENT SUBTOTAL						\$ 370,000.00
ADDITIVE ALTERNATE NO. 1 MOHAWK WTP CHEMICAL TANK REPLACEMENT						
16	01 23 00	ADD ALTERNATE NO. 1 - SODIUM HYDROXIDE TRENCH CLEANING AND COATING	EA	1		\$ -
ADD ALTERNATIVE NO. 1 MOHAWK WTP CHEMICAL TANK REPLACEMENT SUBTOTAL						\$ -
TOTAL BASE BID + ADDITIVE ALTERNATE						\$ 370,000.00

SIGNATURE PAGE
PROJECT NO: TMUA-W 24-03

TOTAL BASE BID
ADD ALTERNATIVE NO. 1
BASE BID PLUS ADDITIVE ALTERNATE

\$370,000.00
\$0.00
\$370,000.00

Enclosed is a () Bidder's Surety Bond, () Certified Check, () Cashier's Check for

Dollars (\$)
Figures

which the City of Tulsa may retain or recover as liquidated damages in the event that the undersigned fails to enter into contract for the work covered by this proposal., provided the Contract is awarded to the undersigned within thirty (30) days, or within ninety (90) days if Federal funds are utilized, from the date fixed for opening of bids and the undersigned fails to execute said Contract and furnish the required bonds and other requirements as called for in these Contract Documents within thirty (30) days after award of Contract.

Dated at Tulsa, Oklahoma, this _____ day of _____, 20__

Respectfully submitted,

(Complete legal name of company)

(State of Organization)

By:

Title:

Printed Name:

ATTEST:

Title: Corporate Secretary

Printed Name:

(SEAL)

Address: _____

Telephone Number: _____

Fax Number: _____

By signing above the bidder acknowledges receipt of the following Addenda (give number and date of each):

Certificate of Secretary

The undersigned _____ (Assistant) Secretary of _____, a _____ corporation, (the "Corporation") hereby certifies that the following is a true and correct copy of a Resolution duly adopted by the Board of Directors of the Corporation on the _____ day of _____, 20__.

RESOLVED, that _____ is authorized to execute and enter into bids, contracts, bonds, affidavits and any ancillary documents, on behalf of the Corporation.

The undersigned further certifies that this Resolution is in full force and effect as of the date of this Certificate and has not been amended, modified, revoked or rescinded.

IN WITNESS WHEREOF, I have executed this Certificate this ____ day of _____, 20__.

(Signature)

Printed Name

(Assistant) Secretary

Consent of Members

The undersigned, being all of the Members of [Name of Company], LLC, an Oklahoma Limited Liability Company, hereby authorize, consent to, approve and ratify the execution by _____ on behalf of [Name of Company], LLC of bid proposals, contracts, affidavits and related documents in connection with [Name of Project] of the City of Tulsa.

DATED, this ____ day of _____, 20__.

Name printed: _____

Name Printed: _____

[ADD ADDITIONAL LINES FOR ADDITIONAL MEMBERS]



TMUA: Tulsa Metropolitan Utility Authority

(DATE)

(Company Name)

(Address)

(City, State, Zip Code)

RE: Tulsa Metropolitan Utility Authority Project No.

TO WHOM IT MAY CONCERN:

The vendor of materials and supplies under the above referenced contract is hereby authorized to invoice the Tulsa Metropolitan Utility Authority (TMUA), 175 E. 2nd Street, Suite 1300, Tulsa, Oklahoma 74107, for all materials and supplies purchased under the above contract, noting any contract discount and omitting all sales taxes. All invoices shall include the contract number and the name of the contractor ordering the materials or supplies.

Upon receipt the Tulsa Metropolitan Utility Authority will pay the invoice, in accordance with its terms and conditions, as money is due the Contractor per referenced contract.

This letter of authorization expires Date.

Sincerely,

Eric Lee,
Director of Water and Sewer

MV:cc

EXTENSION OF TIME REQUEST
(to be submitted with each partial payment application)

DATE: _____

CONTRACTOR: _____

ADDRESS: _____

CONTRACT NO.: _____

PROJECT NO.: _____

DESCRIPTION: _____

ARE THERE ANY CHANGES TO YOUR SBE UTILIZATION? _____ YES _____ NO

IF YES, GIVE REASON AND ATTACH CHANGE REQUEST FORM (SBE-4): _____

EXTENSION OF CONTRACT TIME REQUIRED: _____ YES _____ NO

TOTAL OF EXTENSION TIME REQUESTED: _____

IF YES GIVE REASON: _____

SIGNATURE - CONTRACTOR

CONSULTING ENGINEER OR DEPARTMENT OF PUBLIC WORKS STAFF RECOMMENDATIONS

APPROVED: _____

REJECTED: _____

REASON: _____

SIGNATURE

DATE

ACTION WILL BE TAKEN WITHIN 30 DAYS FROM RECEIPT OF REQUEST

ETR-1

CONTRACT FOR CONSTRUCTION OF PUBLIC IMPROVEMENTS

TULSA, OKLAHOMA

THIS CONTRACT made and entered into this _____ day of _____, 2026, by and between __, an (list state)_____ (Corporation or Limited Liability Company) of __, Oklahoma hereinafter called the "CONTRACTOR", and the TULSA METROPOLITAN UTILITY AUTHORITY, Tulsa, Oklahoma, a Public Trust, herein called the "Authority".

WITNESSETH:

WHEREAS, the Authority has caused to be prepared the necessary Drawings, Specifications, and other Contract Documents for the public improvements herein described, and has invited bids for the construction thereof in accordance with the terms of the Contract, all of which is hereby designated as:

PROJECT NO. TMUA-W 24-03 MOHAWK WTP CHEMICAL TANK REPLACEMENT

WHEREAS, the Contractor, in response to the Advertisement, has submitted to the Authority, in the manner and at the time specified, a sealed bid in accordance with the terms of this Contract; and,

WHEREAS, the Authority, in the manner prescribed by law, has publicly opened, examined, and canvassed the bids submitted, and has determined the above named Contractor to be the lowest responsible bidder for the work and has duly awarded to the said Contractor therefore, for the sum or sums named in the Contractor's bid, a copy of the Bid Form being attached to and made a part of this Contract;

NOW, THEREFORE, in consideration of the compensation to be paid to the Contractor and of the mutual agreements and covenants herein contained, the parties to this Contract have agreed and hereby agree, as follows:

ARTICLE I. That the contractor shall (a) furnish all tools, equipment, supplies, superintendence, transportation, and other construction accessories, services, and facilities; (b) furnish all materials, supplies, and equipment specified and required to be incorporated in and form a permanent part of the completed work; (c) provide and perform all necessary labor; and (d) in a good, substantial, and workmanlike manner and in accordance with the requirements, stipulations, provisions and conditions of the Contract as defined in the attached General Conditions, said documents forming the Contract and being as fully a part thereof as if repeated verbatim herein, perform, execute, construct, and complete all work included in and covered by the Authority's official award of this Contract to the said Contractor, such award being based on the acceptance by the Authority of the Contractor's bid, or part thereof, as follows:

PROJECT NO. TMUA-W 24-03 MOHAWK WTP CHEMICAL TANK REPLACEMENT

ARTICLE II. That the Authority shall pay to the Contractor for performance of the work embraced in this Contract, and the Contractor will accept as full compensation therefor, the sum (subject to adjustment as provided by the Contract) of AND /100 Dollars (\$_____) for all work covered by and included in the Contract award and designated in the foregoing Article I; payments therefore to be made in cash or its equivalent, in the manner provided in the General Conditions.

ARTICLE IIA. All materials and supplies to be purchased under the terms of this contract shall be ordered by the Contractor from the vendor or supplier who shall be directed to invoice the Tulsa Metropolitan Utility Authority direct. The invoice shall reflect any contractor discount and no sales tax shall be added. The invoice will be paid direct by the Tulsa Metropolitan Utility Authority in accordance with the terms and conditions of the invoice (Oklahoma Tax Commission Rules Part 27 Trust Authority 710:65-13-140). The monies paid direct by Tulsa Metropolitan Utility Authority to the vendor or supplier shall be deducted from the total contract price. The Contractor shall accept delivery and be responsible for and shall warrant and hold the Authority harmless for the safety and security of all of the materials and supplies furnished for the project under this contract.

ARTICLE III. That the Contractor shall start work within ten (10) days following the date stipulated in a written order from the Authority to proceed with the work to be performed hereunder, and shall complete the work within the number of consecutive calendar days after the authorized starting date, as stipulated below:

All Work Completed: **270** calendar days

ARTICLE IV. The sworn, notarized statement below shall be signed and notarized before this Contract will become effective.

ARTICLE V. Prior to submitting a final payment request, the Contractor shall furnish a lien waiver certifying that all subcontractors and suppliers have been paid.

ARTICLE VI. If the Contractor has 10 or more full-time employees, and this contract exceeds \$100,000 in total value, Contractor acknowledges and agrees that, in accordance with and pursuant to 21 O.S. 1289.31, Contractor verifies to Authority that: (i) it does not have a practice, policy, guidance, or directive that discriminates against a firearm entity or firearm trade association, and (ii) will not discriminate against a firearm entity or firearm trade association during the term of this Contract.

IN WITNESS WHEREOF, the Authority and the Contractor hereto have set their hands and seals, respectively, this _____ day of _____, 2026.

APPROVED AS TO SUBSTANCE:

Director Date: _____

TULSA METROPOLITAN UTILITY AUTHORITY, a Public Trust

By:

Chairman Date: _____

ATTEST:

Secretary Date: _____

APPROVED AS TO FORM:

Attorney for the Trust Date: _____

CONTRACTOR

By: _____

Print Name: _____

Title Date: _____ Title Date: _____

ATTEST:

Corporate Secretary

(SEAL)

AFFIDAVIT

STATE OF _____)
)ss
COUNTY OF _____)

_____, of lawful age, being first duly sworn, on oath that (s)he is the agent authorized by the Contractor to submit the above Contract to the Tulsa Metropolitan Utility Authority, Tulsa, Oklahoma.

Signature

SUBSCRIBED AND SWORN to before me this _____ day of _____ 2026.

NOTARY PUBLIC

My Commission Expires:

_____, _____.

City of Tulsa Construction Escalation Process

Step	Contractor Representative(s)	City of Tulsa Representative(s)	Process	Communication / Documentation	Resolution (**)	No Resolution	Typical Time Frame (***)
1.0 Superintendent		Construction Inspector	Field Meeting Request for Information (RFI)	Phone, Text, Email, or RFI / Daily Report	Within Construction Documents	If not resolved within Construction Documents, escalate to 2.0	Same day to 3 days
2.0 Superintendent		Construction Inspector Manager / Construction Inspector	Field Meeting Request for Information (RFI) may apply	Phone, Text, Email, or RFI / Daily Report	Within Construction Documents	If not resolved within Construction Documents, escalate to 3.0	1 day to 3 days
3.0 Project Manager / Superintendent		Construction Manager / Construction Inspector Manager / Construction Inspector Lead Engineer / Project Manager Design Consultant	Contractor submit RFI	Phone, Email, RFI / Daily Report, RFI Log, Progress Mtg	Additional information provided. Potential Allowance Authorization, Extension of Quantities, Change Order, or Other	If not resolved by additional information and within terms of contract, escalate to 4.0	Within 10 calendar days (as ODOT 104.06.B)
4.0 Project Manager / Superintendent		Field Engineering Manager / Construction Manager Lead Engineer / Project Manager Design Consultant	Appeal Construction Manager's Decision	Email, RFI / Daily Report, RFI Log, Progress Mtg	Field Engineering Manager makes determination on appeal. Potential Allowance Authorization, Extension of Quantities, Change Order, or Other	If not resolved by additional information and within terms of contract, escalate to 5.0	Within 10 calendar days (as ODOT 104.06.B)
5.0 Owner / Project Manager / Superintendent		PW Deputy Director and/or other Dept Design Manager / Field Engineering Manager / Construction Manager Lead Engineer / Project Manager Design Consultant	Appeal Field Engineering Manager's Decision	Email, RFI / Daily Report, RFI Log, Progress Mtg	PW Deputy Director and/or other Dept. Design Manager makes determination on appeal. Potential Allowance Authorization, Extension of Quantities, Change Order, or Other	If appeal is not resolved, escalate to 6.0	Within 10 calendar days (as ODOT 104.06.B)
6.0 Owner / Project Manager / Superintendent		Director (*) / PW Deputy Director and/or other Dept Design Manager / Field Engineering Manager / Construction Manager Lead Engineer / Project Manager Design Consultant	Appeal PW Deputy Director's and/or other Dept. Design Manager's Decision	Email, RFI / Daily Report, RFI Log, Progress Mtg	Director makes determination on appeal. Potential Allowance Authorization, Extension of Quantities, Change Order, or Other		Within 10 calendar days (as ODOT 104.06.B)

(*) Director of the Department under whose authority construction is managed by Public Works Field Engineering. Public Works Deputy Director will notify Director of Public Works.

(**) Resolution - Complete information will assist in the most timely resolution. Each escalation step should address any information deficiencies and proposed resolutions, if any, that were unsatisfactory.

(***) Time frames - It is understood that special issues will require a more rapid response and escalation.

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS: That we, the undersigned, _____, (hereinafter called the "Contractor"), duly authorized by law to do business as a construction contractor in the State of Oklahoma, and _____ (hereinafter called the "Surety"), a corporation organized under the laws of the State of _____, and authorized to transact business in the State of Oklahoma, as Surety, are hereby held and firmly bound unto the Tulsa Metropolitan Utility Authority, Tulsa, Oklahoma (hereinafter called the "Authority"), in the penal sum of Dollars **(full amount of the Contract), (\$00)** lawful money of the United States, for the payment of which, well and truly to be made unto the said Authority, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents, as follows:

THE CONDITION OF THE FOREGOING OBLIGATION IS SUCH THAT, WHEREAS, the Contractor has on the _____ day of _____, 20____, entered into a written contract with the Tulsa Metropolitan Utility Authority, Tulsa, Oklahoma, for furnishing all materials, labor, tools, equipment, and transportation necessary for:

PROJECT NO. TMUA-W 24-03 MOHAWK WTP CHEMICAL TANK REPLACEMENT

NOW, THEREFORE, if said Contractor shall well and truly perform and complete said project in accordance with said Contract, Advertisement for Bids, General Conditions, Instructions to Bidders, Bid Form, Plans and Specifications, and related documents, shall comply with all the requirements of the laws of the State of Oklahoma; shall pay as they become due all just claims for work or labor performed and materials furnished in connection with said contract, and shall defend, indemnify and save harmless said Authority against any and all liens, encumbrances, damages, claims, demands, expenses, costs and charges of every kind, including patent infringement claims except as otherwise provided in said specifications and other contract documents, arising out of or in relation to the performance of said work and the provisions of said Contract, then these presents shall be void; otherwise, they shall remain in full force and effect.

This obligation is made for the use of said Authority and also for the use and benefit of all persons who may perform work or labor, or furnish any material in the execution of said Contract, and may be sued on thereby in the name of the Authority.

The Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract, or to the work to be performed thereunder, or the specifications accompanying same, shall in any way affect its obligation on this bond; and it does hereby waive notice of any such change, extension of time, alteration or addition of the terms of the Contract, or to the work or to the specifications.

IN WITNESS WHEREOF, the said Principal has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its duly authorized officers, and the said Surety has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its attorney-in-fact, duly authorized so to do, the day and year first above written.

CONTRACTOR (Principal)

BY:

ATTEST: (S E A L)

Date: _____ Title: _____

Date: _____ Title: _____

Date: _____ Attorney-In-Fact

Date: _____ Surety (S E A L)

** This date shall match the date of the notarized certificate on the Power of Attorney

(Accompany this Bond with Power-Of-Attorney)

APPROVED AS TO FORM:

Date: _____
Attorney for the Tulsa Metropolitan
Utility Authority

APPROVED AS TO FORM:

Date: _____
City Attorney

Date: _____
City Clerk

STATUTORY BOND

WHEREAS, the undersigned _____
has entered into a certain contract dated the _____ day of _____, 20____,
designated as **Project No. TMUA-W 24-03**, for the construction of certain public
improvements consisting of **Mohawk WTP Chemical Tank Replacement** to be
situated and constructed on and through the property described in said Contract,
including all of the work mentioned and described in said Contract, and to be
performed by the undersigned strictly and punctually in accordance with the terms,
conditions, drawings and specifications thereof, on file in the office of the Tulsa
Metropolitan Utility Authority.

NOW, THEREFORE, KNOW ALL MEN BY THESE PRESENTS: That
_____, as Principal, and
_____, a Corporation
organized under the laws of the State of _____, and authorized to
transact business in the State of Oklahoma, as Surety, are held and firmly bound
unto the State of Oklahoma in the penal sum of

Dollars (Full Amount of Contract) (\$_____), lawful money of the United
States, for the payment of which sum well and truly to be made, we bind ourselves,
our successors, and assigns, jointly and severally firmly by these presents.

NOW, THEREFORE, if the said Principal shall fail or neglect to pay all indebtedness
incurred by Principal or sub-contractors of said principal who perform work in the
performance of such contract, for labor and materials and repairs to and parts for
equipment used and consumed in the performance of said contract within thirty (30)
days after the same becomes due and payable, the person, firm or corporation
entitled thereto may sue and recover on this bond the amount so due and unpaid.

The Surety, for value received, hereby stipulates and agrees that no change,
extension of time, alteration, or addition to the terms of the contract or to the work to
be performed thereunder, or the specifications accompanying the same, shall in any
way affect its obligation on this bond, and it does hereby waive notice of any such
change, extension of time, alteration, or addition to the terms of the contract or to the
specifications.

IN WITNESS WHEREOF, the said Principal has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its duly authorized officers, and the said Surety has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its attorney-in-fact, duly authorized so to do, the day and year first above written.

CONTRACTOR(Principal)

BY:

ATTEST: (S E A L)

Date: _____ Title: _____

Date: _____ Attorney-In-Fact _____

Date: _____ Surety (S E A L)

** This date shall match the date of the notarized certificate on the Power of Attorney

(Accompany this Bond with Power-Of-Attorney)

APPROVED AS TO FORM:

Date: _____
Attorney for the Tulsa Metropolitan
Utility Authority

APPROVED AS TO FORM:

Date: _____
City Attorney

Date: _____
City Clerk

11/18/05

MAINTENANCE BOND

KNOW ALL MEN BY THESE PRESENTS:

That _____, as Principal,
and _____, a corporation organized
under the laws of the State of _____ and authorized to transact business in the
State of Oklahoma, as Surety, are held and firmly bound unto the Tulsa Metropolitan Utility
Authority in the Penal Sum of _____

_____ Dollars (full amount of Contract) (\$ _____) in lawful money of the
United States of America for the payment of which, well and truly to be made, we bind
ourselves and each of us, our heirs executors, administrators, trustees, successors, and
assigns, jointly and severally, firmly by these presents.

The condition of this obligation is such that:

WHEREAS, said Principal entered into a written contract with the Tulsa Metropolitan Utility
Authority dated _____, 20____, for

PROJECT NO. TMUA-W 24-03 MOHAWK WTP CHEMICAL TANK REPLACEMENT

all in compliance with the drawings and specifications therefore, made a part of said
Contract and on file in the office of the Authority, Tulsa, Oklahoma.

NOW, THEREFORE, if said Principal shall pay or cause to be paid to the Tulsa
Metropolitan Utility Authority, all damage, loss, and expense which may result by reason of
defective materials and/or workmanship in connection with said work, occurring within a
period of one (1) year for all projects, from and after acceptance of said project by the Tulsa
Metropolitan Utility Authority and if Principal shall pay or cause to be paid all labor and
materials, including the prime contractor and all subcontractors; and if principal shall save
and hold the Tulsa Metropolitan Utility Authority harmless from all damages, loss, and
expense occasioned by or resulting from any failure whatsoever of said Principal, then this
obligation shall be null and void, otherwise to be and remain in full force and effect.

It is further expressly agreed and understood by the parties hereto that no changes or
alterations in said Contract and no deviations from the plan or mode of procedure herein
fixed shall have the effect of releasing the sureties, or any of them, from the obligation of
this Bond.

MB-1

TMUA

11/18/05

IN WITNESS WHEREOF, the said Principal has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its duly authorized officers, and the said Surety has caused these presents to be executed in its name and its corporate seal to be hereunto affixed by its attorney-in-fact, duly authorized so to do, the day and year first above written.

CONTRACTOR(Principal)

BY:

ATTEST: (S E A L)

Date: _____
Title: _____

Date: _____
Title: _____

Date: _____
Attorney-In-Fact **

Date: _____
Surety (S E A L)

** This date shall match the date of the notarized certificate on the Power of Attorney

(Accompany this Bond with Power-Of-Attorney)

APPROVED AS TO FORM:

Date: _____
Attorney for the Tulsa Metropolitan
Utility Authority

APPROVED AS TO FORM:

Date: _____
City Attorney

Date: _____
City Clerk

MB-2

TMUA

AFFIDAVIT OF CLAIMANT

STATE OF _____

COUNTY OF _____

The undersigned, of lawful age, being first duly sworn, on oath says that this contract is true and correct. Affiant further states that the work, services or materials will be completed or supplied in accordance with the contract, plans, specifications, orders or requests furnished the affiant. Affiant further states that (s)he has made no payment directly or indirectly of money or any other thing of value to any elected official, officer or employee of the City of Tulsa or any public trust of which the City is a beneficiary to obtain or procure the contract or purchase order.

By: _____

Signature

Name: _____

Company: _____

Title: _____

Subscribed and sworn to before me this _____ day of _____, 20____.

Notary Public

My Commission Expires: _____

Notary Commission Number: _____

AC-1

**GENERAL
CONDITIONS**

GENERAL CONDITIONS OF CONTRACT

GC-1. SCOPE:

The Contract stipulations which follow are general in scope and may refer to conditions which will not be encountered in the performance of the work included in this Contract, and which are not applicable thereto. Any requirements, provisions, or other stipulations of these General Conditions which pertain to a nonexistent condition and are not applicable to the work to be performed hereunder, shall have no meaning in the Contract.

The specifications and drawings are intended to supplement, but not necessarily duplicate each other. Together they constitute one (1) complete set of specifications and drawings, so that any work exhibited in the one and not in the other shall be executed just as if it had been set forth in both, in order that the work shall be completed according to the complete design or designs as decided and determined by the Engineer.

Should anything be omitted from the specifications and drawings which is necessary to a clear understanding of the work, or should it appear various instructions are in conflict, then the Contractor shall request written clarification from the Engineer before proceeding with the construction affected by such omissions or discrepancies.

GC-2. CONTRACT DOCUMENTS:

It is understood and agreed that the Notice to Bidders, Instructions to Bidders, Proposal, Contract, Statutory Bond, Performance Bond, Maintenance Bond, Power of Attorney, Certificates of Insurance, General Conditions, Specifications, Drawings, Addenda and duly authorized Change Orders, together with any and all supplementary drawings furnished by the Engineer as and when required to make clear and to define in greater detail the intent of the contract, drawings, and specifications, other drawings, specifications, and engineering data furnished by the Contractor (when accepted by the Engineer), and instructions furnished by manufacturers of equipment for the installation thereof, are each and all included in this Contract, and the work shall be done in full compliance and accord therewith.

GC-3. DEFINITIONS:

Any word, phrase, or other expression defined in this paragraph and used in these Contract Documents shall have the meaning herein given:

1. "Contract" or "Contract Documents" shall include all of the documents and drawings mentioned in Paragraph GC-2.
2. "Authority" shall mean the Tulsa Metropolitan Utility Authority, Tulsa County, Oklahoma, a Public Trust.

3. "Contractor" shall mean the entity named and designated in the Contract who has entered into this Contract to perform the work covered thereby, and its, his, or their duly authorized agents and other legal representatives.

4. "Engineer" shall mean the Superintendent of Water Plant or Sewer Plant, or the Architect or Engineers who have been designated, appointed, or employed by the Authority and Superintendent of Water Plant or Sewer Plant for this project, or their duly authorized agents; such agents acting within the scope of the particular duties entrusted to them in each case.

5. "Inspector" shall mean the engineering or technical inspector or inspectors duly authorized by the Engineer, limited in each case to the particular duties entrusted to him or them.

6. "Surety" shall mean any entity that executes, as surety, the Contractor's performance bond, maintenance bond, and statutory bond securing the performance of this Contract.

7. "Drawings" shall mean and include all drawings prepared by the Authority as a basis for proposals; all drawings submitted by the successful bidder with his proposal and by the Contractor to the Authority, when and as accepted by the Engineer, and all drawings submitted by the Authority to the Contractor during the progress of the work as provided herein.

8. "Subcontractor" shall mean a person, firm or corporation to whom any portion of this work has been sublet by the Contractor.

9. "Work" shall mean the task to be performed, necessary for the fulfillment of this Contract.

10. "Unit Price" shall mean the cost per specified unit of measurement of work and/or material.

11. "Lump Sum" shall mean the price of an item of work including all things necessary to complete the item as shown on the drawings and specifications. Such an item is not measured in units but is defined by description.

GC-4. MODIFICATIONS AND ALTERATIONS:

In executing the Contract, the Contractor agrees that the Authority shall have the right to make such modifications, changes, and alterations as the Authority may see fit, in the extent or plan of the Work agreed to be done or any part thereof, or in the materials to be used therein, either before or after the beginning of construction thereof, without affecting the validity of the Contract or the liability of the Sureties upon the performance of this Contract or the Statutory Bond.

Where any modification, change, or alteration increases the quantity of Work to be performed and is within the scope of a fair interpretation thereof, such increase shall be paid for according to the quantity of work actually done, either at Unit Prices included in

the Contract, or in the absence of such unit, as extra Work. Modifications and alterations which reduce the quantity of Work to be done shall not constitute a claim for damages or for anticipated profits on Work involved in such reduction.

The Engineer shall determine, on an equitable basis, the amount of credit due the Authority for Work not performed as a result of modifications or alterations authorized hereunder; where the value of the omitted Work is not fixed by Unit Prices in the Contract; allowance to the Contractor for any actual loss incurred in connection with the purchase, delivery, and subsequent disposal of materials and equipment required for use on the Work as actually built; and any other adjustment of the Contract amount where the method to be used in making such adjustment is not clearly defined in the Contract Documents. In this respect, such determination shall be final and binding only when approved by the Superintendent of Water Plant or Sewer Plant.

GC-5. CPM SCHEDULE AND DRAWINGS TO BE FURNISHED BY CONTRACTOR:

The successful contractor shall furnish a CPM schedule per ODOT 108.03B. If at any time, in the opinion of the Engineer, proper progress is not being maintained, such changes shall be made in the schedule of operations, which will satisfy the Engineer that the work will be completed within the period stated in the Proposal. Monthly progress meeting will be conducted to maintain coordination between all project entities.

The Contractor shall furnish all shop, fabrication, assembly, foundation, and other drawings required by the specifications; drawings of equipment and devices, offered by the Contractor for review by the Engineer shall be in sufficient detail to show adequately the construction and operation thereof; drawings of essential details of any change in design or construction proposed for consideration of the Engineer, by the Contractor in lieu of the design or arrangement required by the Contract or any item of extra work thereunder. The Contractor shall submit to the Engineer, the required number of each copy of such drawing for the Engineer's review. After review by the Engineer, all such drawings shall become a part of the Contract Documents and the work or equipment shown thereby shall be in conformity therewith unless otherwise required by the Authority.

The Engineer's check and acceptance of drawings submitted by the Contractor will be for, and will cover, only general conformity to the plans and specifications and will not constitute a blanket acceptance of all dimensions, quantities, and details of the material or equipment shown; nor shall such acceptance relieve the Contractor of his responsibility for errors contained in such drawings.

GC-6. CONTRACTOR'S BUSINESS ADDRESS:

The business address of the Contractor given in the bid or proposal upon which this Contract is founded is hereby designated as the place to which all notices, letters, and other communications to the Contractor may be mailed or delivered. The delivery at the above named address or depositing in any mailbox regularly maintained by the Post Office, of any notice, letter, or other communication to the Contractor, shall be deemed sufficient service thereof upon the Contractor and the date of said service shall be the date of such delivery or mailing. Such address may be changed at any time by a written

instrument, executed by the Contractor and delivered to the Engineer. Nothing contained herein shall be deemed to preclude or render inoperative the service of any notice, letter, or communication upon the Contractor personally.

GC-7. CONTRACTOR'S RISK AND RESPONSIBILITY:

The performance of the Contract and the Work is at the risk of the Contractor until the final acceptance thereof and payment therefor. The Contractor shall take all responsibility of the Work, and shall bear all losses resulting because of the amount or character of the Work, or because the nature of the land in or on which the Work is done is different from what is assumed or expected, or on account of the weather, floods, fire, windstorm, or other actions of the elements, or any cause or causes, whatsoever, for which the Authority is not responsible. If the Work or any part or parts thereof is destroyed or damaged from any of the aforesaid causes, the Contractor, at his own cost or expense, shall restore the same or remedy the damage.

The Contractor shall, in a good and workmanlike manner, perform all Work and furnish all supplies and materials, machinery, equipment, facilities, and means, except as otherwise expressly specified, necessary or proper to perform and complete all Work required by the Contract within the time herein specified, in accordance with the provisions of these Contract Documents and Drawings of the Work covered by this Contract, and any and all supplemental Drawings. The Contractor shall observe, comply with, and be subject to all terms, conditions, requirements and limitations of the Contract, and shall complete the entire Work to the satisfaction of the Engineer and of the Authority.

GC-8. ASSIGNMENT AND SUBLETTING OF CONTRACT:

The Contractor shall give his personal attention to the fulfillment of this Contract, and shall not let, assign or transfer it or his right, title, or interest in any part thereof, by attorney or otherwise, or sublet any part of the Work to any other person without the prior consent of the Authority in writing.

Should any Subcontractor fail to perform his Work in a satisfactory manner, his subcontract shall be immediately terminated by the Contractor upon notice from the Authority. The Contractor shall be fully responsible to the Authority for the acts and omissions of his Subcontractor and of persons either directly or indirectly employed by his Subcontractor. Nothing contained in these Contract Documents shall create any contractual relation between any Subcontractor and the Authority.

GC-9. CONTRACTOR'S REPRESENTATIVES:

The Contractor shall designate a person on the Work to represent him when absent from the Work site.

GC-10. CONTRACTOR AND HIS EMPLOYEES:

The Contractor shall employ competent foremen, experienced mechanics, and others skilled in the several parts of the Work in this Contract and shall promptly discharge any and all incompetent or otherwise unsatisfactory employees. Contractor's employees directly employed to perform the Work shall not be paid less than the prevailing

minimum wage scale.

Necessary sanitary conveniences for the use of employees on the job site, properly secluded from public observation, shall be provided and maintained by the Contractor. The construction and location of the facility and disposal of the contents shall comply with all laws of the City and State, relating to health and sanitation regulations.

GC-11. CONTRACTOR'S RIGHT OF PROTEST:

If the Contractor considers any work demanded of him to be outside the requirements of the Contract, or considers any record or ruling of the Engineers to be unfair, he shall, immediately upon such Work being demanded or such record or ruling being made, ask for written instructions or decisions, whereupon he shall proceed without delay to perform the Work or to conform to the record or ruling, and within ten (10) days after the date of receipt of written instructions or decision, he shall file a written protest with the Engineer, stating clearly and in detail the basis of his objections. Except for such protests and objections made of record in the manner herein specified and within the time stated, the records, rulings, or decisions of the Engineer shall be final and conclusive.

GC-12. INSURANCE AND BONDS:

The Contractor (and any subcontractors) shall carry and keep in force during this Contract, policies of insurance issued by an insurer authorized to transact business in Oklahoma in minimum amounts as set forth below or as required by the laws of the State of Oklahoma. The Contractor shall also furnish an Owner's Protective Policy in the same amounts naming the Tulsa Metropolitan Utility Authority as the assured, issued by the same insurance company as the Contractor's liability coverage and indemnifying the Authority against any and all actions, claims, judgments or demands arising from injuries of any kind and character sustained by any person or persons because of work performed by the Contractor.

General Liability Insurance with a bodily injury and property damage combined single limit of not less than \$1,000,000.00 for each occurrence.

Employer's Liability and Workmen's Compensation in the amounts as required by law.

The Contractor shall provide proof of such coverage:

- (a) By providing Certificate(s) of Insurance prior to the execution of this contract; and
- (b) By submitting updated Certificate(s) of Insurance with each and every subsequent request for payment. The Certificate(s) should show that the policies are current and should be dated within 30 days of the payment request.

The Contractor shall not cause any required insurance policy to be cancelled or permit it

to lapse. If the Contractor cancels, allows to lapse, fails to renew or in any way fails to keep any required insurance policy in effect, the Authority will suspend all progress and/or final payments for the project until the required insurance is obtained. Further, a Contractor who fails to keep required insurance policies in effect may be deemed by the Authority to be in breach of contract, ineligible to bid on future projects, and/or ineligible to engage in any new contracts.

The Contractor shall execute and furnish a Statutory Bond for the protection of laborers, mechanics, and material men in a sum equal to one hundred percent (100%) of the contract price.

The Contractor shall execute and furnish a Performance Bond in a sum equal to one hundred percent (100%) of the contract price.

The Contractor shall execute and furnish a Maintenance Bond in a sum equal to one hundred percent (100%) of the contract price.

Prior to doing blasting, the Contractor shall furnish a Certificate of Insurance, which shall certify that any damage caused by blasting is within the coverage of the Contractor's liability insurance to the full limits thereof.

All bonds and insurance must be executed by a company licensed to do business in the State of Oklahoma and must be acceptable to the Authority.

GC-13. TIME FOR COMPLETION:

For all projects that will impact the public, a public meeting is required before any work is started. The City of Tulsa requires a minimum of 25 days' notice to get the public meeting scheduled and invitations mailed out.

The Work shall commence within ten (10) days from and after the date of a written order from the Authority. The Contractor agrees that the Work shall be performed regularly, diligently, and uninterruptedly at a uniform rate of progress so as to insure completion within the number of days after the day on which the work order is issued. If the Contractor fails to complete all Work within the time specified, then the Contractor agrees to pay the Authority, not as a penalty, but as liquidated damages for such breach of contract, the sum of **Two Thousand Five Hundred Dollars (\$2,500.00)** for each and every calendar day beyond the date on which the work was to be completed. The said amount is fixed and agreed upon because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the Authority would sustain in such event. It is expressly understood and agreed that the said time for the completion of the Work described herein is a reasonable time for the completion of the same.

The Contractor shall commence work within twenty-four (24) hours of traffic control devices being established at the project location. If the Contractor fails to commence work within twenty-four (24) hours of traffic control devices being established at the

project location, then the Contractor agrees to pay the Authority, not as a penalty, but as liquidated damages the sum of **One Thousand Dollars (\$1,000.00)** per lane for each day of failure to commence work after the specified time set forth. The amount is fixed and agreed upon because of the impracticability and extreme difficulty of fixing and ascertaining the actual damage the Authority would sustain in such event.

The Contractor will be required to provide a full-time, onsite English-speaking superintendent for this Work for direct contact with Authority and coordination of Subcontractors. A working foreman is not acceptable as a work superintendent. The superintendent shall be required to be present at the Work site whenever the Contractor or Subcontractors are performing Work. The superintendent shall be a representative of the Contractor with the authority to make decisions. If the Contractor fails to provide a non-working superintendent on a day when Work is being performed the Contractor agrees to pay the Authority, not as a penalty, but as liquidated damages for such breach of contract, the sum of **One Thousand Dollars (\$1,000.00)** for each and every calendar day it fails to provide a non-working superintendent at the Work site. This amount is fixed and agreed upon because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the Authority would sustain in such event.

It is further agreed that time is of the essence as to each and every portion of this Contract and the specifications wherein a definite and certain time is fixed for the performance of any act whatsoever; and where under the Contract an allowance of additional time for completion of any Work is made, the new time fixed by such extension shall be of the essence of this Contract.

Failure to complete the Work within the specified time, as set forth in the Contract, may be grounds for disqualification for future consideration for contracts with the Authority.

Final acceptance of the Work is defined as the completion of the Work and the Contractor moving off the project site. No defined or additional Work is needed.

Contract Evaluation forms will be compiled by Authority staff upon completion of Work to provide a record of the Contractor's performance for use in subsequent projects.

GC-14. EXTENSIONS OF TIME:

Should the Contractor be delayed in the final completion of the Work by any act or neglect of the Authority or Engineer, or any employee of either, or strikes, injunctions, fire, or other causes outside of and beyond the control of the Contractor and which, in the opinion of the Engineer, could have been neither anticipated nor avoided, then an extension of time sufficient to compensate for the delay, as determined by the Engineer, shall be granted by the Authority, provided, however, that the Contractor shall give the Authority and the Engineer notice in writing of the cause of each delay on the "Extension of Time Request" form enclosed in these documents, and agrees that any such claim shall be fully compensated for by an extension of time to complete performance of the Work.

The Contractor shall submit the "Extension of Time Request" form with each partial

payment application. Failure to submit the Extension of Time Request with a partial payment application shall constitute a complete waiver of any claim for time extension for the period covered by the partial payment.

Extensions of time will not be granted for delays caused by unsuitable ground conditions, inadequate construction force, or the failure of the Contractor to place orders for equipment or materials a sufficient time in advance to ensure delivery when needed. Any extension of time granted by the Authority shall not release the Contractor and Surety herein from the payment of liquidated damages as provided in the General Conditions of this Contract, for a period of time not included in the original Contract or the time extension, as herein provided.

In no event shall the Authority be liable or responsible to the Contractor, Surety, or any person for or on account of any stoppage or delay of Work herein provided for by injunction or any other kind of legal, equitable proceedings, or from or by or on account of any delay from any other cause whatsoever.

GC-15. ENGINEER'S POWERS AND DUTIES:

The Engineer will provide general administration of the Contract, including performance of the functions hereinafter described.

The Engineer will be the Authority's representative during construction and until final payment. The Engineer will have authority to act on behalf of the Authority to the extent provided herein unless otherwise modified by written instrument, which will be shown to the Contractor. The Engineer will advise and consult with the Authority, and all of the Authority's instructions to the Contractor shall be issued through the Engineer. Nothing contained in the Contract documents shall create any contractual relationship between the Engineer and the Contractor.

The Engineer shall at all times have access to the Work as provided elsewhere herein. The Engineer will make periodic visits to the Work site to familiarize himself generally with the progress and quality of the Work and to determine in general whether the Work is proceeding in accordance with the Contract. On the basis of his on-site observations as Engineer, he will keep the Authority informed of the progress of the Work and will endeavor to guard the Authority against defects and deficiencies in the Work caused by the Contractor. The Engineer will not be responsible for construction means, methods, techniques, sequences, or procedures, or for safety precautions and programs in connection with the Work, and will not be responsible for the Contractor's failure to carry out the Work in accordance with the Contract. Based on such observations and the Contractor's applications for payment, the Engineer will determine the amounts owing to the Contractor and will issue certificates for payment in amounts as provided elsewhere herein.

The Engineer may provide one or more full-time project representatives to assist the Engineer in carrying out his responsibilities at the Work site. The duties, responsibilities and limitations of authority of the Engineer as the Authority's representative during construction as set forth herein will not be modified or extended without written consent

of the Authority, the Contractor and the Engineer.

The Engineer will not be responsible for the acts or omissions of the Contractor, any Subcontractors, or any of their agents or employees, or any other persons performing any of the Work.

The Engineer shall decide the meaning and intent of any portion of the specifications, and of any plans or Drawings, where the same are found to be obscure or be in dispute; he shall have the right to correct any errors or omissions therein when such corrections are necessary to further the intent of said specifications, plans or Drawings; the action of such correction shall be effective from the date that the Engineer gives due notice thereof.

Any differences or conflicts which may arise between the Contractor and other contractors with the Authority in regard to their work shall be adjusted as determined by the Engineer.

Neither the Engineer's authority to act under this article or elsewhere in the Contract nor any decision made by the Engineer in good faith either to exercise or not to exercise such authority shall give rise to any duty or responsibility of the Engineer to the Contractor, any Subcontractor, any manufacturer, fabricator, supplier or distributor, or any of their agents or employees or any other person performing any of the Work.

Whenever in the Contract the terms "as ordered", "as directed", "as required", "as allowed", or terms of like effect or import are used, or the adjectives "reasonable", "suitable", "acceptable", "proper", or "satisfactory" or adjectives of like effect or import are used, to describe requirements, direction, review or judgement of the Engineer as to the Work, it is intended that such requirement, direction, review, or judgement will be solely to evaluate the Work for compliance with the Contract (unless there is a specific statement indicating otherwise). The use of any such term or adjective never indicates that the Engineer shall have authority to supervise or direct performance of the Work or authority to undertake responsibility contrary to the provisions of this General Condition.

GC-16. AUTHORITY'S RIGHT OF INSPECTION:

The Authority shall appoint or employ such engineers or inspectors as the Authority may deem proper to inspect the materials furnished and the work performed, and to determine whether said materials are furnished and work is performed in accordance with the Drawings and specifications therefor. The Contractor shall furnish all reasonable aid and assistance required by the Engineer, or by the Inspectors, for the proper inspection and examination of the Work and all parts thereof, even to the extent of uncovering or taking out portions of finished Work. Should the Work thus exposed or examined prove satisfactory, the uncovering or removing and the replacing of the covering or the making good of the parts removed shall be paid for by the Authority; however, should the Work exposed or examined prove unsatisfactory, the uncovering, taking out, replacing, and making good shall be at the expense of the Contractor.

Such inspection shall not relieve the Contractor of any obligation to perform said Work

strictly in accordance with the Drawings and specifications or any modifications thereto as herein provided, and the Work not so constructed shall be removed and made good by the Contractor at his own expense, and free of all expense to the Authority, whenever so ordered by the Engineer, without reference to any previous oversight or error in inspection.

GC-17. SUSPENSION OF WORK ON NOTICE:

The Contractor shall delay or suspend the progress of the Work or any part thereof whenever he shall be so required by written order of the Authority or Engineer, and for such period of time as it or he shall require. Any such order of the Authority or Engineer shall not modify or invalidate in any way the provisions of this Contract.

GC-18. QUALITY OF WORKMANSHIP:

All workmanship shall be the best possible, both as to material and labor, that could be demanded by these Contract Documents, or if no specific description is given, it is understood that the best quality is required.

GC-19. SATURDAY, SUNDAY, HOLIDAY, AND NIGHT WORK:

No work shall be done between the hours of 7:00 p.m. and 7:00 a.m., nor on Saturday, Sunday, or legal holidays without the written approval or permission of the Engineer in each case, except such work as may be necessary for the proper care, maintenance, and protection of work already done, or of equipment, or in the case of an emergency. Allowable working times within secured facilities may be adjusted by Engineer as necessary to facilitate established operational shift schedules.

GC-20. LAWS AND ORDINANCES:

The Contractor shall keep himself fully informed of all existing and current regulations of the City, county, state and national laws which in any way limit or control the actions or operations of those engaged upon the Work, or affecting the materials supplied to or by them. The Contractor shall at all times observe and comply with all applicable ordinances, laws, and regulations, and shall protect and indemnify the Authority and the Authority's employee's officers and agents against any claims or liability arising from or based on any violations of the same.

The contractor certifies that it and all of its Subcontractors to be used in the performance of the Contract are in compliance with 25 O.S. Sec. 1313 and participate in the Status Verification System. The Status Verification System is defined in 25 O. S. Sec. 1312 and includes but is not limited to the free Employee Verification Program (E-Verify) available at www.dhs.gov/E-Verify.

The Contractor shall take the necessary actions to ensure its facilities are in compliance with the requirements of the Americans with Disabilities Act (ADA). It is understood that the program of the Contractor is not a program or activity of the City of Tulsa. The Contractor agrees that its program or activity will comply with the requirements of the ADA. Any costs of such compliance will be the responsibility of the Contractor. Under no circumstances will Contractor conduct any activity, which it deems to not be in compliance with the ADA.

GC-21. TAXES AND PERMITS:

Unless otherwise specified in these Contract Documents, the Contractor shall pay all sales, use, and other taxes that are lawfully assessed against the Authority or Contractor in connection with the Work included in this Contract and shall obtain all licenses, permits, and inspections required for the Work. Contractor shall comply with all zoning ordinances of the City, as provided in the Tulsa Zoning Code, Title 42 Tulsa Revised Ordinances and conform with all zoning requirements established by the Tulsa Metropolitan Area Planning Commission and the Board of Adjustment. Contractor can call the Indian Nations Council of Governments (INCOG) at (918) 584-7526, to determine if any zoning requirements must be met.

GC-22. PROTECTION OF PROPERTY:

The protection of City, state, and government monuments, street signs, and other City property is of prime importance, and if the same be damaged, destroyed, or removed, they shall be repaired, replaced, or paid for by the Contractor.

Work occurring within secured facilities will require the Contractor to obtain City of Tulsa issued ID badges for all employees and subcontractors requiring facility gate access. The Contractor will be responsible for all coordination with City Security as necessary to process background checks and issue badges. The City of Tulsa has the right to deny access to any individual based on evaluation of background check.

GC-23. PATENT RIGHTS:

All fees for any patented invention, article, or arrangement that is based upon, or in any manner connected with the construction, erection, or maintenance of the Work or any part thereof embraced in the Contract and these specifications, shall be included in the price stipulated in the Contract for said Work. The Contractor shall protect and hold harmless the Tulsa Metropolitan Utility Authority, against any and all demands of such fees or claims.

GC-24. DEFENSE OF SUITS:

In case any action at law or suit in equity is brought against the Authority or any employee, officer or agent thereof, for or on account of the failure, omission or neglect of the Contractor to do and perform any of the covenants, acts, matters, or things required by this Contract to be done or performed, or for injury or damage caused by negligence or willful act of the Contractor or his Subcontractors or his or their agents, or in connection with any claim or claims based on the lawful demands of Subcontractors, workmen, materialmen, or suppliers of machinery and parts thereof, equipment, power tools, and supplies incurred in the fulfillment of this Contract, the Contractor shall indemnify and save harmless the Authority and its employees, officers and agents, and the Engineer and any employees, officers and agents thereof, of and from all losses, damages, costs, expenses, judgements, or decrees whatsoever arising out of such action or suit that may be brought, without requiring said parties to give any notice thereof.

The Authority may suspend payments of any sum due or to become due for work done

on this Contract until such claims, suits, actions, or proceedings are final and liability has been determined. The amount of such damages or liability shall be deducted from sums due or to become due on this Contract. The sums mentioned above will be retained by the Authority until the Contractor furnishes evidence that satisfactory settlement has been made. Any action taken by the Authority shall not excuse the Contractor for failure to perform this Contract or bar the Authority from legal action to recover from the Contractor the amount of damages or liability suffered in excess of the amount retained.

The Contractor shall furnish the Authority with satisfactory evidence, upon demand, that all persons who have done work on the Contract or furnished materials for the Contract have been paid in full. If such evidence is not furnished, the amount necessary to pay the lawful claims may be retained until such evidence is furnished, or if such evidence is not furnished, the Authority may apply any sums retained to valid claims and charge the amounts disbursed, including the costs of any action that may be necessary to prove or disprove the claims against the Contractor.

GC-25. REMOVAL OF CONDEMNED MATERIALS AND STRUCTURES:

The Contractor shall remove from the site of the Work, without delay, all rejected and condemned materials or structures of any kind brought to or incorporated in the Work, and upon his failure to do so, or to make satisfactory progress in so doing, within forty-eight (48) hours after the service of a written notice from the Engineer ordering such removal, the condemned material or structures may be removed by the Authority and the cost of such removal be taken out of the money that may be due or may become due the Contractor by virtue of this Contract. No such rejected or condemned material shall again be offered for use by the Contractor under this or any other Contract under this project.

GC-26. EXTRA WORK:

If a modification increases the amount of the Work, and the added Work or any part thereof is of a type and character which can properly and fairly be classified under one or more Unit Price items of the Bid Form, then the added Work or part thereof shall be paid for according to the amount actually done and at the applicable Unit Price. Otherwise, such work shall be paid for as hereafter provided.

Claims for extra work will not be paid unless the Work covered by such claims was authorized in writing by the Authority. The Contractor shall not have the right to take action in court to recover for extra work unless the claim is based upon a written order from the Authority. Payments for extra Work will be based on agreed lump sums or on agreed Unit Prices whenever the Authority and the Contractor agree upon such prices before the extra Work is started.

For the purpose of determining whether proposed extra work will be authorized, or for determining the payment method for extra work, the Contractor shall submit to the Engineer, upon request, a detailed cost estimate for proposed extra work. The estimate shall show itemized quantities and charges for all elements of direct cost.

The cost shall include only those extra costs for labor and materials expended in direct performance of the extra work and may include:

- (a) **Labor.** For all labor and foremen in direct charge of the specific operations, the Contractor shall receive the rate of wage (or scale) agreed upon in writing before beginning work for each and every hour that said labor and foremen are actually engaged in such work. An amount equal to fifteen (15) percent of the sum of the above items will also be paid the Contractor.
- (b) **Bond, Insurance, and Tax.** For property damage, liability, and workmen's compensation insurance premiums, unemployment insurance contributions and social security taxes on the force account work, the Contractor shall receive the actual cost, to which cost no percentage will be added. The Contractor shall furnish satisfactory evidence of the rate or rates paid for such bond, insurance, and tax.
- (c) **Materials.** For materials accepted by the Engineer and used, the Contractor shall receive the actual cost of such materials delivered on the Work site, including transportation charges paid by him (exclusive of machinery rentals as hereinafter set forth), to which cost ten (10) percent will be added.
- (d) **Equipment.** For any machinery or special equipment (other than small tools) including fuel, lubricants and transportation costs, the use of which has been authorized by the Engineer, the Contractor shall receive the rental rates agreed upon in writing before such work is begun for the actual time that such equipment is in operations on the Work, as provided in Subsection 109.04(b3), to which rental sum no percentage will be added.
- (e) **Miscellaneous.** No additional allowance will be made for general superintendence, the use of small tools, or other costs for which no specific allowance is herein provided.

The form on which field cost records are kept, the construction methods and the type and quantity of equipment used shall be submitted to the Engineer for approval.

Construction equipment which the Contractor has on the Work site and which is of a type and size suitable for use in performing the extra Work shall be used. The hourly rental charges for equipment, including all insurance, taxes, fuel, and operating costs, shall not exceed twelve (12) percent of the latest applicable Associated Equipment Distributors published monthly rental rates and shall apply to only the actual time the equipment is used in performing the extra Work.

When extra Work requires the use of equipment, which the Contractor does not have on the work site, the Contractor shall obtain the approval of the Engineer before renting or otherwise acquiring additional equipment. The rental charges for the additional equipment shall not exceed the latest applicable Associated Equipment Distributors published rental rates.

The Contractor shall file with the Engineer, certified lists in duplicate, of any equipment and the schedule of pay rates for common and semi-skilled labor and operators of various classes which are intended to be used in performing the Work covered by this Contract. These rates shall be subject to the review of the Engineer. This information will be used by the Engineer for computation of extra work as mentioned above, however, if the Contractor fails to file these lists with the Engineer prior to starting any Work covered by this Contract, then the Engineer's computation shall be based on average wages and rates paid on Authority work.

GC-27. PAYMENT FOR CONTRACTOR'S PLANT AND MISCELLANEOUS TEMPORARY WORK:

For providing plant, tools, and equipment, and for furnishing, erecting, maintaining, and removing scaffolding and construction plant, construction roads, camps, sanitary conveniences, temporary water supply, trestles, dewatering and other temporary works, the Contractor shall receive no direct payment, but compensation for them shall be considered as having been included in the prices stipulated for the appropriate items.

GC-28. BASIS OF PAYMENT FOR ITEMS OF WORK:

The Contractor shall be paid for all Work performed under the Contract based on the Engineer's computations of as-built quantities and the Contractor's Unit Price or Lump Sum bid per item. This payment shall be full compensation for furnishing all supplies, materials, tools, equipment, transportation, and labor required to do the Work; for all loss or damage, because of the nature of the work, the action of the elements or any unforeseen obstruction or difficulty which may be encountered in the performance of the Work, and for which payment is not specifically provided; for all expense incurred by or because of any suspension or discontinuance of all or any part of the Work; and for faithfully completing the Contract according to the Drawings and specifications and requirements of the Engineer.

GC-29. PAYMENTS:

(1) Partial: If the work is progressing in good and workmanlike manner and if the Contractor is faithfully carrying out the terms of this Contract, approximate estimates of the work done shall be made by the Engineers between the first and fifteenth of each calendar month, including labor actually performed and supplies or materials actually used or incorporated in the Work, and an allowance will be made for acceptable materials satisfactorily delivered, stored and secured on the site of the Work in such amount as can be incorporated in the Work within a reasonable time. The Authority shall have a lien as owner on any materials stored on the site of the Work.

Each partial estimate for payment shall contain or have attached an affidavit in the form found in this book of specifications, as required by law.

The Contractor shall submit with each partial pay estimate a complete list of vendors and suppliers with itemized purchases and invoices from each vendor. Each list shall contain the name of the Contractor or Subcontractor ordering the materials or supplies, and the specific use or placement of each of the materials purchased by the Tulsa

Metropolitan Utility Authority for this project in accordance with Article IIB of the Contract. At the direction of the Contractor, the Tulsa Metropolitan Utility Authority will withhold retainage in the amount of 5% on materials and supplies to be purchased under the terms of this Contract. If fuels are purchased, they shall be limited to dyed diesel fuel and/or kerosene for non-highway use. No unleaded gasoline will be permitted.

Each month that work is performed for which payment is due, the Contractor shall submit to the Engineer an application for such payment, provided said payment is not less than \$1,000.00, and, if required, receipts or other vouchers from Subcontractors showing his payments to them shall be submitted.

Each estimate shall be of the approximate value of all work performed and materials in place or delivered to the Work site, determined as aforesaid from the beginning of this contract to the date fixed for the current estimate, from which shall be deducted five percent (5%), or a lesser amount approved by the Authority, and, in addition thereto, all previous payments and all other sums withheld under the foregoing provisions of this Contract, the remainder to become due and payable; after the estimate has been reviewed and signed by the Engineer and the Authority, shall pay the estimate in the regular manner in the amount determined as due unless it shall be known by the Authority that there is good reason under the terms of this Contract for withholding same.

When the Contractor has completed Work constituting more than fifty percent (50%) of the total Contract amount, the retainage will continue at two and one-half percent (2.5%) for the balance of the remaining work; provided, however, that the City or its duly authorized representative has determined that satisfactory progress is being made and upon approval by the Surety.

The Contractor may withdraw any part or the whole of the amount which has been retained from partial payment to the Contractor pursuant to the terms of Contract, upon depositing with or delivery to the City:

- (1) United States Treasury Bonds, United States Treasury Notes, United States Treasury bills, or
- (2) General Obligation Bonds of the State of Oklahoma, or
- (3) Certificates of Deposit from a state or national bank having its principal office in the State of Oklahoma.

No retained amount shall be withdrawn which would represent an amount in excess of the market value of the securities at the time of deposit or of the par value of such securities, whichever is lower.

All partial estimates are subject to correction in the final estimate.

(2) Final Payment:

When this contract, in the opinion of the Engineer, shall be completely performed on the part of the Contractor, the Engineer shall proceed with all reasonable diligence to measure up the Work and shall make out the final estimate for the same, and shall, except for cause herein specified, give to the Contractor, within thirty (30) days after receiving said certificate, an order on the Authority for the balance found to be due, excepting therefrom such sum or sums as may be lawfully retained under any of the provisions of the Contract; PROVIDED, that nothing herein contained shall be construed to affect the rights of the Authority hereby reserved to reject the whole or any portion of the aforesaid Work should the said estimate and certificate be found or known to be inconsistent with the terms of this Contract or otherwise improperly given; PROVIDED, that if after the work hereunder has been accepted and final payment made, it shall be discovered that any part of the Contract has not been fully performed or has been done in an improper or faulty manner, the Contractor shall immediately remedy such defect, or, in case of neglect to do so within a reasonable time after notice thereof, shall be liable for and shall pay to the Authority the cost of remedying such defect or a sum equal to the damages sustained thereby, as the Authority shall elect and the acceptance of and final payment for the Work shall be no bar to suit on any bond against any principal or principals, or Surety or Sureties, or both, given for the due performance of the Contract, or for the recovery of such cost or the equivalent of such damage.

The Authority will pay to the Contractor interest at the rate of three-fourths percent (3/4%) per month on the final payment due the Contractor. For lump sum contracts, the interest shall commence thirty (30) days after the Work under the Contract has been completed and accepted and all required material certifications and other documentation required by the Contract have been furnished the Authority by the Contractor, and shall run until the date when the final payment or estimate is tendered to the Contractor. For contracts bid by Unit Prices, the interest will commence sixty (60) days after the above conditions are satisfied. When contract quantities or the final payment amount is in dispute, the interest-bearing period will be suspended until the conclusion and settlement of the dispute.

GC-30. CONTRACTOR REIMBURSEMENT FOR SURETY BOND:

For contracts of \$1,000,000.00 or more, the Contractor may receive reimbursement for the cost of the surety bonds after issuance of a work order. To receive reimbursement, the Contractor shall submit a standard partial payment form and affidavit, and a copy of the surety bond invoice. The final partial pay estimate will be reduced by the amount paid for surety bond reimbursement.

GC-31. RELEASE OF LIABILITY AND ACCEPTANCE:

The acceptance by the Contractor of the final payment shall operate as, and shall be a release to the Authority and every employee, officers and agents thereof, from all claims and liability to the Contractor for anything done or furnished for or relating to the Work, or for any act or neglect of the Authority or of any person relating to or affecting the Work, and, following such acceptance, no person, firm, or corporation other than the signer of this Contract as Contractor, will have any interest hereunder, and no claim shall be made or be valid, and neither the Authority nor any employees or agent thereof

shall be liable or be held to pay any money, except as herein provided.

It shall be the duty of the Engineer to determine when the Work is completed and the Contract fulfilled, and to recommend its acceptance by the Authority. The Work herein specified to be performed shall not be considered finally accepted until all the Work has been accepted by the Authority.

GC-32. RIGHT OF AUTHORITY TO TERMINATE CONTRACT:

If the Work to be done under this Contract shall be abandoned by the Contractor, or if this Contract shall be assigned by him otherwise than as herein provided, or if the Contractor should be adjudged bankrupt, or if a general assignment of his assets be made for the benefit of his creditors, or if a receiver should be appointed for the Contractor or any of his property; or if at any time the Engineer shall certify in writing to the Authority that the performance of the Work under this Contract is being unnecessarily delayed, or that the Contractor is executing the same in bad faith or otherwise not in accordance with the terms of the Contract; or if the work be not substantially completed within the time named for its completion, or within the time to which such completion date may be extended; then the Authority may serve written notice upon the Contractor and his Surety of Authority's intention to terminate this Contract, and unless, within five (5) days after service of such notice upon the Contractor, a satisfactory arrangement is made for the continuance of the Contract, this Contract shall cease and terminate. In the event of such termination, the Authority shall immediately serve notice upon the Surety and Contractor, and the Surety shall have the right to take over and complete the Work, provided, however, that if the Surety does not commence performance thereof within fifteen (15) days from the date of said notice of termination, the Authority may take over the Work and perform same to completion, by Contract or otherwise, for the account and at the expense of the Contractor, and the Contractor, and his Surety, shall be liable to the Authority for any and all excess cost sustained by the Authority by reason of such performance and completion. In such event the Authority may take possession of and utilize in completing the Work, all such materials, equipment, tools, and plant as may be on the site of the Work and necessary therefor. The Contractor shall not receive any other payment under the Contract until said Work is wholly finished, at which time, if the unpaid balance of the amount to be paid under the Contract shall exceed the expense incurred by the Authority in finishing the Work as aforesaid, the amount of the excess shall be paid to the Contractor, but if such expense shall exceed the unpaid balance, the Contractor shall pay the difference to the Authority.

GC-33. ADMINISTRATIVE COSTS AND FEES:

Cash Improvements - In the event the improvements are to be paid for in cash: the costs and fees for publication, engineering, filing, recording, abstracting, acquisition of easements, flushings, and pipe testing, shall be paid by the Authority unless otherwise provided for in these Contract Documents.

Assessment Improvements: In the event the improvements are to be paid for by the issuance of special assessment bonds, the costs and fees for publication, engineering, filing, recording, abstracting, acquisition of easements, flushing, pipe testing, and other

authorized costs shall be added to the contract price and paid for in the same manner as the other Work included in this Contract. The Contractor shall pay the Authority the amount of said charges before the execution and delivery of the special assessment bonds or other payments. If the Contractor fails, neglects, or refuses to pay said charges within thirty (30) days after the bonds are ready for delivery, he shall pay the Authority interest at the rate of seven percent (7%) per annum and shall be liable for same in a civil suit. The Contractor shall pay the pipe testing fees directly to the testing laboratory.

GC-34. PAYMENT OR ACCEPTANCE NOT A WAIVER BY AUTHORITY:

Neither acceptance by the Authority or the Engineer or any employee of either nor any order by Authority for the payment of money, or the payment thereof, nor any taking of possession by Authority, nor the granting of any extension of time, shall operate as a waiver of any rights or powers of the Authority hereunder, and in the event that after the Work hereunder has been accepted and final payment made, it should be discovered that any part of this Contract has not been fully performed, or has been done in a faulty or improper manner, the Contractor shall immediately remedy such defect, or in the event of neglect to do so within a reasonable time after notice thereof, shall be liable for and shall pay to Authority the cost of remedying such defect, or a sum equal to the damage caused thereby, as Authority may elect. The acceptance of the Work or final payment therefor shall be no bar to suit against the Contractor or Surety, or both.

GC-35. CONTRACTOR'S OBLIGATION AFTER ACCEPTANCE:

Contractor further agrees, without cost other than is specially provided for in this Contract, at any and all times during one (1) year next following the completion and final acceptance of the Work embraced in this Contract, without notice from Authority, to refill all trenches or ditches that may sink or settle; and to repair all breaks and failures that may occur in the construction work due to defective material or workmanship; and to indemnify, save harmless and defend the Authority from any and all suits and actions of every description brought against Authority for, or on account of injuries or damages alleged to have been received or sustained by any party or parties by reasons of, or arising out of the failure of Contractor to refill all trenches and ditches and to repair all breaks or failures of said construction work, which said injuries or damages are alleged to have been received or incurred within one (1) year from the final acceptance of the Work hereunder, and to pay any and all judgements that might be rendered against Authority in any suits and actions, together with such expenses or attorney's fees expended or incurred by Authority in the defense thereof, and Contractor hereby expressly waives any notice that might by law be required to be given to them by Authority of any defect, break, settling, or failure or of any other condition that might be the cause of injury or damage to any person on account of which a claim or suit might be made or filed against Authority, or a judgement taken for damages against Authority. It is expressly agreed that the acceptance of the Work by Authority shall constitute no bar against any person injured or damaged by the failure of the Contractor to perform all of his covenants and agreements hereunder from maintaining an action against the Contractor, or against Authority from enforcing its rights against the Contractor hereunder.

GC-36. NOTICES:

Any notices or other communications hereunder may be given to Contractor at the address listed in the Proposal, to the Surety at the office of the Attorney-in-Fact signing the bond or at Surety's home office address on file with the Insurance Commissioner of the State of Oklahoma, and to Authority in care of the City of Tulsa's Director of Public Works, or at such other place as may be designated in writing. The delivery at such address, or depositing in any mailbox regularly maintained by the Post Office, of any notice, letter, or other communication to the Contractor, shall be deemed sufficient service thereof, and the date of said service shall be the date of such delivery or mailing.

GC-37. RELATION TO OTHER CONTRACTORS:

Nothing herein contained and nothing marked upon the Drawings shall be interpreted as giving the Contractor exclusive occupancy of the territory or right-of-way provided. The Authority and its employees, officers, and agents for any just purpose, and other contractors of the Authority for any purpose required by their respective contracts, may enter upon or cross this territory or occupy portions of it or take materials therefrom as directed or permitted. When two or more contracts are being executed at one time on the same or adjacent land in such manner that the work on one contract may interfere with the work on another, the Engineers shall decide which contractor shall cease work and which shall continue, or whether the work on both contracts shall progress at the same time and in what manner. When the territory of one contract is the necessary or convenient means of access for the transportation or movement of men, machines, or appliances for the execution of another contract, such privilege of access or any other reasonable privilege may be granted by the Engineers to the contractor desiring it, to the extent, amount, in the manner and at the time permitted. Any decision regarding the method or time of conducting the work or the use of the territory shall not be made the basis of claims for delay or damage except as otherwise stipulated. The Contractor shall not cause any unnecessary hindrance or delay to any other contractors on the premises and shall bear all damages done to the work of such other contractors by him or by his employees.

GC-38. PARTIAL OCCUPANCY AND USE:

The Authority, upon advance written notification to the Contractor, shall have the right to occupy and use any completed or partially completed portions of the Work site when such occupancy and use are in the Authority's best interest, notwithstanding completion of the entire project.

Such partial occupancy and use shall be upon the following terms:

- a. The Engineer shall make an inspection of the portion or portions of the Work concerned, and report to the Authority his findings as to the acceptability and completeness of the Work. The Engineer's report shall include a list of items to be completed or corrected before final payment.
- b. The Authority, upon acceptance of the Engineer's report, shall give

written notice to the Contractor of the Authority's intention to occupy and use said portions of the Work site. The Authority's notice shall include a copy of the Engineer's report, shall clearly identify the portions of the Work site to be occupied and used, and shall establish the date of said occupancy and use.

- c. From the date thus established, the Authority shall assume all responsibilities for operation, maintenance, and the furnishing of water, gas, and electrical power for the portions of the Work site thus occupied and used. The Authority shall have the right to exclude the Contractor from those portions of the Work site but shall provide the Contractor reasonable access to complete or correct necessary items of Work.
- d. The one-year guarantee required by the General Conditions shall not begin until completion and final acceptance of the entire project. If, before final acceptance, the Contractor completes any mechanical or electrical equipment such as pumps, blowers, process equipment, instrumentation, controls, metering equipment, heating, and ventilation equipment and similar items having movable or operable components, the Contractor may then request partial acceptance of each completed equipment system. In response, the Engineer will perform a final inspection of each system and determine if all specifications are satisfied, including but not limited to start-up conditions, performance criteria, control systems, training, and final operation manuals (O & M's). Once found to be complete, ready for operation, and isolated from all remaining work, the Engineer will provide Contractor with written notice of partial acceptance and the start date for the one-year guarantee required by the General Conditions.
- e. Occupancy or use of any space in the Work site shall not constitute acceptance of Work not performed in accordance with the Contract, nor relieve the Contractor of liability to perform any Work required by the Contract but not completed at the time of said occupancy and use.
- f. The Contractor shall not be held responsible for normal wear and tear or damage resulting from said occupancy, except to the extent that such damage is covered by the one-year guarantee.
- g. The partial occupancy and use of any portions of the Work site by the Authority shall not constitute grounds for claims by the Contractor for release of any amounts retained from payments under the provisions of the Contract. The retained amounts will not be due until completion of the entire project for final acceptance and final payment, as set forth in the General Conditions.

**SPECIAL
PROVISIONS**

SPECIAL PROVISION
SUPPLEMENTAL CONTRACT REQUIREMENTS
PROJECT NO. TMUA-W 24-03
MOHAWK WTP CHEMICAL TANK REPLACEMENT

1. Apparent lowest, responsible bidder shall return their signed contract documents (including bonds and insurance) to the City of Tulsa, Contract Administration Section 175 E. 2nd Street, 13th Floor, OK 74103 within fifteen (15) days after notification by the City.
2. If the apparent lowest, responsible bidder provides their signed contract documents (including bonds and insurance) and the contract is executed by the City, the Pre-Construction Conference for this project will be held within sixty (60) days after bid opening.
3. The Notice to Proceed or written work order (NTP) will be issued in the normal time period (approximately within ten (10) days of the Pre-Construction Conference).

The City will grant up to ninety (90) days for a delayed (flexed) NTP after the Pre-Construction Conference. No delayed (flexed) NTP above this amount will be granted unless approved by the City Engineer or designee.

4. There will be no additional compensation due to the use of a delayed (flexed) NTP.
5. This Special Provision does not alter the Public Meeting requirements (and public notice) defined in the General Conditions.

SPECIAL PROVISIONS
INSURANCE REQUIREMENTS

In reference to Ordinance No. 24616 Adoption of State Specification for Highway Construction, Section 107.12 shall be modified as follows:

The CONTRACTOR (and any subcontractors) shall carry and keep in force during this Contract, policies of insurance issued by an insurer authorized to transact business in Oklahoma in minimum amounts as set forth below or as required by the laws of the State of Oklahoma. The CONTRACTOR shall also furnish an Owner's Protective Policy in the same amounts naming the Tulsa Metropolitan Utility Authority as the assured, issued by the same insurance company as the CONTRACTOR'S liability coverage and indemnifying the Tulsa Metropolitan Utility Authority against any and all actions, claims, judgments or demands arising from injuries of any kind and character sustained by any person or persons because of work performed by the CONTRACTOR.

General Liability Insurance with a bodily injury and property damage combined single limit of not less than \$1,000,000.00 for each occurrence.

Employer's Liability and Workmen's Compensation in the amounts as required by law.

The CONTRACTOR shall provide proof of such coverage:

- (a) By providing Certificate(s) of Insurance prior to the execution of this contract; and
- (b) By submitting updated Certificate(s) of Insurance with each and every subsequent request for payment. The Certificate(s) should show that the policies are current and should be dated within 30 days of payment request.

The CONTRACTOR shall not cause any required insurance policy to be cancelled or permit it to lapse. If the CONTRACTOR cancels, allows to lapse, fails to renew or in any way fails to keep any required insurance policy in effect, the City will suspend all progress and/or final payments for the project until the required insurance is obtained. Further, a CONTRACTOR who fails to keep required insurance policies in effect may be deemed by the City to be in breach of contract, ineligible to bid on future projects, and/or ineligible to engage in any new contracts.

The Contractor shall execute and furnish a Statutory Bond for the protection of laborers, mechanics, and material men in a sum equal to one hundred percent (100%) of the contract price.

The Contractor shall execute and furnish a Performance Bond in a sum equal to one hundred percent (100%) of the contract price.

The Contractor shall execute and furnish a Maintenance Bond in a sum equal to one hundred percent (100%) of the contract price.

Prior to doing blasting, the Contractor shall furnish a Certificate of Insurance, which shall certify that any damage caused by blasting is within the coverage of the Contractor's liability insurance to the full limits thereof.

All bonds and insurance must be executed by a company licensed to do business in the State of Oklahoma and must be acceptable to the City.

SPECIAL PROVISIONS
OWNER ALLOWANCE

The "Owner Allowance" may be used for various work and miscellaneous items not specifically identified in the Contract Documents with the following provisions:

- A. The allowance shall be used for cost of design and construction, including all materials, labor, equipment, profit and overhead, of work items not specifically identified in the Construction Documents, or included in original pay items bid for the contract.
- B. The allowance shall be utilized only at the discretion of the City of Tulsa. Any balance remaining at the completion of the Project will be retained by the City of Tulsa.
- C. The Contractor shall provide, to the City of Tulsa, a written request for the use of any allowance, including a schedule of values and associated backup information, including validity of need, materials, labor, equipment, and time required to perform the associated work.

Contractor shall proceed with the allowance work only after receiving written permission from the City of Tulsa. Proceeding with associated allowance work without written permission from the City of Tulsa will be at the Contractor's sole expense.

SPECIAL PROVISION
FOR UTILITY RELOCATIONS
AND DESIGN ISSUES

It is the intent of this specification to provide no more than seventy-five **(75)** calendar days due to delays caused by required utility relocations and required design clarifications. Should the Contractor be delayed in the final completion of work by any utility relocation or design issue, additional days as determined by the Engineer shall be granted by the City. However, the Contractor shall give the Engineer notice in writing of the cause of the delay in each case on the Extension of Time Request Form enclosed in these documents, and agrees that any claim shall be fully compensated for by the provisions of this specification to complete performance of the work. An adjustment will not be made to the contract time bid for incentive purposes.

Any time granted for utility relocations or design issues up to **(75)** calendar days will be in addition to the number of days shown in the proposal for computation of disincentive and liquidated damages.

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			Date Created	8/23/2016
			Date Revised	6/2/2025
			Approved by	Dustin Davis
			Control No.	MOH-SAF-001
			Department/Work Group	WSD/MOH

Prior to beginning work at the City of Tulsa Mohawk WTP, all contractors shall appoint an Onsite Safety Representative. The Onsite Safety Representative will receive an orientation briefing from the plant superintendent regarding contractor requirements and expectations. This briefing will include the following:

- Visitor and Security Policy
- Contact and emergency information
- Completion of Contractor's designated onsite safety representative form
- Protection of drinking water quality and discharge streams
- Tools and equipment
- Site tobacco policy
- Site parking and driving requirements
- Site housekeeping requirements
- Discrimination policy
- Drug and alcohol policy
- Emergency Action Plan
- Notification of accidents, incidents, and near misses
- Required Personal Protective Equipment (PPE)
- Required permits for performing the work and means of obtaining permits, i.e. hot work permit, confined space, etc.
- Fall protection
- Lockout-tagout
- Permit-required confined spaces
- Use of electrical equipment
- General Contractor responsibilities

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CONTRACTOR MANAGEMENT TRAINING CHECKLIST		
1.0 VISITOR AND SECURITY POLICY		Y Completed
Provide a copy and review Visitor and Security Policy.		
2.0 CONTACT AND EMERGENCY INFORMATION		Y Completed
Internal Resources	Office	Mobile
Dylan Hutchcraft Plant Superintendent	918-591-4028	918-200-3545
Greg Cato Operations Supervisor	918-591-4029	918-218-8498
Dillon Williams Maintenance Supervisor	918-591-4041	918-284-9190
External Resources		
Police/ Fire Department/HAZMAT	911	
City of Tulsa Security	918-576-5502	
CHEMTREC	800-424-9300	
3.0 DESIGNATION OF CONTRACTOR'S ONSITE SAFETY REPRESENTATIVE		Y Completed
Complete ONSITE SAFETY REPRESENTATIVE form.		
4.0 TOOLS AND EQUIPMENT		Y Completed
All work performed will be completed with Contractor's tools and equipment. City of Tulsa tools and equipment will not be used.		
5.0 SITE TOBACCO POLICY		Y Completed
Tobacco materials shall be defined as cigarettes, e-cigarettes, cigars, pipes, smokeless tobacco, and other tobacco-related substances. The use of tobacco materials shall always be prohibited within City-owned or leased facilities except for the areas approved by the Mayor and appropriately marked as "Smoking Area".		



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Mohawk Water Treatment Plant**
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6.0 PARKING AND DRIVING REQUIREMENTS	Y Completed
• Parking and driving of vehicles should only be done on paved areas within the plant. • Speed Limit within the plant is 15 mph. • Seatbelts are required by all vehicle occupants when in motion inside plant grounds. • Yield to pedestrians approaching internal roadways. • Come to a complete stop at all STOP signs.	
7.0 SITE HOUSEKEEPING REQUIREMENTS	Y Completed
It is the responsibility of the Contractor to maintain a clean and orderly work area to minimize safety hazards. It has been shown that poor housekeeping leads to slips, trips, and falls on construction sites. The Contractor shall ensure that all work areas are clean at the end of each work day. All equipment and/or material stored outside shall be secured to prevent hazards created by adverse weather conditions. Clear access shall always be maintained to electrical panels, fire extinguishers, safety showers/eyewash stations, and fire hydrants. The function of this facility is to produce drinking water consumed by the public. It is the responsibility of the Contractor to properly contain and dispose of any trash, chemicals, wastewater runoff, and any other waste or byproduct produced from their work. Some worksites may be near treatment processes which must not be contaminated, directly or indirectly, as result of the contractor's work. If an incidence of contamination occurs, or is suspected, it must be immediately reported to the plant superintendent.	
8.0 DISCRIMINATION POLICY	Y Completed
The City of Tulsa is committed to, and shall provide, a work environment which is free from all forms of discrimination and harassment. Unprofessional behavior that creates a hostile work environment for individuals regarding gender, age, race, religion, physical disabilities, or sexual orientation will not be tolerated. Violators will be removed from the site.	
9.0 DRUG AND ALCOHOL POLICY	Y Completed
Employees and visitors shall not report to work at the site under the influence of any substance that may affect their ability to safely perform their work or that may in any way jeopardize the health and safety of others. If there is reason to believe that someone is under the influence of drugs or alcohol, that person will be removed from the worksite. If a controlled or illegal substance is suspected, the proper authorities will be contacted. Illegal substances shall not be brought to the site.	

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10.0 SITE-SPECIFIC EMERGENCY ACTION PLAN (EAP)	Y Completed
A copy of the site-specific EAP will be distributed and reviewed.	
11.0 NOTIFICATION OF CONTRACTOR ACCIDENTS, INCIDENTS AND NEAR MISSES	Y Completed
All incidents and accidents must be reported immediately to the plant superintendent. All near misses must be reported to the plant superintendent by the end of the day.	
12.0 REQUIRED PERSONAL PROTECTIVE EQUIPMENT (PPE)	Y Completed
Contractors are responsible for providing their employees with proper PPE and must train them in the proper inspection, maintenance, and safe use of that equipment. Contractors are responsible for conducting job assessments to determine the proper PPE necessary for each job. At a minimum, contractor employees are expected to wear hard hats, steel-toed work boots, and safety glasses at all times. Additionally, fall protection, respirators, gloves, face shields, and hearing protection may be required, depending on hazards present.	
13.0 REQUIRED PERMITS FOR CERTAIN ACTIVITIES AND MEANS FOR OBTAINING THOSE PERMITS	Y Completed
_____ Hot Work Permit Anything that generates heat, flame, or spark, or any electrical hot work requires a hot work permit. An appropriate fire extinguisher and a dedicated, trained fire watch person who understands the hazards associated with hot work must always be present. Coordinate with the site maintenance supervisor to obtain a hot work permit. _____ Confined Space Entry (CSE) Permit All contractors conducting CSE must coordinate with the plant maintenance supervisor prior to entering any confined space. Contractors must provide proof that their employees have been adequately trained in their duties and hazards associated with their work. Contractors must provide their own calibrated air monitors and rescue equipment. Coordinate with the site maintenance supervisor to obtain a CSE permit. _____ Lockout/Tagout (LO/TO) Permit Contractors must coordinate their LO/TO procedures with the maintenance supervisor. Once affected circuits, piping, dissipated hazardous energy, switches, valves and/or other processes have been locked and tagged out by Mohawk WTP personnel, the Contractor shall place a lock on the City's to ensure against accidental start-up.	

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14.0 FALL PROTECTION	Y Completed
Contractors performing work 6' or more above a lower level shall use fall protection in accordance with applicable OSHA regulations and City of Tulsa Policies and Procedures.	
15.0 LOCKOUT-TAGOUT	Y Completed
Distribute and review the City of Tulsa Personnel Policies and Procedures Manual (PPPM) Section 934, "The Control of Hazardous Energy (Lockout/Tagout)". All work requiring Lockout/Tagout shall be in accordance with applicable OSHA regulations and City of Tulsa Policies and Procedures.	
16.0 PERMIT-REQUIRED CONFINED SPACES	Y Completed
Review designated site-specific permit-required confined space locations. All permit-required confined space entries shall be performed in accordance with applicable OSHA regulations and City of Tulsa Policies and Procedures.	
17.0 USE OF ELECTRICAL EQUIPMENT AND GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)	Y Completed
All electrical equipment must be connected to a GFCI. Tools shall be regularly inspected for defects such as cuts, exposed insulation, missing ground pins, etc. Tools with damaged cords or plugs shall be removed from service immediately. Contractors must provide their own source of power for all tools and equipment. Site electrical outlets should not be used for powering tools and equipment. Electrical panels and PLC cabinets shall not be opened without consent of the plant superintendent, or his/her designee.	



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18.0 CONTRACTOR RESPONSIBILITIES

Y Completed

- Comply with current federal safety and environmental regulations and all applicable state and local laws, codes, rules, regulations, and ordinances governing the work.
- Ensure Contractor provides all necessary tools and equipment, including personal protective equipment, required for safe completion of required tasks.
- Train employees and ensure they understand expectations of this Program. A copy of the CONTRACTOR TRAINING LOG must be completed and submitted to the plant superintendent prior to any employee beginning work at the facility. The training log must be updated if Contractor adds any employees throughout the duration of work.
- Provide documentation of employee training, as requested.
- Perform inspection of work activities and areas for compliance with requirements of this Program.
- Inform plant superintendent of any subcontractors to be used as part of the work. The Onsite Safety Representative must review this program with all subcontractor employees prior to any site work. Training should be documented on the SUBCONTRACTOR TRAINING LOG and submitted to the plant superintendent each time employees are added. Contractor is responsible for ensuring subcontractor employees comply with requirements of this program.
- Ensure that no Contractor activities endanger other personnel working at the site.
- Participate in all evacuation drills.
- Understand that failure to comply with requirements of this Program, including failure to correct unsafe practices and conditions, are sufficient grounds for the plant superintendent to stop all work until deficiencies have been corrected.
- To reserve a meeting room for construction progress meetings, contact the office administrator at 918-591-4025, at a minimum of one week prior to the scheduled date to ensure availability.

Date Completed: _____

Contractor Name: _____

Site Safety Representative: _____

Phone Number/Email Address: _____

Plant Superintendent: _____

 CITY OF Tulsa A New Kind of Energy.	Water and Sewer Department Mohawk Water Treatment Plant Written Programs Contractor Site Management Program	Version No.	6
		Date Created	8/23/2016
		Date Revised	6/2/2025
		Approved by	Dustin Davis
		Control No.	MOH-SAF-001
		Department/Work Group	WSD/MOH

CONTRACTOR ONSITE SAFETY REPRESENTATIVE



Tulsa
A New Kind of Energy.

**Water and Sewer Department
Mohawk Water Treatment Plant**
Written Programs
Contractor Site Management Program

Version No.	6
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Control No.	MOH-SAF-001
Department/Work Group	WSD/MOH

Name of Contractor: _____

Project: _____

The following person has been designated as the Contractor Onsite Safety Representative for the above-referenced contract. He/she is capable of identifying hazards on the jobsite, including working conditions that are unsanitary, hazardous, or dangerous to employees. In addition, this employee is the contact person between the City of Tulsa Mohawk WTP and _____ (Contractor) in the event that the City of Tulsa drinking water treatment personnel observe any unsafe condition, practice, etc.

Contractor Onsite Safety Representative:

Name (printed): _____

Title: _____

Signature: _____

Date: _____



**CITY OF
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CONTRACTOR TRAINING LOG

Instructor: _____ Date: _____

I have trained the employees listed below on the City of Tulsa Mohawk WTP Contractor Site Management Program.

Instructor Signature: _____

Employee Name	Employee Signature	Contractor	Date



**CITY OF
Tulsa**
A New Kind of Energy.

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Department/Work Group	WSD/MOH

SUBCONTRACTOR TRAINING LOG

Instructor: _____ Date: _____

I have trained the employees listed below on the City of Tulsa Mohawk WTP Contractor Site Management Program.

Instructor Signature: _____

Employee Name	Employee Signature	Contractor	Date

SPECIFICATIONS

SPECIFICATIONS

- A. Oklahoma Department of Transportation Standard Specifications for Highway Construction, 2019 Edition as modified by Ordinance 24616, shall be used on this project including Section 100-General Provisions.
- B. City of Tulsa, Public Work, Engineering Division, Construction Specifications – March 2022 are incorporated herein as if fully set forth and are on file, including all revisions posted on internet prior to bid opening, with the Public Works Department, Engineering Division, 175 E. 2nd Street, Tulsa, Oklahoma or access on the internet at:
<https://www.cityoftulsa.org/government/departments/public-works/engineering-services/specifications-checklists-and-details/>

**FRONT-END DOCUMENTS AND
TECHNICAL SPECIFICATIONS
FOR
PROJECT NO. TMUA-W 24-03
MOHAWK WTP CHEMICAL TANK REPLACEMENT
3600 MOHAWK BLVD.**

BID SET

PREPARED BY:

GARVER LLC
6100 South Yale Suite 1300
Tulsa, OK 74136
Phone: 918-250-5922



ERIC LEE, DIRECTOR OF WATER AND SEWER

VOLUME II – TECHNICAL SPECIFICATIONS

Water and Sewer Department
175 E. 2nd Street
Tulsa, Oklahoma 74103
(918) 596-9845

CERTIFICATIONS

**MOHAWK WTP CHEMICAL TANK REPLACEMENT
GARVER PROJECT NO. 2302343
TULSA METROPOLITAN UTILITY AUTHORITY PROJECT NO. TMUA-W 24-03**

I hereby certify that the applicable portions of this project's specifications, details, and plans were prepared by me or under my direct supervision and that I am a duly Licensed Engineer under the laws of the State of Oklahoma.

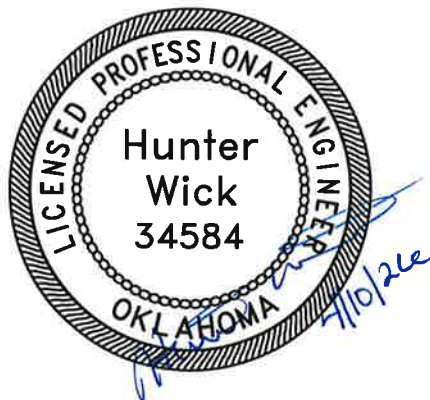
SEAL AND SIGNATURE	APPLICABLE DIVISION OR PROJECT RESPONSIBILITY

STEVE SCHULTZ, P.E.



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HUNTER WICK, P.E.



Division 26
Sections 40 61 13 through 40 73 45

CERTIFICATIONS

GARVER, LLC CERTIFICATE OF AUTHORIZATION:
OK SURVEYING AND ENGINEERING COA NO. CA4193 Expiration Date: 06/30/2026

MOHAWK WTP CHEMICAL TANK REPLACEMENT

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DIVISION 1
GENERAL REQUIREMENTS

SECTION 01 10 00 – SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Project information.
 - 2. Summary of Work.
 - 3. Work by Owner or others.
 - 4. Owner-furnished products.
 - 5. Future work.
 - 6. Owner's product Purchase contracts.
 - 7. Owner occupancy.
 - 8. Permits.
 - 9. Specification conventions.
 - 10. Project Design Criteria
- B. Related Sections:
 - 1. Section 01 20 00 – Price and Payment Procedures.
 - 2. Section 01 32 16 – Construction Progress Schedule.
 - 3. Section 01 50 00 – Temporary Facilities and Controls.
 - 4. Section 01 70 00 – Execution Requirements.

1.2 PROJECT INFORMATION

- A. Name: TMUA Mohawk WTP Chemical Tank Improvements.
 - 1. Project Location: 3600 Mohawk Blvd, Tulsa, OK, 74115.
- B. Owner: Tulsa Metropolitan Utility Authority.
 - 1. Owner's Representative: Daniel Al-Khouri.
- C. Project Engineer: Garver.
 - 1. Engineer's Representative: Michael C. Niblett, PE.

1.3 SUMMARY OF WORK

- A. Work of the Project generally includes replacement of the existing chemical bulk storage tanks, addition of two new chemical day storage tanks for sodium hydroxide, sodium hydroxide chemical transfer pumps, along with all required operational appurtenances. More specifically, the Work includes, but is NOT limited to, construction of:
 - 1. Chemical Storage Building:
 - a. Perform demolition work of pilot filtration and dry polymer mixing systems. Coordinate with owner on storage of pilot filtration equipment. Reinstall pilot equipment after all chemical storage improvements are complete. At end of project repair floor where containment curb has been removed.
 - b. Construct temporary chemical storage and transfer pump facility for Hydrofluorsilicic Acid and temporary storage facility for Cationic Polymer systems.
 - c. Remove and replace three FRP 18,720-gallon aluminum chlorohydrate storage tanks.
 - d. Remove and replace three FRP 18,720-gallon caustic soda (sodium hydroxide storage tanks).
 - e. Remove and replace one FRP 12,384-gallon hydrofluorosilicic acid tank.
 - f. Remove and replace one FRP 12,384-gallon cationic polymer storage tank.

- g. Inspect all tank pads upon removal of storage tanks and provide Owner and Engineer an RFI describing the condition of the pads, include photographs.
- h. Install two new 550-gallon caustic soda (sodium hydroxide) day tanks with electronic scales.
- i. Install two new sodium hydroxide chemical transfer pumps.
- j. Integrate new sodium hydroxide chemical tank scales, transfer pumps, and motorized valves into existing plant DCS system.
- k. Install new radar level sensors on all bulk tanks and connect to existing plant DCS system.
- l. Clean and recoat the sodium hydroxide pipe trench inside the chemical building.
- m. Replace piping, gaskets, and fittings associated with all tanks as shown in drawings. All connections to existing piping and valves to be replaced with new, chemically compatible, gaskets.
- 2. Site electrical improvements to support items above including control systems, wiring and conduit.

1.4 SUBSURFACE UTILITY CONDITIONS

- A. Coordinate Work with utilities of Owner and public or private agencies. Verify locations of utilities and facilities which may exist by contacting the utility locating service for the state where Work is performed.
 - 1. One-Call 405-522-6543
 - 2. Abide by easement and right-of-way restrictions.
- B. Exercise reasonable care to verify location of existing subsurface facilities and utilities.
- C. Areas immediate and adjacent to planned excavations shall be thoroughly checked by means of visual examination and with electronic metal and pipe detection equipment for indications of underground utilities and facilities.
- D. Make exploratory excavation where existing underground facilities or utilities may potentially conflict with proposed excavations and facilities, or where there is reasonable cause to verify the presence or absence of underground facilities or utilities. Expose sanitary and storm sewers, water, gas, electric, communication lines, and other underground facilities to permit survey location prior to commencement of Work in affected area:
 - 1. Conduct exploratory excavations prior to proceeding with major excavation in the area, and sufficiently in advance of construction to avoid possible delays to the Work. Promptly take measurements, photographs, and obtain survey data.
 - 2. Notify the Owner when Work will be in progress. Make arrangements for potential emergency repairs as specified in standards of utility owners, including individual or residential facilities.
 - 3. Assume responsibility for repair of facilities damaged by performance of the Work.
- E. Relocation of Existing Utilities:
 - 1. During construction it is expected that minor relocations of existing utilities, beyond those explicitly specified in Drawings, will be necessary as part of the Work.
 - 2. When relocation of utilities is required as part of the Work, perform as specified in the standards of affected utility owner. Match materials of existing utilities unless otherwise specified.
 - 3. Adjustment to contract price and contract time for concealed conditions, if any, will be made as stipulated in conditions of the Contract.
- F. Construction Plan:
 - 1. Before start of construction, post electronic files to web-based project management software of construction plan regarding access to Work, use of Site, and utility outages

for acceptance by Owner. After acceptance of plan, construction operations shall comply with accepted plan unless deviations are accepted by Owner in writing.

1.5 OWNER OCCUPANCY

- A. Schedule and substantially complete designated portions of the Work, as designated in Specification 01 14 00 – Work Restrictions, for Owner's use and occupancy before Substantial Completion of the entire Work.
 - 1. Owner's use and occupancy of designated areas before Substantial Completion of entire Project DO NOT relieve Contractor of responsibility to maintain specified insurance coverages on a 100% basis until date of final payment.
- B. Owner will occupy Site during entire period of construction for conduct of normal operations. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- C. Schedule Work to accommodate Owner occupancy.

1.6 PERMITS

- A. Secure and pay for all necessary permits for construction of Work, including but NOT limited to:
 - 1. Building permits including plumbing, mechanical, and electrical.
 - 2. Stormwater permit. It is the Contractor's responsibility to maintain the required controls and record keeping complying with the SWPPP and associated stormwater permit.
 - 3. OSHA excavation permit.
 - 4. Department of Transportation permits.
- B. Comply with codes, ordinances, regulations, orders, and other legal requirements of public authorities having bearing on the performance of the Work.

1.7 SPECIFICATION CONVENTIONS

- A. Specification Arrangement:
 - 1. Specification section numbers and formatting are in CSI Three-Part Section format, and as specified in CSI MasterFormat™, except where departures have been deemed necessary.
- B. Specification Content:
 - 1. The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations.
 - 2. These conventions are:
 - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - b. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; NO emphasis is implied by text with these characteristics.
 - c. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is NOT residing in the Specifications. Unless otherwise specified, linked information is NOT part of the Contract Documents.
 - d. "Provide" means to manufacture, fabricate, deliver, furnish, install, complete, assemble, erect in place, test, render ready for use or operation, including necessary related material, labor, appurtenances, services, and incidentals.
 - e. Related documents and sections: the Contract Documents are complementary; what is called for by one is as binding as if called for by all.

- C. Drawing Coordination:
1. Requirements for materials and products identified on Drawings are described in detail in the Specifications.
 2. One or more are used on Drawings to identify materials and products:
 - a. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - b. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings and published as part of the U.S. National CAD Standard.
 - c. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.8 DESIGN CRITERIA

- A. Project Design Criteria:
1. All equipment and materials for the project are to be suitable for performance in the Water Treatment Plant environment.
 2. Outdoor temperatures: 0°F –105°F.
 3. Indoor process area temperatures: 50°F –105°F.
 4. Indoor conditioned spaces: 50°F –90°F.
 5. Frost line is assumed 20 inches below grade.
 6. Moisture conditions: Defined in Specification Sections.
 7. Site elevation: Generally ranges from 610 – 635 ft above mean sea level.
- B. Anchoring Design Criteria:
1. Anchorage of electrical and mechanical equipment shall comply with:
 - a. Seismic Criteria:
 - 1) Risk Category: III
 - 2) Soil Site Class: D.
 - 3) Design spectral acceleration at short period, S_{DS} : 0.142g.
 - 4) Design spectral acceleration at short period, S_{D1} : 0.116 g.
 - 5) Seismic Design Category: B.
 - 6) Importance Factor, I : 1.25.
 - 7) Component amplification factor, a_p : As specified in ASCE 7-16
 - 8) Component response modification factor, R_p : As specified in ASCE 7-16.
 - 9) Component importance factor, I_p : As specified in ASCE 7-16.
 - 10) DO NOT use friction to resist sliding due to seismic forces.
 - b. Wind Criteria:
 - 1) Occupancy category: III.
 - 2) Basic wind speed: 116 mph.
 - 3) Exposure Category: C.
 - 4) Topographic Factor, K_{zt} : 1.0.
 - 5) Wind Importance Factor, I_w : 1.0.
 - c. Use anchor bolts, bolts, or welded studs for anchors for resisting seismic and wind forces. Anchor bolts used to resist seismic and wind forces shall have a standard hex bolt head embedded in the concrete. DO NOT use anchor bolts fabricated from rod stock with an L or J shape.
 - d. DO NOT use chemical anchors, concrete anchors, flush shells, powder actuated fasteners, sleeve anchors, or other types of anchors unless specified in the Drawings or accepted in writing by the Engineer.
 - e. Seismic and wind forces must be resisted by direct bearing on the fasteners used to resist seismic and wind forces.
 - f. Complete shop drawings, seismic calculations, and wind calculations signed and sealed by a civil or structural engineer licensed in the state where the Project is located.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

WORSECTION 01 14 00 – WORK RESTRICTIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work restrictions.
 - 2. Work sequencing.
- B. Related Section:
 - 1. Section 01 20 00 – Price and Payment Procedures.
 - 2. Section 01 32 16 – Construction Progress Schedule.
 - 3. Section 01 50 00 – Temporary Facilities and Controls
 - 4. Section 01 70 00 – Execution Requirements
 - 5. Section 01 77 00 – Closeout Procedures

1.2 GENERAL WORK RESTRICTIONS

- A. Water Treatment Facilities:
 - 1. The existing Mohawk Water Treatment Plant is one of two of the City of Tulsa's means of treating and distributing potable water to the City's potable water customers. Impairing the operational capabilities of this facility will result in serious financial damage to the City and result in water usage restrictions for the City's potable water customers.
 - 2. Contractor shall bear the cost of penalties imposed on the Owner for potable water quality or other violations caused by actions of the Contractor.
 - 3. Conduct work in a manner that WILL NOT impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant as mandated by the Oklahoma Department of Environmental Quality to treat the quality of potable water to applicable water quality regulations.
 - 4. The status of the treatment plant shall be defined as "operational" when it is capable of treating the rated capacity of 100 mgd of potable water production as set forth by the State regulations.
- B. Construction Scheduling Requirements
 - 1. Construction shall commence no earlier than November 1st and must reach substantial completion by April 30th.
- C. Time Restrictions for Performing Work:
 - 1. Regular operating hours as determined by the Owner.
- D. Onsite Workday Restrictions:
 - 1. DO NOT perform Work on Site during Work blackout days specified by Owner.
- E. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction (AHJ).
- F. Provide safe, continuous access to process control equipment for plant operations personnel.
- G. Noise, Vibration, Dust, and Odors:
 - 1. Coordinate with Owner operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy.
 - 2. Notify Engineer or Owner NOT less than two days in advance of proposed disruptive operations.

3. Obtain Engineer's or Owner's written permission before proceeding with disruptive operations.
- H. Smoking and Controlled Substance Restrictions:
1. Use of tobacco products, alcoholic beverages, marijuana, and other controlled substances on Project Site, premises, or on Owner's property is NOT permitted.
- I. Employee Identification:
1. Provide identification tags for Contractor personnel working on Project Site. Require personnel to use identification tags at all times.
- J. Employee Screening:
1. Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project Site.
 2. Maintain list of approved screened personnel with Owner's representative.
- 1.3 CONTRACTOR'S USE OF SITE AND PREMISES
- A. Restricted Use of Site:
1. Contractor shall have limited use of Project Site for construction operations as specified in Drawings by the Contract limits and as specified in this Section.
- B. Limits on Use of Site:
1. Limit use of Project Site to Work in areas specified.
 2. DO NOT disturb portions of Project Site beyond areas in which the Work is specified.
- C. Limits on Use of Site:
1. Limit use of Site and premises to allow:
 - a. Owner occupancy.
 - b. Work by Owner.
 - c. Work by Others.
 - d. Use by the public where required.
 2. Driveways, Walkways, and Entrances:
 - a. Keep driveways, parking areas, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. DO NOT use these areas for parking or for storage of materials.
 - b. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - c. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on Site.
- D. Construction Operations:
1. Limited to areas specified in Drawings.
 2. Noisy and Disruptive Operations (such as Use of Jack Hammers and Other Noisy Equipment):
 - a. NOT allowed in close proximity to existing building during regular hours of operation. Coordinate and schedule such operations with Owner to minimize disruptions.
- E. Sound Level Restrictions:
1. Sound pressure level measured at boundary of Site SHALL NOT exceed levels required by local ordinances or codes, and at NO time shall exceed 80 dBA

1.4 FACILITY OPERATIONS

- A. Existing Utility Interruptions:
 - 1. DO NOT interrupt utilities serving facilities occupied by Owner or others unless permitted under the conditions, and only after arranging for temporary utility services as specified:
 - a. Notify Engineer and Owner NOT less than seven days in advance of proposed utility interruptions.
 - b. Submit outage request plan to Engineer and Owner itemizing dates, times, and duration of each requested outage.
 - c. Obtain Owner's written permission before proceeding with utility interruptions.
- B. Existing Operations Interruptions:
 - 1. DO NOT shutdown, interrupt, or otherwise impair the operational capability of treatment facilities or processes unless permitted under the following conditions. A facility or process shall be considered operational when it can achieve its defined treatment or process objective as defined by the Owner or Engineer.
 - 2. Specify required shutdowns of existing facilities or interruptions of existing operations on Construction Progress Schedule.
 - 3. Where required to minimize interruptions or impairments to systems operations while complying with specified work constraints, provide temporary treatment equipment, pumping, bypass systems, connections, power, lighting, controls, instrumentation, and safety devices.
 - 4. DO NOT remove or demolish systems required to keep the existing facilities operational at the capacities specified until the existing systems are replaced by temporary or new systems.
- C. Shutdown Constraints:
 - 1. Perform work within critical operational constraints:
 - a. Temporary chemical feed systems
 - b. Sodium Hydroxide metering pumps to remain in service the entire length of the project.
- D. Shutdown Definitions:
 - 1. Minor Shutdown:
 - a. Any shutdown requiring less than 4 hrs.
 - 2. Major Shutdown:
 - a. Any shutdown other than a minor shutdown.
- E. Shutdown Procedures:
 - 1. Notify Engineer and Owner NOT less than 14 days in advance of proposed minor shutdowns.
 - 2. Notify Engineer and Owner NOT less than 30 days in advance of proposed major shutdowns.
 - 3. Contractor shall schedule a shutdown coordination meeting with Owner and Engineer one week prior to each shutdown.
 - 4. Any and all plant shutdowns shall require a shutdown plan, including detailed schedule, backup tools and equipment, personnel involved, contingency plan, and any procedures involved in restarting the process or facility.
 - 5. Obtain Engineer's or Owner's written permission before proceeding with proposed shutdowns.

1.5 WORK SEQUENCE

- A. Use identified work sequences in this section as a GUIDELINE for scheduling and performing work. Perform work in a manner that WILL NOT prevent the facility from achieving the final treated water quality requirements established by regulation. It is ultimately the responsibility of

the Contractor to execute the work in a sequence that meets all requirements of the contract documents.

- B. Work sequence and constraints presented DO NOT include all items affecting completion of the Work. They are intended to describe critical events necessary to minimize disruption to existing operations and to ensure compliance with treatment regulations and permit requirements.
- C. Construct Work in stages during construction period. Coordinate construction schedule and operations with the Owner:
 - 1. Stage 1: Demolish existing dry polymer equipment and removal of pilot filtration equipment. Coordinate with owner on storage pilot filtration equipment and associated platforms.
 - 2. Stage 2: Construct temporary hydrofluorosilicic acid (HFS) and cationic polymer (CPO) storage and chemical transfer lines where pilot equipment was located.
 - a. Sequence 1: Connect CPO totes to existing CPO transfer pump that supplies existing day tanks.
 - b. Sequence 2: Install a new HFS transfer pump and connect to HFS totes and existing HFS day tank.
 - c. Sequence 3: Test temporary chemical bulk storage and transfer pump.
 - 3. Stage 3: Demolish existing aluminum chlorohydrate (ACH) Tank 7-T-3, HFS and CPO bulk storage tanks and associated tank piping. Protect valves as they will be reused.
 - 4. Stage 4: Demolish exiting ACH tank 7-T-1 and associate piping, valves to be protected and reused. ACH tank 7-T-2 to remain in service.
 - 5. Stage 5: Install the new ACH tank 7-T-1 and connect to the existing chemical system. Verify tank is feeding existing chemical feed system.
 - 6. Stage: Demolish existing ACH tank 7-T-2 and piping and install the new tank 7-T-2. Valves to be protected and reused.
 - 7. Stage 6: Install the new HFS tank 7-T-8 and connect to the existing chemical feed system.
 - 8. Stage 7: Install the new CPO tank 7-T-6 and connect to the existing chemical feed system.
 - 9. Stage 8: Install new ACH tank 7-T-3.
 - 10. Stage 9: Remove temporary HFS and CPO chemical storage and transfer system.
 - 11. Stage 10: Demolish Sodium Hydroxide (NaOH) tanks 7-T-11 and 7-T-12 and associate pipe. Tank 7-T-10 and NaOH feed system to remain in service. Protect valves as they are to be reused. Containment curbing can be removed to expedite removal and installation of tanks. Temporary containment curbing must be in place during demolition and construction. Transition to 25% Sodium Hydroxide (SHX) during demolition and construction of NaOH storage tanks.
 - 12. Stage 11: Install new NaOH tanks 7-T-12 and temporarily connect to existing NaOH feed system progressive cavity pumps.
 - 13. Stage 12: Demolish existing NaOH tank 7-T-10.
 - 14. Stage 13: Install new NaOH tanks 7-T-11 and 7-T-10. Temporarily connect back to the existing chemical feed system progressive cavity pumps.
 - 15. Stage 14: Install NaOH day tanks and transfer pumps. Connect tanks 7-T-10 and 7-T-11 to new transfer pumps while leaving 7-T-12 connected to existing chemical feed progressive cavity pumps.
 - 16. Stage 15: Disconnect 7-T-12 from existing chemical feed and connect new NaOH day tanks to existing chemical feed pumps. Connect new tank 7-T-12 to day tanks. Replace any containment curbing demolished during NaOH equipment installation with new concrete containment curbing.
 - 17. Reinstall pilot filter equipment.

1.6 SEQUENCING OF CONSTRUCTION PLAN

- A. Before start of construction, post electronic file to Project website of construction plan regarding phasing of project and new Work for acceptance by Owner.
- B. After acceptance of plan, comply with accepted plan when coordinating construction sequencing unless deviations are accepted by Owner in writing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

SECTION 01 20 00 – PRICE AND PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Chemical allowance
 - 2. Defect assessment

1.2 CHEMICAL ALLOWANCE

- A. Refer to the Bid Form for Chemical Allowance schedule.
- B. The allowance shall be used for the cost of materials, labor, installation, and overhead and profit, in accordance with GC-26, for supplying temporary chemicals and maintaining the temporary chemical storage system, as described in specification 01 50 00 Temporary Facilities, during the rehabilitation construction of the chemical building.
- C. The allowance shall be used only at the discretion of the City. Any allowance balance remaining will be credited back to the City on the final application for payment submitted by the contractor.
- D. The Contractor shall provide, to the City, a written request for the use of the allowance, with a schedule of values, and associated backup information, including any time extensions required to perform the work.
- E. The Contractor shall proceed with the work included in the allowance only after receiving a written order, from the Engineer and City, authorizing such work. Proceeding with work in the allowance without written order from the City will be at the Contractor's cost.

1.3 DEFECT ASSESSMENT

- A. Replace the Work, or portions of the Work, not conforming to specified requirements.
- B. If, in the opinion of Engineer or Owner, it is not practical to remove and replace the Work, Engineer or Owner will direct appropriate remedy or adjust payment. Potential remedies may include:
 - 1. The defective Work may remain, but unit sum/price will be adjusted to new sum/price at discretion of Engineer or Owner.
 - 2. Defective Work will be partially repaired according to instructions of Engineer or Owner, and unit sum/price will be adjusted to new sum/price at discretion of Engineer or Owner.
- C. Individual Specification Sections may modify these options or may identify specific formula or percentage sum/price reduction.
- D. Authority of Engineer or Owner to assess defects and identify payment adjustments is final.
- E. Nonpayment for Rejected Products:
 - 1. Payment will not be made for rejected products for any of the reasons below:
 - a. Products wasted or disposed of in a manner that is not acceptable.
 - b. Products determined as unacceptable before or after placement.
 - c. Products not completely unloaded from transporting vehicle.
 - d. Products placed beyond lines and levels of the required Work.
 - e. Products remaining on hand after completion of the Work.
 - f. Loading, hauling, and disposing of rejected products.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for alternates.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Alternate No. 1: Clean and Recoat Sodium Hydroxide Pipe Trench.
 - 1. Base Bid: All items in contract specifications and drawings excluding rehabilitation of the concrete in the sodium hydroxide chemical pipe trench.
 - 2. Alternate: Sodium hydroxide chemical pipe trench is to be cleaned and recoated as indicated on Drawings 07-P103, 07-P401, and 07-P402 and as specified in Section 09 96 00 High-Performance Coatings and 09 96 00.01 High-Performance Coating System Schedule.

END OF SECTION

SECTION 01 25 00 – SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Quality assurance.
 - 2. Product options.
 - 3. Product substitution procedures.

1.2 QUALITY ASSURANCE

- A. Contract is based on products and standards established in Contract Documents without consideration of proposed substitutions.
- B. Products specified define standard of quality, type, function, dimension, appearance, and performance required.
- C. Substitution Proposals: Permitted for specified products except where specified otherwise. Do not substitute products unless substitution has been accepted and approved in writing by Owner.

1.3 PRODUCT OPTIONS

- A. See Section 01 60 00 – Product Requirements.

1.4 PRODUCT SUBSTITUTION PROCEDURES

- A. Document 00 21 00 – Instructions to Bidders specifies time restrictions for submitting requests for substitutions during Bidding period.
- B. Engineer will not consider requests for substitutions prior to the date of the Owner-Contractor Agreement.
- C. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.
- D. Document each request with complete data, substantiating compliance of proposed substitution with Contract Documents, including:
 - 1. Manufacturer's name and address, product, trade name, model, or catalog number, performance and test data, and reference standards.
 - 2. Itemized point-by-point comparison of proposed substitution with specified product, listing variations in quality, performance, and other pertinent characteristics.
 - 3. Reference to Article and Paragraph numbers in Specification Section.
 - 4. Cost data comparing proposed substitution with specified product and amount of net change to Contract Sum.
 - 5. Impact to Contract time.
 - 6. Changes required in other Work.
 - 7. Availability of maintenance service and source of replacement parts as applicable.
 - 8. Certified test data to show compliance with performance characteristics specified.
 - 9. Samples when applicable or requested.
 - 10. Other information as necessary to assist Engineer's evaluation.
- E. A request constitutes a representation that Bidder or Contractor:

1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
 2. Will provide same warranty for substitution as for specified product.
 3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
 4. Waives claims for additional costs or time extension that may subsequently become apparent.
 5. Will coordinate installation of the accepted substitute, making such changes as may be required for the Work to be complete in all respects.
 6. Will reimburse Owner, and Engineer if applicable, for review or redesign services associated with reapproval by authorities having jurisdiction.
- F. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals without separate written request or when acceptance will require revision to Contract Documents.
- G. Substitution Submittal Procedure:
1. Submit requests for substitutions on form approved by Engineer and Owner.
 2. Submit electronic files to Project website of Request for Substitution for consideration. Limit each request to one proposed substitution.
 3. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
 4. Engineer will notify Contractor in writing of decision to accept or reject request.

1.5 INSTALLER SUBSTITUTION PROCEDURES

- A. Engineer will consider requests for substitutions within 30 days after date of Owner-Contractor Agreement. Requests received after that time may be considered or rejected at discretion of Engineer.
- B. Document each request with:
1. Installer's qualifications.
 2. Installer's experience in work similar to that specified.
 3. Other information as necessary to assist Engineer's evaluation.
- C. Substitution Submittal Procedure:
1. Submit electronic files to Project website of Request for Substitution for consideration. Limit each request to one proposed substitution.
 2. Engineer will notify Contractor in writing of decision to accept or reject request.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 26 00 – CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Field Orders
 - 2. Change Proposals.
 - 3. Work Change Directives
 - 4. Change Orders.

1.2 CHANGE PROCEDURES

- A. Submittals:
 - 1. Submit name of individual who is authorized to receive change documents and is responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.
- B. Carefully study and compare Contract Documents before proceeding with fabrication and installation of Work. Promptly advise Engineer of any error, inconsistency, omission, or apparent discrepancy.
- C. Requests for Interpretation (RFI) and Clarifications:
 - 1. Allot time in construction scheduling for liaison with Engineer; establish procedures for handling queries and clarifications.
 - 2. Use form and method acceptable to Engineer for requesting interpretations.
 - 3. Engineer may respond with a direct answer on the Request for Interpretation form, or within the project management website used for submittals and RFIs as specified Section 01 33 00 – Submittal Procedures.

1.3 FIELD ORDERS

- A. Engineer will advise of minor changes in the Work not involving adjustment to Contract Price or Contract Time by issuing supplemental instructions on EJCDC C-942 or other similar form.
- B. Contractor shall acknowledge receipt by signing and returning one electronic copy to Engineer.

1.4 CHANGE PROPOSALS

- A. Engineer may, in anticipation of ordering a revision to the Work, issue to the Contractor a Proposal Request including a detailed description and/or supplementary drawings and specifications.
- B. Proposal Requests are not instructions either to stop work in progress or to execute the proposed change.
- C. Contractor will prepare and submit, within 10 days, a detailed response to the Proposal Request with a detailed breakdown of proposed change in Contract Price and Contract Time. The proposed change in cost and time shall remain firm for a minimum period of 30 days after receipt by Engineer or Owner.
- D. Contractor may submit a Change Proposal to the Engineer without receipt of a Proposal Request, describing proposed change and its full effect on the Work. Include a statement

describing reason for the change and the effect on Contract Price and Contract Time with full documentation and a statement describing effect on the Work by separate or other Contractors.

1.5 WORK CHANGE DIRECTIVES

- A. Work Directive Change:
 - 1. Engineer may issue directive, on EJCDC C-940 – Work Change Directive or similar form signed by Owner, instructing Contractor to proceed with change in the Work, for subsequent inclusion in a Change Order. Document will describe changes in the Work and designate method of determining any change in Contract Price or Contract Time. A Work Change Directive is not a Change Order.
- B. Promptly execute the change described in the Work Change Directive.
- C. Contractor shall keep detailed records of work performed as a result of a Work Change Directive to substantiate resulting change in Contract Time or Contract Price. Detailed records may include but are not limited to:
 - 1. Date the work was performed
 - 2. Parties performing the work
 - 3. Time records, wage rates paid, and equipment rental rates
 - 4. Invoices and receipts for materials, equipment, and subcontracts.

1.6 CHANGE ORDERS

- A. Execution of Change Orders:
 - 1. Engineer will issue Change Orders for signatures of parties as provided in Conditions of the Contract.
- B. Change Order Forms:
 - 1. EJCDC C-941 – Change Order or similar form.
- C. Stipulated Sum/Price Change Order:
 - 1. Based on Proposal Request and Contractor's fixed price quotation.
- D. Unit Price Change Order:
 - 1. For Contract unit prices and quantities, the Change Order will be executed on a fixed unit price basis. For unit costs or quantities of units of that which are not predetermined, execute Work under Work Directive Change. Changes in Contract Price or Contract Time will be computed as specified for Time and Material Change Order.
- E. Time and Material Change Order:
 - 1. Submit itemized account and supporting data after completion of change, within time limits specified in Conditions of the Contract. Engineer will determine change allowable in Contract Price and Contract Time as provided in Contract Documents.
- F. Maintain detailed records of Work done on time and material basis. Provide full information required for evaluation of proposed changes and to substantiate costs for changes in the Work.
- G. Document each quotation for change in Project Cost or Time with sufficient data to allow evaluation of quotation.
- H. Correlation of Contractor Submittals:
 - 1. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as separate line item and adjust Contract Price.

2. Promptly revise Progress Schedules to reflect change in Contract Time, revise sub-schedules to adjust times for other items of Work affected by the change and resubmit.
3. Promptly enter changes in Record Documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 30 00 – ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Coordination and Project conditions.
 - 2. Requests for Information.
 - 3. Construction safety plan.
 - 4. Web-based project management software.
 - 5. Project meetings.

1.2 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate scheduling, submittals, and Work of various Sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Verify that utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate Work of various Sections having interdependent responsibilities for installing, connecting to, and placing operating equipment in service.
- C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit as closely as practical; place runs parallel with lines of building. Use spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. Coordination Drawings:
 - 1. Prepare as required to coordinate all portions of Work. Show relationship and integration of different construction elements that require coordination during fabrication or installation to fit in space provided or to function as intended. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important.
 - 2. Content shall be drawn to scale and large enough to indicate and resolve conflicts.
 - 3. Indicate functional and spatial relationships of architectural, structural, civil, mechanical, and electrical systems.
 - 4. Indicate space requirements for code or maintenance required clearances.
- E. Coordination Meetings:
 - 1. In addition to other meetings specified in this Section, hold coordination meetings with personnel and Subcontractors to ensure coordination of Work.
- F. In finished areas, except as otherwise indicated, conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.
- G. Coordinate completion and cleanup of Work of separate Sections in preparation for Substantial Completion and for portions of Work designated for Owner's occupancy.
- H. After Owner's occupancy of premises, coordinate access to Site for correction of defective Work and Work not complying with Contract Documents, to minimize disruption of Owner's activities.

1.3 REQUESTS FOR INFORMATION

- A. Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
- B. Coordinate and submit RFIs in a prompt manner to avoid delays in Work.
- C. RFI Content:
 - 1. Detailed description of item needing information or interpretation
 - 2. Project name
 - 3. Owner name
 - 4. Owner project number
 - 5. Engineer name
 - 6. Engineer project number
 - 7. Date
 - 8. Contractor name
 - 9. RFI number
 - 10. RFI subject
 - 11. Specification section number, title, and related paragraphs, as appropriate
 - 12. Drawing number and detail references, as appropriate
 - 13. Field dimensions and pictures, as appropriate
 - 14. Contractor suggested resolution. If suggested resolution impacts Contract Time or Contract Price, it shall be explicitly stated in the RFI.
- D. Engineer will review and response to RFIs. Incomplete, inaccurate, or frivolous RFIs will be returned without response.
- E. Engineer's response may result in a change to the Contract Time or Contract Price. If Contractor believes response warrants this change, notify the Engineer in writing no more than 5 days from receipt of RFI response, and submit Change Proposal as specified in Section 01 26 00 – Contract Modification Procedures.
- F. RFI shall be submitted through the web-based project management software system.

1.4 CONSTRUCTION SAFETY PLAN

- A. Detail the methods and procedures to comply with federal, state, and local health and safety laws, rules, and requirements for the duration of the Contract Times. Include:
 - 1. Identification of the Certified or Licensed Safety Consultant, who will prepare, initiate, maintain, and supervise safety programs, and procedures.
 - 2. Procedures for providing workers with an awareness of safety and health hazards expected to be encountered during construction.
 - 3. Safety equipment appropriate to the safety and health hazards expected to be encountered during construction. Include warning devices, barricades, safety equipment in public right-of-way and protected areas, and safety equipment used in multi-level structures.
 - 4. Methods for minimizing employees' exposure to safety and health hazards expected during construction.
 - 5. Procedures for reporting safety or health hazards.
 - 6. Procedures to follow to correct a recognized safety and health hazard.
 - 7. Procedures for investigation of accidents, injuries, illnesses, and unusual events that have occurred at the construction site.
 - 8. Periodic and scheduled inspections of general work areas and specific workstations.
 - 9. Training for employees and workers at the jobsite.
 - 10. Methods of communication of safe working conditions, work practices and required personal protection equipment.

- B. Assume responsibility for every aspect of health and safety on the jobsite, including the health and safety of subcontractors, suppliers, and other persons on the jobsite:
 - 1. Forward available information and reports to the Safety Consultant who shall make the necessary recommendations concerning worker health and safety at the jobsite.
 - 2. Employ additional health and safety measures specified by the Safety Consultant, as necessary, for workers as specified in OSHA guidelines.
- C. Transmit to Owner and Engineer copies of reports and other documents related to accidents or injuries encountered during construction.

1.5 WEB-BASED PROJECT MANAGEMENT SOFTWARE PACKAGE

- A. Web-Based Project Management Software Package:
 - 1. Use Engineer's web-based Project Management software package for purposes of hosting and managing Project communication and documentation until final completion.
 - 2. Web-based Project management software includes, at a minimum, the following features:
 - a. Compilation of Project data, including Contractor, Subcontractors, Engineer, Engineer's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow among Project entities.
 - d. Create, log, track, and notify Project members of Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, minor changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Process and track payment applications.
 - h. Process and track contract modifications.
 - i. Create and distribute meeting minutes.
 - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility, including smartphones and tablets.

1.6 DIGITAL PROJECT DATA LICENSING

- A. Engineer's Data Files Not Available:
 - 1. Engineer will not provide Engineer's BIM model or CAD drawing digital data files for Contractor's use during construction.

1.7 PRECONSTRUCTION MEETING

- A. Engineer will schedule a preconstruction meeting at a mutually agreeable time after Notice of Award.
- B. Attendance Required:
 - 1. Engineer, Owner, Resident Project Representative, any appropriate governmental agency representatives, major Subcontractors, Contractor, and others necessary to agenda.
- C. Minimum Agenda:

1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of Subcontractors, list of products, schedule of values, and Progress Schedule.
5. Designation of personnel representing parties in Contract, and Engineer.
6. Communication procedures.
7. Procedures and processing of requests for interpretations, field decisions, field orders, submittals, substitutions, Applications for Payments, proposal request, Change Orders, and Contract closeout procedures.
8. Scheduling.
9. Critical Work sequencing.
10. Scheduling activities of Surveyors.
11. Construction waste management plan.
12. Safety plan.
13. Use of premises by Owner and Contractor.
14. Owner's requirements and partial occupancy.
15. Construction facilities and controls provided by Owner.
16. Temporary utilities provided by Owner.
17. Survey and building layout.
18. Security and housekeeping procedures.
19. Procedures for testing.
20. Procedures for maintaining record documents.
21. Requirements for startup of equipment.
22. Inspection and acceptance of equipment put into service during construction period

D. Engineer:

1. Will preside over meeting and record minutes and distribute copies to participants, with one electronic copy each to Engineer, Owner, Contractor, and those affected by decisions made.

1.8 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at weekly intervals. Meetings to take place in Contractor's field office, Engineer's field office, or mutually agreed upon place.
- B. Contractor will make arrangements for meetings and prepare agenda with copies for participants.
- C. Attendance Required:
 1. Job superintendent, major Subcontractors, Contractors and suppliers, and Engineer and Owner as appropriate to agenda topics for each meeting.
- D. Minimum Agenda:
 1. Review minutes of previous meetings.
 2. Review of Work progress.
 3. Field observations, problems, and decisions.
 4. Identification of problems impeding planned progress.
 5. Review of submittal schedule and status of submittals.
 6. Review of offsite fabrication and delivery schedules.
 7. Maintenance of Progress Schedule.
 8. Corrective measures to regain projected schedules.
 9. Planned progress during succeeding work period.
 10. Coordination of projected progress.
 11. Maintenance of quality and work standards.

12. Effect of proposed changes on Progress Schedule and coordination.
13. Other business relating to Work.

E. Contractor:

1. Record minutes and distribute copies to participants within seven days after meeting, with one electronic copy each to Engineer, Owner, and those affected by decisions made.

1.9 PREINSTALLATION MEETINGS

- A. Scheduled by Contractor on a regular basis and as necessary to coordinate with manufacturers and installers before starting Work of major units of construction.
- B. Require attendance of parties directly affecting, or affected by, the Work.
- C. Notify Engineer and subcontractors seven days in advance of meeting date.
- D. Prepare agenda and preside over meeting:
 1. Review conditions of installation, preparation, and installation procedures.
 2. Review coordination with related Work.
- E. Record minutes and distribute copies to participants within three days after meeting, with an electronic copy each to Engineer, Owner, and those affected by decisions made.

1.10 FACILITY STARTUP MEETINGS

- A. Schedule and preside over facility startup meetings prior to startup and testing of major process equipment. Prepare a facility startup plan for each process facility as specified in Section 01 75 00 – Startup Testing and Training.
- B. Agenda shall include discussion of the facility startup plan including coordination needed between various parties and identified risks with proposed mitigation action plan.
- C. Attendees will include Contractor, Engineer's representative, Owner, subcontractors and equipment manufacturers, and others deemed necessary.

1.11 CLOSEOUT MEETING

- A. Schedule Project closeout meeting with sufficient time to prepare for requesting Substantial Completion. Preside over meeting and be responsible for minutes.
- B. Attendance Required:
 1. Contractor, major Subcontractors, Engineer, Owner, and others appropriate to agenda.
- C. Notify Engineer seven days in advance of meeting date.
- D. Minimum Agenda:
 1. Startup of facilities and systems.
 2. Operations and maintenance manuals.
 3. Testing, adjusting, and balancing.
 4. System demonstration and observation.
 5. Operation and maintenance instructions for Owner's personnel.
 6. Contractor's inspection of Work.
 7. Contractor's preparation of an initial "punch list."
 8. Procedure to request Engineer inspection to determine date of Substantial Completion.
 9. Completion time for correcting deficiencies.

10. Inspections by authorities having jurisdiction.
11. Certificate of Occupancy and transfer of insurance responsibilities.
12. Partial release of retainage.
13. Final cleaning.
14. Preparation for final inspection.
15. Closeout Submittals:
 - a. Project record documents.
 - b. Operating and maintenance documents.
 - c. Operating and maintenance materials.
 - d. Affidavits.
16. Final Application for Payment.
17. Contractor's demobilization of Site.
18. Maintenance.

- E. Record minutes and distribute copies to participants within two days after meeting, with one electronic copy each to Engineer, Owner, Construction Manager, and those affected by decisions made.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 16 – CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Project schedules.
 - 2. Review and evaluation.
 - 3. Updating schedules.
 - 4. Adjustment of Contract Times

1.2 QUALITY ASSURANCE

- A. The Contractor shall provide a schedule for the project based on the Critical Path Method (CPM).
- B. Scheduler:
 - 1. Contractor's personnel specializing in CPM scheduling with 2 years of minimum experience in scheduling construction work of complexity comparable to the Project and having use of computer facilities capable of delivering detailed graphic printout within 48 hrs. of request.
- C. Software:
 - 1. Prepare computerized schedule using Primavera or Microsoft Project, most current versions. Provide one licensed copy of the software to the Engineer for the duration of the project.
- D. Make all schedule submittals as electronic files using the web-based project management software specified in 01 30 00 – Administrative Requirements.

1.3 PRELIMINARY SCHEDULE

- A. Within 10 days after date of Owner-Contractor Agreement, and at least 7 days prior to the preconstruction meeting, submit proposed preliminary schedule in Gannt chart format defining planned operations for first 60 days of Work, with general outline for remainder of Work. Work activities depicted on the schedule shall include, but are not limited to:
 - 1. Notice to Proceed
 - 2. Permits
 - 3. Submittals
 - 4. Early procurement activities
 - 5. Site work
 - 6. Work sequences
 - 7. Contract milestones and completion dates
 - 8. Major facility Work
 - 9. System startup summary
 - 10. Project closeout summary
- B. Preliminary schedule shall be accompanied by a list of all shop drawings and submittals anticipated for the project. Acceptance of submittal schedule is required for payment application approval.
- C. Participate in review of preliminary schedule jointly with Engineer within 10 calendar days of submission.

- D. Within 20 days after joint review of proposed preliminary schedule, submit draft of proposed complete schedule for review. Include written certification that major Subcontractors have reviewed and accepted proposed schedule.
- E. An accepted preliminary schedule, in conjunction with the schedule of values specified in Section 01 20 00 – Price and Payment Procedures, shall be the basis for progress payments for the first 60 days of Work. The preliminary schedule shall be updated monthly until the complete project schedule is approved.

1.4 COMPLETE SCHEDULE

- A. Within 45 days after Notice of Award, submit complete cost loaded schedule using the Critical Path Method (CPM). The complete schedule shall show sequence and interdependence of all activities required for complete performance of all work, beginning with date of Notice to Proceed and concluding with date of final completion of Contract. Schedule shall be in Gantt Chart format.
- B. Acceptance of the complete schedule is required for payment application approval after the first 60 days of Work.
- C. Submit updated schedules every 30 days, as part of progress payment process. Failure to do so may result in the Owner withholding all or part of the monthly progress payment until the schedule is updated in a manner acceptable to Engineer.

1.5 COMPLETE SCHEDULE FORMAT

- A. Provide a clear, legible, and accurate time-scaled logic diagram in Gantt chart format, indicating interdependence of activities and critical paths for the project.
- B. In addition to native electronic file format, provide electronic PDF version in 22 in. by 34 in. drawing size.
- C. Illustrate order and interdependence of activities and sequence of Work; how start of given activity depends on completion of preceding activities, and how completion of activity may restrain start of subsequent activities.
- D. Illustrate complete sequence of construction by activity, identifying Work of separate stages. Indicate dates for submittals, including dates for Owner-furnished items, and return of submittals; dates for procurement and delivery of critical products; and dates for installation and provision for testing. Include legend for symbols and abbreviations used.
- E. Complete schedule shall include all Work activities with the potential to delay project construction, including construction activity, procurement and submittal review activity, Owner activities, startup activities, and closeout activities.
- F. Schedules shall include provisions for Weather Days as defined in the Contract Documents.
- G. No activity, exclusive of submittal reviews and equipment lead times, shall have a duration longer than 15 days.
- H. At a minimum, identify the execution of the list below, omitting items not applicable to Work:
 - 1. Obtaining permits
 - 2. Mobilization
 - 3. Site work
 - 4. Submittal reviews

5. Equipment lead times
6. Excavation and shoring
7. Dewatering
8. Concrete work, including installation of forms and reinforcement, placement of concrete, curing, finishing, and patching
9. Tests for leakage of concrete structures intended to hold water
10. Structural steel work
11. Masonry work
12. Framing work
13. Finish carpentry work
14. Architectural work.
15. Process equipment including pumps, conveyors, etc.
16. Building specialties
17. Process mechanical work including pipes, vales, gates, etc.
18. Building mechanical work including HVAC and plumbing
19. Electrical work
20. Instrumentation and Control work
21. Grading and paving
22. Fencing and landscaping
23. Testing and startup
24. Project closeout

I. Include information for each Work activity identified in the schedule:

1. Preceding and following event numbers.
2. Activity description.
3. Estimated duration of activity, in maximum 15-day intervals. Status of critical activities.
4. Earliest start date.
5. Earliest finish date.
6. Actual start date.
7. Actual finish date.
8. Latest start date.
9. Latest finish date.
10. Total and free float.
11. Monetary value of activity, keyed to Schedule of Values.
12. Percentage of activity completed.
13. Responsibility.

J. Required Sorts:

1. By preceding Work item or event number from lowest to highest.
2. By longest float, then in order of early start.
3. By responsibility in order of earliest possible start date.
4. In order of latest allowable start dates.
5. In order of latest allowable finish dates.
6. Contractor's periodic payment request sorted by Schedule of Values list.
7. List of basic input data-generating report.
8. List of activities on critical path.

K. Prepare sub-schedules for each stage of Work and Sequencing of Construction Plan identified in Section 01 14 00 – Work Restrictions.

L. Cost Loading:

1. Coordinate contents with Schedule of Values in Section 01 20 00 – Price and Payment Procedures.
2. The sum of all activity costs shall equal the Contract Price.

- M. Produce a Summary Schedule alongside each updated Complete Schedule with consolidates groups of activities associated with major items of Work, intended to give an overall indication of the project schedule.

1.6 REVIEW AND EVALUATION

- A. Participate in joint review and evaluation of schedules with Engineer at each submittal.
- B. Evaluate Project status to determine Work behind schedule and Work ahead of schedule.
- C. After reviews, revise schedules incorporating results of review, and resubmit within 10 days.
- D. When schedule reflects Owner's and Contractor's agreement of project approach and sequence, schedule will be accepted by Owner. Use accepted schedule for planning, organizing, directing Work, and reporting progress.
- E. Engineer's acceptance of schedule will not make any change in Contract requirements. Schedule remains the Contractor's responsibility and Contractor retains responsibility for performing all activities, activity durations, and sequences required to perform the Work in accordance with the Contract Documents.

1.7 UPDATING SCHEDULES

- A. Schedule Updates:
 - 1. Overall percent complete, projected, and actual.
 - 2. Completion progress by listed activity and sub-activity, to within five working days prior to submittal.
 - 3. Changes in Work scope and activities modified since submittal.
 - 4. Delays in submittals or resubmittals, deliveries, or Work.
 - 5. Adjusted or modified sequences of Work.
 - 6. Other identifiable changes.
 - 7. Revised projections of progress and completion.
- B. Narrative Progress Report:
 - 1. Submit with each monthly submission of Progress Schedule.
 - 2. Summary of Work completed during the past period between reports.
 - 3. Work planned during the next period.
 - 4. Explanation of differences between summary of Work completed and Work planned in previously submitted report.
 - 5. Current and anticipated delaying factors and estimated impact on other activities and completion milestones.
 - 6. Corrective action taken or proposed.
- C. Maintain schedules to record actual start and finish dates of completed activities.
- D. Indicate progress of each activity to date of revision, with projected completion date of each activity. Update schedules to depict current status of Work.
- E. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
- F. Upon approval of a Change Order, include the change in the next schedule submittal.
- G. Indicate changes required to maintain Date of Substantial Completion.

- H. Submit sorts as required to support recommended changes.
- I. Prepare narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect including effects of changes on schedules of separate Contractors, if applicable.

1.8 ADJUSTMENT OF CONTRACT TIMES

- A. Contract time will be adjusted only for causes specified in Contract Documents. Reference the General Conditions and Section 01 26 00 – Contract Modification Procedures.
- B. Project delays are defined in these categories:
 - 1. Inexcusable Delay: Actions or inactions of the Contractor, or events for which the Contractor has assumed contractual responsibility (including actions or inactions of subcontractors or suppliers) which would independently delay the completion of the Work beyond the current Contract completion date shall be designated as inexcusable delay. The Contractor shall not receive any time extension for such delays.
 - 2. Excusable Delay: Events which are unforeseeable, outside the control of, and without the fault or negligence of either the Owner or the Contractor (or any party for whom either is responsible), which would independently delay the completion of the Work beyond the current Contract completion date shall be designated as excusable delay. The Contractor is entitled to a time extension only and shall not receive any other damages.
 - 3. Compensable Delay: Actions or inactions of the Owner, or events for which the Owner has assumed contractual responsibility, which would independently delay the completion of the Work beyond the current Contract completion date shall be designated as compensable delay. The Contractor is entitled to a time extension and delay damages.
 - 4. Concurrent Delay: Concurrent delay is any combination of the above three types of delay occurring on the same calendar date(s), except in cases where the combination consists of two or more instances of the same type of delay occurring on the same calendar date(s). When one cause of delay is Owner-caused or caused by an event which is beyond the control and without the fault or negligence of either the Owner or the Contractor and the other Contractor-caused, the Contractor is entitled only to a time extension and no delay damages.
- C. If the Contractor believes that the Owner has impacted its work, such that the project completion date will be delayed, the Contractor must submit proof demonstrating the delay to the critical path. This proof, in the form of a Time Impact Analysis, may entitle the Contractor to an adjustment of Contract Time.
- D. Time Impact Analysis:
 - 1. The Time Impact Analysis submitted by the Contractor shall utilize the accepted schedule update that is current relative to the time frame of the delay event (change order, third party delay, or other Owner-caused delay). The Contractor shall represent the delay event in the schedule by
 - a. inserting new activities associated with the delay event into the schedule
 - or
 - b. revising activity logic
 - or
 - c. revising activity durations.
 - 2. If the project schedule's critical path and completion date are impacted as a result of adding this delay event to the schedule, a time extension equal to the magnitude of the impact may be warranted.
 - 3. The Time Impact Analysis submittal shall consist of:
 - a. a fragment of the portion of the schedule affected by the delay event.
 - b. a narrative explanation of the delay issue and how it impacted the schedule.

- E. When a delay to the project as a whole can be avoided by revising preferential sequencing or logic, and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension and no compensation for extended overhead.
- F. Indicate clearly that the Contractor has used, in full, all project float available for the work involved in the request, including any float that may exist between the Contractor's planned completion date and the Contract completion date. Utilize the latest version of the Schedule Update accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.
- G. Float shall be for the mutual benefit of the Owner and the Contractor. Adjustment of the Contract Times will be granted only when the Contract Float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the contract completion date. Adjustment of the Contract Times will be made only for the number of days that the planned completion of the work has been extended.
 - 1. Float time is a Project resource available to both parties to meet contract Milestones and Contract Times.
 - 2. Use of float suppression techniques, such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity times are prohibited. Use of float time disclosed or implied by use of alternate float-suppression techniques shall be shared to proportionate benefit of Owner and Contractor.
 - 3. Pursuant to above float-sharing requirement, no time extensions will be granted nor delay damages paid until a delay occurs, which:
 - a. Impacts Project's critical path.
 - b. Consumes all available float or contingency time.
 - c. Extends Work beyond contract completion date.
- H. Actual delays in activities which do not affect the critical path work or which do not move the Contractor's planned completion date beyond the Contract completion date will not be the basis for an adjustment to the contract time.
- I. The new Progress Schedule data, if accepted by the Owner, shall be included in the next monthly Schedule Update.
- J. When the Owner has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect an interim adjustment as acceptable to Engineer. It is understood and agreed that any such interim acceptance by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the Engineer has been made. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 33 – PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Preconstruction photos
 - 2. Periodic construction progress photos
 - 3. Post construction photos
 - 4. Video recordings
- B. Related Sections:
 - 1. Section 01 75 00 – Startup Testing and Training.

1.2 SUBMITTALS

- A. Digital Photographs
 - 1. Submit construction progress image files monthly along with Application for Payment. Files shall be uploaded to web-based project management software.
 - 2. Contractor shall prepare, update, and submit a log of photos with each submittal of photos. Log shall historically track the submittal of photos in reverse order, i.e. most recent photos being first in the log. The log shall document :
 - a. Identify each photo for topic of discussion. Identify name of Project, Contract number, phase, orientation of view, date and time of view, name and organization of photographer.
 - 3. Deliver complete set of digital image electronic files on CD, DVD, or USB flash drive to Owner with Project record documents. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as sensor, uncropped.

1.3 PHOTOGRAPH REQUIREMENTS

- A. Provide photographs in digital format of Site and construction throughout progress of Work produced by an experienced photographer acceptable to Engineer.
 - 1. Digital Images: JPG format, produced by digital camera with minimum sensor size of 12 megapixels, image resolution of not less than 3200 x 2400 pixels, and image stabilization technology. Compression shall be set to preserve quality over file size. Resizing to a smaller size when high resolution JPGs are available shall not be permitted.
 - 2. Submit digital media as originally recorded without alternation, manipulation, or modification using image-editing software.
 - 3. File Naming: Include date and time in filename for each image, as well as item being photographed and orientation of photo. Keep file naming convention consistent for all digital photographs.
- B. Preconstruction Photographs
 - 1. Before commencement of the Work, take photographs of Project Site and surrounding properties, including existing items to remain during construction, from different vantage points.
 - 2. Take a minimum of 20 site photographs from different directions and 20 interior photographs of each building or structure to capture existing conditions. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- C. Concealed Work Photographs

1. Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed work including, but not limited to:
 - a. Underground utilities
 - b. Underslab services
 - c. Piping
 - d. Electrical conduit
 - e. Waterproofing barriers
- D. Periodic Progress Photographs:
 1. Photographically demonstrate progress of construction, taking photographs as frequent as required to document all major aspects of construction, but not less than once per week.
 2. At a minimum, take 10 Site photographs from different directions and 20 interior photographs of all work areas indicating relative progress of the Work.
- E. Post Construction Photographs:
 1. Upon completion of the Work, take a minimum of 20 photographs of Project Site and surrounding properties from different vantage points.
 2. Take a minimum of 20 photographs of each new building or structure.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Definitions.
 - 2. Submittal procedures.
 - 3. Proposed product list.
 - 4. Product data.
 - 5. Shop Drawings.
 - 6. Samples.
 - 7. Other submittals.
 - 8. Design data.
 - 9. Test reports.
 - 10. Certificates.
 - 11. Manufacturer's instructions.
 - 12. Manufacturer's field reports.
 - 13. Erection Drawings.
 - 14. Contractor review.
 - 15. Engineer review.

1.2 DEFINITIONS

- A. Action Submittals:
 - 1. Written and graphic information and physical samples that require Engineer's responsive action.
- B. Informational Submittals:
 - 1. Written and graphic information and physical Samples that DO NOT require Engineer's responsive action. Submittals may be rejected for NOT complying with requirements.

1.3 SUBMITTAL PROCEDURES

- A. Transmit each submittal with Engineer-accepted form. Package submittal information by individual specification section. DO NOT combine different specification sections together in submittal package, unless otherwise directed in specification or items are part of a common system.
- B. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.
- C. Identify:
 - 1. Project (Engineer's project number and title), Contractor, Subcontractor and supplier, pertinent Drawing and detail number, and Specification Section number appropriate to submittal.
- D. The Contractor shall review all submittals before submitting to Engineer. Apply Contractor's stamp, signed or initialed, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is as specified in requirements of the Work and Contract Documents.
- E. Provide a submittal schedule, in electronic spreadsheet format, at the beginning of the project to identify all expected submittals.

- F. Post electronic submittals as PDF electronic files to the web-based project management software. Coordinate submission of related items.
- G. For each submittal for review, allow 30 days excluding delivery time to and from Contractor.
- H. Identify variations in Contract Documents and product or system limitations that may be detrimental to successful performance of completed Work.
- I. Allow space on submittals for Contractor and Engineer review stamps.
- J. When revised for resubmission, identify changes made since previous submission.
- K. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
- L. Submittals not requested WILL NOT be recognized nor processed.
- M. Incomplete Submittals:
 - 1. Engineer WILL NOT review. Complete submittals for each item are required. Delays resulting from incomplete submittals are NOT the responsibility of Engineer.

1.4 PROPOSED PRODUCT LIST

- A. Within 15 days after date of Owner-Contractor Agreement, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, indicate manufacturer, trade name, model or catalog designation, and reference standards.

1.5 PRODUCT DATA

- A. Action Submittal:
 - 1. Submit to Engineer for review for assessing conformance with information given and design concept expressed in Contract Documents.
- B. Post electronic submittals as PDF electronic files to web-based project management software.
- C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- E. After review, produce copies and distribute as specified in Paragraph 1.3 "Submittal Procedures" and for record documents specified in Section 01 77 00 – Closeout Procedures.

1.6 SHOP DRAWINGS

- A. Action Submittal:
 - 1. Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.
- B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

- C. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a professional Engineer responsible for designing components specified in Shop Drawings.
 - 1. Include signed and sealed calculations to support design.
 - 2. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
 - 3. Make revisions and provide additional information when required by authorities having jurisdiction.
- D. Post electronic submittals as PDF electronic files to web-based project management software.
- E. After review, produce copies and distribute as specified in Paragraph 1.3 "Submittal Procedures" and for record documents described in Section 01 77 00 – Closeout Procedures.

1.7 SAMPLES

- A. Action Submittal:
 - 1. Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.
- B. Samples for Selection as Specified in Product Sections:
 - 1. Submit to Engineer for aesthetic, color, and finish selection.
 - 2. Submit Samples of finishes, textures, and patterns for Engineer selection.
- C. Submit Samples to illustrate functional and aesthetic characteristics of products, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.
- D. Include identification on each Sample, with full Project information.
- E. Submit number of Samples specified in individual Specification Sections; Engineer or Owner will retain one Sample.
- F. Reviewed Samples that may be used in the Work are specified in individual Specification Sections.
- G. Samples WILL NOT be used for testing purposes unless specifically stated in Specification Section.
- H. After review, produce copies and distribute as specified in Paragraph 1.3 "Submittal Procedures" and for record documents described in Section 01 77 00 – Closeout Procedures.

1.8 ERECTION DRAWINGS

- A. Action Submittal:
 - 1. Submit Drawings for information assessing conformance with information given and design concept expressed in Contract Documents.
- B. After review, produce copies and distribute as specified in Paragraph 1.3 "Submittal Procedures" and for record documents described in Section 01 77 00 – Closeout Procedures.

1.9 OTHER SUBMITTALS

- A. Closeout Submittals:
 - 1. See Section 01 77 00 – Closeout Procedures.
- B. Informational Submittal:

1. Submit data for Engineer's knowledge as Contract administrator or for Owner.
 - C. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.
- 1.10 TEST REPORTS
- A. Informational Submittal:
 1. Submit reports for Engineer's knowledge as Contract administrator or for Owner.
 - B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.
- 1.11 CERTIFICATES
- A. Informational Submittal:
 1. Submit certification by manufacturer, installation/application Subcontractor, or Contractor to Engineer, in quantities specified for Product Data.
 - B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 - C. Certificates may be recent or previous test results on material or product but must be acceptable to Engineer.
- 1.12 MANUFACTURER'S INSTRUCTIONS
- A. Informational Submittal:
 1. Submit manufacturer's installation instructions for Engineer's knowledge as Contract administrator or for Owner.
 - B. Submit printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, to Engineer in quantities specified for Product Data.
 - C. Specify special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
- 1.13 MANUFACTURER'S FIELD REPORTS
- A. Informational Submittal:
 1. Submit reports for Engineer's knowledge as Contract administrator or for Owner.
 - B. Submit report in duplicate and in electronic format (pdf) within 5 days of observation to Engineer for information.
 - C. Submit reports for information for assessing conformance with information given and design concept expressed in Contract Documents.
- 1.14 CONTRACTOR REVIEW
- A. Review for compliance with Contract Documents and approve submittals before transmitting to Engineer. If during the Engineer's review it becomes clear that a submittal was inadequately reviewed by the Contractor, the submittal will be rejected.
 - B. Contractor Responsibilities:

1. Determination and verification of materials including manufacturer's catalog numbers.
 2. Determination and verification of field measurements and field construction criteria.
 3. Checking and coordinating information in submittal with requirements of Work and of Contract Documents.
 4. Determination of accuracy and completeness of dimensions and quantities.
 5. Confirmation and coordination of dimensions and field conditions at Site.
 6. Construction means, techniques, sequences, and procedures.
 7. Safety precautions.
 8. Coordination and performance of Work of all trades.
- C. Stamp, sign or initial, and date each submittal to certify compliance with requirements of Contract Documents.
- D. DO NOT fabricate products or begin Work for which submittals are required until approved submittals have been received from Engineer.

1.15 ENGINEER REVIEW

- A. DO NOT make "mass submittals" to Engineer. "Mass submittals" are defined as six or more submittals or items in one day or 20 or more submittals or items in one week. If "mass submittals" are received, Engineer's review time stated above will be extended as necessary to perform proper review. Engineer will review "mass submittals" based on priority determined by Engineer after consultation with Owner and Contractor.
- B. Informational submittals and other similar data are for Engineer's information, DO NOT require Engineer's responsive action, and WILL NOT be reviewed or returned with comment.
- C. Submittals made by Contractor that are NOT required by Contract Documents may be returned without action.
- D. Submittal approval DOES NOT authorize changes to Contract requirements unless accompanied by Change Order or Work Change Directive.
- E. Action Submittal Dispositions:
1. Engineer will review, markup, stamp as appropriate, and distribute markedup electronic copies to appropriate parties as noted.
 2. Furnish as Submitted:
 - a. Contractor may incorporate product(s) or implement Work covered by submittal.
 3. Furnish as Corrected or Noted:
 - a. Contractor may incorporate product(s) or implement Work covered by submittal, as specified in Engineer's notations.
 4. Revise and Resubmit:
 - a. Make corrections or obtain missing portions and resubmit.
 5. Partial Resubmittal:
 - a. Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, as specified in Engineer's notations.
 6. Rejected:
 - a. Contractor may NOT incorporate product(s) or implement Work covered by submittal.
- F. Owner may withhold monies due to Contractor to cover additional costs beyond the second submittal review.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 40 00 – QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Quality control.
 - 2. Tolerances.
 - 3. References.
 - 4. Delegated Design Services.
 - 5. Conflicting Requirements.
 - 6. Labeling.
 - 7. Mockup requirements.
 - 8. Testing and inspection services.
 - 9. Manufacturers' field services.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.2 QUALITY CONTROL

- A. Monitor quality control over suppliers, manufacturers, products, services, Site conditions, and workmanship, to produce Work of specified quality.
- B. See specified standards as the minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- C. Perform Work using persons qualified to produce required and specified quality.
- D. Products, materials, and equipment may be subject to inspection by Engineer and Owner at place of manufacture or fabrication. Such inspections shall not relieve Contractor of complying with requirements of Contract Documents.
- E. Supervise performance of Work in such manner and by such means to ensure that Work, whether completed or in progress, will not be subjected to harmful, dangerous, damaging, or otherwise deleterious exposure during construction period.

1.3 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

- B. Comply with manufacturers' recommended tolerances and tolerance requirements in reference standards. When such tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

- A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard except when more rigid requirements are specified or are required by applicable codes.
- B. Dating of reference standards may conflict with applicable building codes that reference standards with established dates. Therefore, individual SpecText Sections do not date reference standards, but rely on the first Paragraph below for applicable date of issue. Conversely, some products may be tested to specifically dated standards.
- C. Conform to reference standard by date of issue current as of date for receiving Bids except where specific date is established by code.
- D. Obtain copies of standards and maintain on Site when required by product Specification Sections.
- E. When requirements of indicated reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
- F. Neither contractual relationships, duties, or responsibilities of parties in Contract nor those of Engineer shall be altered from Contract Documents by mention or inference in reference documents.

1.5 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria:
 - 1. Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 2. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.
- B. Delegated Design Services Statement:
 - 1. Submit a statement signed and sealed by the responsible design professional licensed in the state of Work, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.6 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements:
 - 1. If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Engineer regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Engineer for clarification before proceeding.

- B. Minimum Quantity or Quality Levels:
 - 1. The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.7 LABELING

- A. Attach label from agency approved by authorities having jurisdiction for products, assemblies, and systems required to be labeled by applicable code.
- B. Label Information:
 - 1. Include manufacturer's or fabricator's identification, approved agency identification, and the applicable information on each label:
 - a. Model number.
 - b. Serial number.
 - c. Performance characteristics.
- C. Manufacturer's Nameplates, Trademarks, Logos, and Other Identifying Marks on Products:
 - 1. Not allowed on surfaces exposed to view in public areas, interior or exterior.

1.8 MOCK-UP REQUIREMENTS

- A. Use this Article for full-size assemblies for review of construction or for assemblies requiring esthetic review or coordination of several Sections of the Work. An example is a glazed wall, adjacent solid wall, and perimeter construction, which may require testing or assessment for quality of Work.
- B. A mockup can also be used to educate and inform installers as to detailed relationship and connections between adjoining and adjacent products as mockup is being assembled or constructed.
- C. Individual Specification Sections should specify mockup size and requirements for performance testing such as air or water infiltration or the operation of the item.
- D. Tests will be performed under provisions identified in this Section and identified in individual product Specification Sections.
- E. Assemble and erect specified or indicated items with specified or indicated attachment and anchorage devices, flashings, seals, and finishes.
- F. Accepted mockups shall be comparison standard for remaining Work.
- G. Where mockup has been accepted by Engineer and is specified in product Specification Sections to be removed, remove mockup and clear area when directed to do so by Engineer.

1.9 QUALIFICATIONS

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications:

1. A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications:
1. A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications:
1. A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications:
1. A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.
- F. Specialists:
1. Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
 2. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing and Inspecting Agency Qualifications:
1. An independent agency with the experience and capability to conduct testing and inspection indicated, as documented as specified in ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Manufacturer's Technical Representative Qualifications:
1. An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications:
1. An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- 1.10 OWNER'S REPRESENTATIVE
- A. Owner's project representative employed or retained by the Owner is authorized to inspect the Work in determining when the Work is faulty, defective, damaged, or does not conform to Contract Documents. Deficiencies or defects in the Work which have been observed will be called to the Contractor's attention.
- B. Owner's representative WILL NOT:
1. Alter or waive provisions of the Contract.

2. Inspect Contractor's means or methods of construction.
3. Accept portions of the Work.
4. Supervise, control, or direct Contractor's safety programs.

1.11 CONTRACTOR TESTING AND INSPECTION SERVICES

- A. Employ and pay for services of an independent testing agency or laboratory acceptable to Owner to perform specified testing and inspection as required in the Specification Sections for various work and materials.
 1. Before starting Work, submit testing laboratory name, address, and telephone number, and names of full-time Professional Engineer or specialist and responsible officer.
 2. Submit copy of report of laboratory facilities' inspection made by Materials Reference Laboratory of National Bureau of Standards during most recent inspection, with memorandum of remedies of deficiencies reported by inspection.
- B. Testing, inspections, and source quality control may occur on or off Project Site. Perform offsite testing as required by Engineer or Owner.
- C. Reports shall be submitted by independent firm to Engineer, Contractor, and authorities having jurisdiction, indicating observations and results of tests and compliance or noncompliance with Contract Documents.
 1. Submit final report indicating correction of Work previously reported as noncompliant.
- D. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
 1. Provide Engineer and independent firm with ample notice before expected time for operations requiring services, no less than 48 hours.
 2. Make arrangements with independent firm and pay for additional Samples and tests required for Contractor's use.
- E. Employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work as specified in requirements of Contract Documents.
- F. Retesting/Reinspecting:
 1. Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- G. Agency Responsibilities:
 1. Test Samples of mixes submitted by Contractor.
 2. Provide qualified personnel at Site. Cooperate with Engineer and Contractor in performance of services.
 3. Perform indicated sampling and testing of products as specified in standards.
 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 5. Promptly notify Engineer and Contractor of observed irregularities or nonconformance of Work or products.
 6. Perform additional tests required by Engineer.
 7. Attend preconstruction meetings and progress meetings.
- H. Agency Reports:
 1. After each test, promptly submit a copy of report to Engineer, Contractor, and authorities having jurisdiction. When requested by Engineer, provide interpretation of test results.
 2. Include:
 - a. Date issued.
 - b. Project title and number.

- c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and Specification Section.
 - f. Location in Project.
 - g. Type of inspection or test.
 - h. Date of test.
 - i. Results of tests.
 - j. Conformance with Contract Documents.
- I. Limits on Testing Authority:
- 1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency or laboratory may not approve or accept any portion of the Work.
 - 3. Agency or laboratory may not assume duties of Contractor.
 - 4. Agency or laboratory has no authority to stop the Work.
 - a. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.
 - 5. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor-retained and Owner-retained services, commissioning activities, and other Project-required services paid for by other entities.
 - 6. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections:
- 1. Owner may employ and pay for a qualified special inspector to conduct special tests and inspections required by authorities having jurisdiction, as defined in Chapter 17 of the International Building Code (IBC). These special tests and inspections are in addition to all other testing and inspection requirements.
- B. Contractor's Responsibilities:
- 1. The Contractor shall assist the Owner's special tests and inspections by making available materials for testing, providing advanced notice of needed inspections, and providing sufficient time in project schedule for execution of Owner's special tests and inspections. The costs of these support activities are included in the Contract Price.
 - 2. Cooperate with Owner's independent testing firm or laboratory personnel and provide access to construction operations.
 - 3. Secure and deliver to Owner's independent testing firm or laboratory adequate quantities of representative samples to be used and which require testing.
 - 4. Provide to Owner's independent testing firm or laboratory preliminary mix design proposed to be used for concrete and other material mixes which require control by testing laboratory.
 - 5. Provide incidental labor and facilities:
 - a. To provide access to construction
 - b. To obtain and handle samples at Project Site or at source of product to be tested.
 - c. To facilitate tests and inspections.
 - d. For storage and curing of test samples.
 - 6. Notify Owner's independent testing firm or laboratory 48 hours in advance of when testing is needed for laboratory to schedule and perform services.
- C. See Section 01 45 24 – Special Tests and Inspections for additional special test and inspection requirements.

1.13 OWNER TESTING AND INSPECTION SERVICES

- A. Owner will employ and Contractor shall pay, from cash allowances specified in Section 01 20 00 – Price and Payment Procedures, for services of an independent firm to perform testing and inspection as directed by the Owner or Engineer to confirm Contractor's compliance with Contract Documents. Owner tests and inspections paid for by allowance are solely at the discretion of the Owner and Engineer, to confirm results of Contractor's independent testing and inspections. They are not for the Contractor's use to fulfill the testing and inspection requirements of the Contract Documents.
- B. Contractor's Responsibilities:
 - 1. The Contractor shall assist the Owner's special tests and inspections in the same manner as defined in "Special Tests and Inspections" Article of this Specification. The costs of these requirements are included in the Contract Price.

1.14 MANUFACTURER'S FIELD SERVICES

- A. When specified in individual Specification Sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe Site conditions, conditions of surfaces and installation, quality of workmanship, startup of equipment, testing, adjusting, and balancing of equipment, and commissioning as applicable, and to initiate instructions when necessary.
- B. Submit qualifications of staff 30 days in advance of required observations. Observer is subject to approval of Engineer or Owner.
- C. Report observations and Site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturer's written instructions.
- D. See Section 01 33 00 – Submittal Procedures, "Manufacturer's Field Reports" Article.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 24 – SPECIAL TESTS AND INSPECTIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. This Section describes the requirements of the Contractor to support special tests and inspections performed by the Owner's special inspector and testing laboratory as required by Chapter 17 of the International Building Code (IBC). The Contractor does not perform the tests and inspections described within this section, unless specifically directed to do so by another specification section included in the Contract Documents.
- B. Related Sections:
 - 1. Section 01 40 00 – Quality Requirements.

1.2 REFERENCES

- A. ASTM International:
 - 1. C140 – Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
 - 2. C270 – Standard Specification for Mortar for Unit Masonry.
 - 3. C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
 - 4. C1019 – Standard Test Method for Sampling and Testing Grout.
 - 5. C1314 – Standard Test Method for Compressive Strength of Masonry Prisms.
- B. IBC (International Building Code).

1.3 DESCRIPTION

- A. This Section describes special tests and inspections of structural assemblies and components to be performed in compliance with IBC. The Owner will employ one or more inspectors who will provide special inspections during construction.
- B. The Contractor shall support special tests and inspections as required by this document.

1.4 INSPECTION

- A. Make available all Work required for inspection by the Owner's Special Inspector. Duties of the Special Inspector are described in the IBC.

1.5 SPECIAL TESTING AND INSPECTIONS

- A. Selection of the material required to be tested shall be by the Owner's testing laboratory and not the Contractor. Special tests will be performed by the Owner's testing laboratory.
- B. OWNER reserves the right to positive material identification tests.
 - 1. Contractor must make materials available for testing.
- C. The types of work require special inspection or testing as described in IBC.
 - 1. Schedules:
 - a. Appendix A – Cast-In-Place Concrete Special Inspection Schedule.
 - b. Appendix B – Essential Architectural, Mechanical and Electrical Inspection Schedule.

- c. Appendix C – Essential Masonry Special Inspection Schedule.
- d. Appendix D – Soils Verification and Inspection Schedule.
- e. Appendix E – Structural Steel Special Inspection Schedule.
- f. Appendix F – Other Special Inspection.

1.6 OTHER SPECIFIC TESTS

- A. Masonry shall be tested as specified in IBC.
 - 1. Minimum strength of units shall be tested as specified in ASTM C140.
 - 2. Minimum strength of grout shall be tested as specified in ASTM C1019.
 - 3. Prior to construction, obtain samples of the aggregates, additives, and water; mix and test in laboratory as specified in ASTM C270.
 - 4. During construction, sample and test masonry for consistency prior to use on each structure as specified in ASTM C780.
 - 5. When approved by the building official, if installed masonry does not meet requirements, conduct prism tests as specified in ASTM C1314.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULE

- A. The Contractor shall allow time necessary for Special Inspections as listed above.
- B. Sufficient notice shall be given so that the Special Inspections can be performed. This includes time for off-site Special Inspectors to plan the inspection and travel to site.

3.2 PROCEDURE

- A. The Special Inspector will immediately notify the Engineer, Owner, and Contractor of any corrections required and follow notification with appropriate documentation.
- B. The Contractor shall take corrective actions based on Special Inspector's findings and recommendations at no additional cost to the Owner.
- C. The Contractor shall not proceed until the Work is satisfactory to the Special Inspector, Owner, and Engineer.

END OF SECTION

APPENDIX A
CAST-IN-PLACE CONCRETE SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Inspection of reinforcing steel, including prestressing tendons, and placement.		–	X
2. Inspection of reinforcing steel welding.	IBC Table 1704.3, Item 5B	X	–
3. Inspect bolts to be installed in concrete prior to and during placement of concrete.		X	–
4. Verifying use of required design mix.		–	X
5. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.		X	–
6. Inspection of concrete and shotcrete placement for proper application techniques.		X	–
7. Inspection for maintenance of specified curing temperature and techniques.		–	X

APPENDIX B
ESSENTIAL ARCHITECTURAL, MECHANICAL AND ELECTRICAL
INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Suspended ceiling system including anchorage.		–	X
2. Anchorage of electrical equipment for emergency standby power.		–	X
3. Anchorage of other electrical or mechanical equipment on floors or roofs.		–	X
4. Anchorage of ducts.		–	X
5. Anchorage of pipes.		–	X
6. Steel storage racks supporting pipelines.		–	X
7. Elevator installation.		–	X

APPENDIX C
ESSENTIAL MASONRY SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. From the beginning of masonry construction, the following shall be verified for compliance:			
a. Proportions of site-prepared mortar and grout.		–	X
b. Placement of masonry units and construction of mortar joints.		–	X
c. Placement of reinforcement and connectors.		–	X
d. Grout space prior to grouting.		X	–
e. Placement of grout.		X	–
2. The inspection program shall verify:			
a. Size and location of structural elements.		–	X
b. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction.		X	–
c. Specified size, grade and type of reinforcement.			X
d. Welding of reinforcing couplers.		X	–
e. Protection of masonry during cold weather (temperature below 40° F) or hot weather (temperature above 90° F).		–	X
3. Preparation of any required grout specimens, mortar specimens and/or prisms shall be observed.		X	–
4. Compliance with required inspection provisions of the construction documents and the approved submittals shall be verified.		–	X

APPENDIX D
SOILS VERIFICATION AND INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Verify materials below footings are adequate to achieve the design bearing capacity.		–	X
2. Verify excavations are extended to proper depth and have reached proper material.		–	X
3. Perform classification and testing of controlled fill materials.		–	X
4. Verify use of proper materials, densities, and lift thicknesses during placement and compaction of controlled fill.		X	–
5. Prior to placement of controlled fill, observe subgrade and verify that site has been prepared properly.		–	X

APPENDIX E
STRUCTURAL STEEL SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Material verification of high-strength bolts, nuts and washers:			
a. Identification markings to conform to ASTM standards specified in the approved construction documents.		–	X
b. Manufacturer's certificate of compliance required.		–	X
2. Inspection of high-strength bolting:			
a. Bearing-type connections.		–	X
b. Slip-critical connections.		X	X
3. Material verification of structural steel:			
a. Identification markings to conform to ASTM standards specified in the approved construction documents.		–	X
b. Manufacturers' certified mill test reports.		X	–
4. Material verification of weld filler materials:			
a. Identification markings to conform to AWS specification in the approved construction documents.		–	X
b. Manufacturer's certificate of compliance required.		–	X
5. Inspection of welding:			
a. Structural steel:		–	–
1) Complete and partial penetration groove welds.		X	–
2) Multi-pass fillet welds.		X	–
3) Single-pass fillet welds > 5/16".		X	–
4) Single-pass fillet welds ≤ 5/16".		–	X
5) Floor and deck welds.		–	X
b. Reinforcing steel:		–	–
1) Verification of weldability of reinforcing steel other than ASTM A706.		–	X
2) Reinforcing steel-resisting flexural and axial forces in boundary elements of special reinforced concrete shear walls and shear reinforcement.		X	–
3) Shear reinforcement.		X	–
4) "Form Saver" (reinforcing couplers).		X	–
6. Inspection of steel frame joint details for compliance with approved construction documents:			X
a. Details such as bracing and stiffening.		X	–
b. Member locations.		X	–
c. Application of joint details at each connection.		X	
7. Seismic force resisting systems identified on structural plans.		X	–

**APPENDIX F
OTHER SPECIAL INSPECTION SCHEDULE**

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Shoring of Excavations.		–	X
2. Reinforced gypsum concrete.		–	X
3. Shotcrete.		–	X
4. Smoke control system.		–	X
5. Special grading, excavating, and filling.		–	X
6. Spray applied fire resistive material.		–	X
7. Special seismic resistance details.		–	X

SECTION 01 50 00 – TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Temporary Utilities:
 - a. Temporary electricity.
 - b. Temporary lighting for construction purposes.
 - c. Temporary heating.
 - d. Temporary cooling.
 - e. Temporary ventilation.
 - f. Communication services.
 - g. Temporary water service.
 - h. Temporary sanitary facilities.
 - i. Temporary process pumping and piping
 - j. Temporary Chemical Storage Facility
 - 2. Construction Facilities:
 - a. Field offices and sheds.
 - b. Vehicular access.
 - c. Parking.
 - d. Progress cleaning and waste removal.
 - e. Project identification.
 - f. Traffic regulation.
 - g. Fire-prevention facilities.
 - 3. Temporary Controls:
 - a. Barriers.
 - b. Enclosures and fencing.
 - c. Security.
 - d. Water control.
 - e. Dust control.
 - f. Erosion and sediment control.
 - g. Noise control.
 - h. Pest and rodent control.
 - i. Pollution control.
 - 4. Removal of utilities, facilities, and controls.

1.2 REFERENCES

- A. ASTM International:
 - 1. E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. E90 – Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - 3. E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Temporary Pumping Systems:
 - 1. Submit pump data, performance curves, and other operating information.
 - 2. Submit sketches showing layout of temporary pumping system, including pump quantity and location.
 - 3. Submit all information at least 30 days prior to when temporary pumping system is scheduled to be installed.

- C. Temporary Piping Systems:
 - 1. Submit layout drawings showing proposed routing of piping, including proposed pipe support and pipe restraint locations.
 - 2. Submit product data for piping, fittings, restraints, supports, and all appurtenances of the piping system.
 - 3. Submit piping headloss calculations based on proposed layout.
 - 4. Submit all information at least 30 days prior to when the temporary piping system is scheduled to be installed.
- D. Temporary Chemical Storage Facility
 - 1. Submit layout sketches showing proposed facility layout, including pumps, totes, piping, valves, and electrical.
 - 2. Submit pump data, performance curves, and other operating information.
 - 3. Submit sketches showing layout of temporary pumping system, including pump quantity and location.
 - 4. Submit product data for piping, fittings, restraints, supports, and all appurtenances of the piping system.
 - 5. Submit all information at least 30 days prior to when temporary chemical storage facility is scheduled to be installed.
 - 6. Use TMUA's current chemical supplier to provide IBC totes of hydrofluorosilicic acid and cationic polymer. Provide chemical quality sheets for review and approval of chemicals.
 - a. Dubois Chemicals - Hydrofluorosilicic acid
 - b. Polydyne Inc. - Cationic Polymer
 - 7. Provide minimum 30 days of each chemical onsite.
 - a. Hydrofluorosilicic Acid - 3300 gallons (based on current use)
 - b. Cationic Polymer - 1045 gallons (based on current use)

1.4 TEMPORARY FACILITIES

- A. Temporary Provisions Provided by Contractor:
 - 1. Temporary barriers, barricades, covered walkways, fencing, exterior closures, and interior closures.
 - 2. Temporary field offices.
 - 3. Cleaning during construction.
 - 4. Access roads and approaches.
 - 5. Temporary sanitary facilities.
 - 6. Temporary heating and ventilating after enclosure.
 - 7. Temporary electrical service and distribution system for power and lighting.
 - 8. Temporary telephone and internet service.
 - 9. Temporary tree and plant protection.
 - 10. Temporary heating before building enclosure.
 - 11. Temporary fire protection, dust control, erosion and sediment control, water control, noise control, and other necessary temporary controls
 - 12. Temporary provisions for protection of installed Work
 - 13. Temporary chemical storage facilities

1.5 TEMPORARY ELECTRICITY

- A. Provide and pay for temporary power service required from utility source as needed for construction operation.
- B. When using Owner's existing power service, provide separate metering, and reimburse Owner for cost of energy used.
- C. Complement existing power service capacity and characteristics as required for construction operations.

- D. Provide power outlets with branch wiring and distribution boxes located as required for construction operations. Provide suitable, flexible power cords as required for portable construction tools and equipment. All temporary electrical work shall comply with electrical codes and regulations.

1.6 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain lighting for construction operations at lighting levels NOT less than required by OSHA (Occupational Safety and Health Administration).
- B. Provide and maintain lighting to exterior staging and storage areas and interior work areas after dark for security purposes.
- C. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, lamps, and the like, for specified lighting levels.
- D. Permanent building lighting may be used during construction. When used, maintain lighting and provide routine repairs including replacement of lamps.

1.7 TEMPORARY HEATING

- A. Provide temporary heating devices and heat as needed to maintain specified conditions for construction operations.
- B. Before operating permanent equipment for temporary heating purposes, verify installation is approved for operation, equipment is lubricated, and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts. Replace filters at Substantial Completion.
- C. Maintain minimum ambient temperature of 50°F in areas where construction is in progress unless indicated otherwise in individual product Sections.

1.8 TEMPORARY COOLING

- A. Provide cooling devices and cooling as needed to maintain specified conditions for construction operations.
- B. Before operating permanent equipment for temporary cooling purposes, verify installation is approved for operation, equipment is lubricated, and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts. Replace filters at Substantial Completion.
- C. Maintain maximum ambient temperature of 80°F in areas where construction is in progress unless indicated otherwise in individual product Sections.

1.9 TEMPORARY VENTILATION

- A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- B. For construction activity is hazardous locations, provide ventilation levels to achieve unclassified ratings in accordance with NFPA 820.

1.10 COMMUNICATION SERVICES

- A. Internet Service:
 - 1. Provide, maintain, and pay for broadband Internet service to field office at time of Project mobilization. Internet service must provide a minimum of 1,000 mbps upload and download speeds. Provide desktop computer with Microsoft operating system and appropriate office function software, modem, and printer.

1.11 TEMPORARY WATER SERVICE

- A. Provide and pay for suitable quality water service as needed to maintain specified conditions for construction operations. Where existing water service is used, provide separate metering and reimburse Owner for cost of water used.
- B. Extend branch piping with outlets located so that water is available by hoses with threaded connections. Provide temporary pipe insulation and heat tape to prevent freezing as necessary.
- C. Remove temporary piping and connections and restore affected portions of the facility to original condition before Final Completion.

1.12 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Existing facility use is NOT permitted. Provide facilities at time of Project mobilization. Remove facilities at completion of project and leave Site in neat and sanitary condition.

1.13 FIELD OFFICES AND SHEDS

- A. DO NOT use existing facilities for field offices or for storage.
- B. Contractor's Field Office:
 - 1. Portable or mobile building, or building constructed with floors raised aboveground, securely fixed to foundations with steps and landings at entrance doors.
 - 2. Construction: Structurally sound, secure, weathertight enclosures for office and storage spaces. Maintain during progress of Work; remove enclosures at completion of Work.
 - 3. Provide lighting, electrical outlets, heating, cooling, and ventilating equipment, and equipped with sturdy furniture including conference table, drawing rack, filing cabinets, and drawing display table.
 - 4. Provide space for Project meetings, with table and chairs to accommodate eight people.
 - 5. Thermal Resistance of Floors, Walls, and Ceilings: Compatible with occupancy and storage requirements.
 - 6. Exterior Materials: Weather-resistant, finished in color acceptable to Engineer.
 - 7. Interior Materials in Field Offices: Sheet-type materials for walls and ceilings, prefinished or painted; resilient floors and bases.
 - 8. Environmental Control:
 - a. Heating, Cooling, and Ventilating for Offices: Automatic equipment to maintain comfort conditions.
- C. Storage Areas and Sheds:
 - 1. Size to storage requirements for products of individual Sections, allowing for access and orderly provision for maintenance and inspection of products to suit requirements in Section 01 60 00 – Product Requirements.
- D. Preparation:
 - 1. Fill and grade Sites for temporary structures sloped for drainage away from buildings.

- E. Installation:
 - 1. Install field office spaces ready for occupancy 15 days after date established by Notice to Proceed.
 - 2. Locate field offices where directed.
 - 3. Raise grade under field offices, as necessary, to elevation adequate to avoid flooding.
 - 4. Provide sanitary facilities in compliance with state and local health authorities.
- F. Maintenance and Cleaning:
 - 1. Arrange and pay for Janitorial service including daily trash service, continuous supply of toilet paper, hand towels, and hand soap, and monthly comprehensive cleaning for both Contractor field offices.
 - 2. Maintain walks free of mud, water, snow, and the like.
- G. Removal:
 - 1. At completion of Work remove buildings, foundations, utility services, and debris. Restore areas to same or better condition as original condition.

1.14 VEHICULAR ACCESS

- A. Construct temporary all-weather access roads from public thoroughfares to serve construction area, of width and load-bearing capacity to accommodate unimpeded traffic for construction purposes. Roads shall be use gravel, crushed rock, or other stabilization material.
- B. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage.
- C. Where access roads cross existing fences, install and maintain gates.
- D. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.
- E. Extend and relocate vehicular access as Work progress requires and provide detours as necessary for unimpeded traffic flow.
- F. Locate as required and within easements, rights-of-way, or Project limits. Obtain Engineer's approval of access roads.
- G. Provide unimpeded access for emergency vehicles.
- H. Provide and maintain access to fire hydrants and control valves free of obstructions.
- I. Provide means of removing mud from vehicle wheels before entering streets.
- J. Only use existing onsite roads for construction traffic when designated and with Owner or Engineer approval.
- K. Upon completion of construction, restore ground surface disturbed by access road construction to original condition.

1.15 PARKING

- A. Arrange for temporary surface parking areas to accommodate construction personnel.
- B. Locate as specified in Drawings or as approved by Engineer or Owner.
- C. If Site space is NOT adequate, provide additional offsite parking.

- D. NO employee or equipment parking will be permitted on Owner's existing parking areas, except as specifically designated for Contractor's use.
- E. DO NOT allow heavy vehicles or construction equipment in parking areas.
- F. DO NOT allow vehicle parking on existing pavement.
- G. Designate parking spaces for Engineer or Owner construction observation personnel.
- H. Permanent Pavements and Parking Facilities:
 - 1. Before Substantial Completion, bases for permanent roads and parking areas may be used for construction traffic.
 - 2. Avoid traffic loading beyond paving design capacity. Tracked vehicles are NOT allowed.
 - 3. Use of permanent parking structures is NOT permitted.
- I. Maintenance:
 - 1. Maintain traffic and parking areas in sound condition free of excavated material, construction equipment, products, mud, snow, ice, and the like.
 - 2. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original condition.
- J. Removal, Repair:
 - 1. Remove temporary materials and construction when permanent paving is usable.
 - 2. Remove underground Work and compacted materials to depth of 2 ft; fill and grade Site as specified.
 - 3. Repair facilities damaged by use, to original condition.
- K. Mud from Site vehicles:
 - 1. Provide means of removing mud from vehicle wheels before entering streets.

1.16 PROGRESS CLEANING AND WASTE REMOVAL

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain Site in clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, before enclosing spaces.
- C. Broom and vacuum clean interior areas before starting surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and rubbish from Site to maintain a clean and orderly Site and dispose of offsite, at least at weekly intervals.
- E. Open free-fall chutes are NOT permitted. Terminate closed chutes into appropriate containers with lids.

1.17 PROJECT IDENTIFICATION

- A. Project Identification Sign:
 - 1. One painted sign, 32 ft² area, bottom 6 ft aboveground.
 - 2. Content:
 - a. Project number, title, logo, and name of Owner.
 - b. Names and titles of authorities.

- c. Names and titles of Engineer and Consultants.
 - d. Name of Prime Contractor.
- 3. Lettering: Series C of Standard Alphabet for Traffic Control Devices, "Manual on Uniform Traffic Control Devices for Streets and Highways," Federal Highway Administration.
- B. Project Informational Signs:
 - 1. Painted informational signs of same colors and lettering as Project identification sign or standard products; size lettering for legibility at 100 ft distance.
 - 2. Provide sign at each field office and storage shed, and provide directional signs to direct traffic into and within Site. Relocate as Work progress requires.
 - 3. NO other signs are allowed without Owner's permission except those required by law.
- C. Design signs and structure to withstand 60 mph wind velocity.
- D. Finishes, Painting:
 - 1. Adequate to withstand weathering, fading, and chipping for duration of construction.
- E. Sign Materials:
 - 1. Structure and Framing: Metal or treated wood, structurally adequate.
 - 2. Sign Surfaces: Exterior grade plywood with medium-density overlay, minimum of 3/4 in. thick, standard large sizes to minimize joints.
 - 3. Rough Hardware: Galvanized or aluminum.
 - 4. Paint and Primers: Exterior quality, two coats.
 - 5. Lettering: Exterior quality paint, contrasting colors.
- F. Installation:
 - 1. Install Project identification sign within 15 days after date established by Notice to Proceed.
 - 2. Erect at designated location.
 - 3. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
 - 4. Install sign surface plumb and level, with butt joints. Anchor securely.
 - 5. Paint exposed surfaces of sign, supports, and framing.
- G. Maintenance:
 - 1. Maintain clean signs and supports; repair deterioration and damage.
- H. Removal:
 - 1. Remove signs, framing, supports, and foundations at completion of Project and restore area.

1.18 TRAFFIC REGULATION

- A. Signs, Signals, and Devices:
 - 1. Post-Mounted and Wall-Mounted Traffic Control and Informational Signs: As approved by authorities having jurisdiction.
 - 2. Traffic Control Signals: As approved by local jurisdictions.
 - 3. Traffic Cones, Drums, Flares, and Lights: As approved by authorities having jurisdiction.
 - 4. Flag Person Equipment: As required by authorities having jurisdiction.
- B. Flag Persons:
 - 1. Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.
- C. Flares and Lights:

1. Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.
 - D. Haul Routes:
 1. Consult with authorities having jurisdiction and establish public thoroughfares to be used for haul routes and Site access.
 - E. Traffic Signs and Signals:
 1. Provide signs at approaches to Site and on Site, at crossroads, detours, parking areas, and elsewhere as needed to direct construction and affected public traffic.
 2. Provide, operate, and maintain traffic control signals to direct and maintain orderly flow of traffic in areas under Contractor's control and areas affected by Contractor's operations.
 3. Relocate signs and signals as Work progresses, to maintain effective traffic control.
 - F. Removal:
 1. Remove equipment and devices when NO longer required.
 2. Repair damage caused by installation.
 3. Remove post settings to depth of 2 ft.
- 1.19 FIRE-PREVENTION FACILITIES
- A. Establish fire watch for cutting, welding, and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does NOT exist.
 - B. Portable Fire Extinguishers:
 1. NFPA 10; 10 lb. capacity, 4A-60B: C UL rating.
 2. Provide one fire extinguisher at each stairway on each floor of buildings under construction and demolition.
 3. Provide minimum of one fire extinguisher in every construction trailer and storage shed.
 4. Provide minimum of one fire extinguisher on roof during roofing operations using heat-producing equipment.
- 1.20 CONSTRUCTION AIDS
- A. Provide railings, kick plates, enclosure, safety devices, and controls as required for adequate protection of life and property as required by applicable laws and regulations.
 - B. Design temporary supports with adequate safety factor for designed load bearing capability. When requested, provide design calculations by a Professional Engineer prior to application of loads. Submitted design calculations are for information and record purposes only.
- 1.21 BARRIERS
- A. Provide barriers to prevent unauthorized entry to construction areas, to allow for Owner's use of Site, and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
 - B. Provide barricades and covered walkways required by authorities having jurisdiction for public rights-of-way and for public access to existing building. All devices shall conform to minimum requirements of OSHA and State agencies.
 - C. Tree and Plant Protection:
 1. Preserve and protect existing trees and plants designated to remain.

2. Protect areas within drip lines from traffic, parking, storage, dumping, chemically injurious materials and liquids, ponding, and continuous running water.
3. Replace trees and plants damaged by construction operations.

D. Protect non-owned vehicular traffic, stored materials, Site, and structures from damage.

1.22 ENCLOSURES AND FENCING

A. Construction:

1. Contractor's option for fence.

B. Provide 6 ft high fence around construction Site to protect Work against theft, violence, and vandalism; equip with vehicular and pedestrian gates with locks, as required.

C. Exterior Enclosures:

1. Provide temporary weathertight closure of exterior openings to accommodate acceptable working conditions and protection for products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual Specification Sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

D. Interior Enclosures:

1. Provide temporary partitions and ceilings as indicated on Drawings to separate work areas from Owner-occupied areas, to prevent penetration of dust and moisture into Owner-occupied areas, and to prevent damage to existing materials and equipment.
2. Construction: Framing and sheet materials with closed joints and sealed edges at intersections with existing surfaces.
3. Paint surfaces exposed to view from Owner-occupied areas.

1.23 SECURITY

A. Security Program:

1. Protect Work on existing premises and Owner's operations from theft, vandalism, and unauthorized entry.
2. Initiate program in coordination with Owner's existing security system at Project mobilization.
3. Maintain program throughout construction period until Owner occupancy or as directed by Engineer.

B. Entry Control:

1. Restrict entrance of persons and vehicles to Project Site.
2. Allow entrance only to authorized persons with proper identification.
3. Maintain log of workers and visitors and make available to Owner on request.
4. Coordinate access of Owner's personnel to Site in coordination with Owner's security forces.

C. Personnel Identification:

1. Provide identification badge for each person authorized to enter premises.
2. Badge to Include: Personal photograph, name, expiration date, and employer.
3. Maintain list of accredited persons and submit copy to Owner on request.
4. Require return of badges at expiration of employment on the Work.

D. Restrictions:

1. DO NOT allow cameras on Site or photographs taken except by written approval of Owner.

1.24 WATER CONTROL

- A. Grade Site to drain. Maintain excavations free of water. Provide, operate, and maintain necessary pumping equipment.
- B. Protect Site from puddles or running water. Provide water barriers as required to protect Site from soil erosion.

1.25 DUST CONTROL

- A. Execute Work by methods that minimize raising dust from construction operations.
- B. Provide positive means to prevent airborne dust from dispersing into atmosphere, into Owner-occupied areas, and onto roadways, including dust pollution as a result of dumping and hauling rock or dirt.

1.26 EROSION AND SEDIMENT CONTROL

- A. Plan and execute construction by methods to control surface drainage from cuts and fills from borrow and waste disposal areas. Prevent erosion and sedimentation.
- B. Minimize surface area of bare soil exposed at one time.
- C. Provide temporary measures including berms, dikes, drains, and other devices to prevent water flow.
- D. Construct fill and waste areas by selective placement to avoid erosive surface silts and clays.
- E. Periodically inspect earthwork to detect evidence of erosion and sedimentation. Promptly apply corrective measures.
- F. See sediment and erosion control plan as specified in Drawings.

1.27 NOISE CONTROL

- A. Provide methods, means, and facilities to minimize noise produced by construction operations.

1.28 PEST AND RODENT CONTROL

- A. Provide methods, means, and facilities to prevent pests and insects from damaging the Work.
- B. Provide methods, means, and facilities to prevent rodents from accessing or invading premises.

1.29 POLLUTION CONTROL

- A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances and pollutants produced by construction operations.
- B. DO NOT cause or permit action to occur which would result in an overflow to an existing waterway.
- C. Burning of waste materials, rubbish, or other debris will NOT be permitted on or adjacent to Site.

- D. See pollution and environmental control requirements of authorities having jurisdiction, including EPA guidance document 430/9-73-007 "Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity".

1.30 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, and materials before Substantial Completion inspection.
- B. Remove underground installations to minimum depth of 2 ft and grade to match surrounding conditions.
- C. Clean and repair damage caused by installation or use of temporary Work.
- D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

1.31 PROTECTION OF WORK AND PROPERTY

- A. Maintain in continuous service all existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and all other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made.
- B. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
- C. Maintain original Site drainage wherever possible

1.32 TEMPORARY PROCESS PIPING

- A. Contractor shall provide all piping, appurtenances, and other materials as required to provide temporary piping systems as specified herein, as indicated on the Drawings, and as needed to perform the Work.
- B. Contractor shall field route piping as needed and as field conditions dictate, unless otherwise indicated on the Drawings, and determine appropriate lengths of piping and quantity/type of pipe fittings needed to construct temporary piping system. DO NOT block access points such as stairs, doors, and walkways to existing facilities unless approved in writing by the Owner.
- C. Restrain piping at valves and at fitting where piping changes direction, changes sizes, and at ends:
 - 1. When piping is buried, use concrete thrust block or mechanical restraints.
 - 2. When piping is exposed or under water, use mechanical or structural restraints.
 - 3. Determine thrust forces by multiplying the nominal cross-sectional area of the piping by the operating pressure of the piping.
- D. Temporary piping systems shall be installed in a manner that WILL NOT damage existing or new facilities.
- E. Piping material, including gaskets, shall be suitable for the process fluid requiring temporary piping.
- F. After temporary piping is NO longer required, remove piping, clean and repair damage cause by installation or use, and restore existing facilities to original condition.

1.33 TEMPORARY PROCESS PUMPING

- A. Contractor shall provide temporary process pumping where required to complete the Work. Temporary process pumping shall be coordinated with the Owner and Engineer prior to implementation.
1. Anticipated pressure will vary based on headloss and the final length and size of temporary piping. Contractor shall calculate headlosses and provide pumping with sufficient pressure to meet flow requirements. Calculations shall be sealed and signed by a Professional Engineer registered in the State where the Work is being performed.
 2. Pumps shall be capable of passing solids of a sufficient size for the type of liquid being pumped.
 3. Temporary pump systems must be configured to match the operational condition of permanent systems. Where required, provide variable speed pumping to match incoming flows.
 4. Provide and pay for all power required to operate temporary pump system.
 5. All electrical and instrumentation components shall comply with applicable code requirements.
 6. Temporary pumping will be required 24 hours per day during the time period when pumping is required and is critical to the proper operation of the Owner's system. Provide 24 hr. onsite supervision of pumps to ensure that pumps are always operational and performing as required. Notify the Owner immediately if temporary pumping CANNOT be provided.
 7. Contractor shall be responsible for repairing any damage or reimbursing the Owner for any regulatory fines or additional plant staff time resulting from the Contractor's failure to maintain temporary pumping.
 8. Provide N + 1 standby pumping capacity, such that a failure of the largest pumping unit does NOT result in reduced capacity of the pumping system. Standby pump(s) shall be capable of providing required pumping capacity immediately upon failure of duty pump(s).
 9. All necessary spare equipment and appurtenances shall be available at the Site to allow immediate repair and/or replacement of any pumping system component that is NOT functioning properly.
- B. After temporary process pumping is NO longer required, remove pumping system components, clean and repair damage cause by installation or use, and restore existing facilities to original condition.

1.34 TEMPORARY CHEMICAL STORAGE FACILITY

1. Cationic Polymer storage area to be designed to hold a minimum of 1,100 gallons of chemical in IBC totes. Contractor responsible for supplying chemical and removing empty totes until cationic polymer bulk tank is substantially complete and providing beneficial use to the Owner. Thirty-day estimated chemical consumption, 1,100 gallons.
2. Hydrofluorosilicic Acid storage is to be designed to hold a minimum of 3,300 gallons of chemical in IBC totes. Contractor responsible for supplying chemical and removing empty totes until hydrofluorosilicic bulk tank is substantially complete and providing beneficial use to the Owner. Thirty-day estimated chemical consumption 3,300 gallons.
3. Contractor responsible for filling day tanks before the end of the workday.
4. Contractor to purchase chemicals from existing TMUA Mohawk chemical suppliers:
 - a. Cationic Polymer - Polydyne Inc.
 - b. Hydrofluorosilicic Acid - Dubois Chemical
5. Chemicals must be stored in separate containment areas. Containment areas are to hold a minimum of 120% the volume of one IBC tote. Chemical containment barriers to be temporary.
6. All temporary piping, valves, and tube/hose to be compatible with chemicals being conveyed to existing day tanks.

7. A temporary chemical transfer pump will be required to fill the hydrofluorosilicic acid day tank from the IBC totes. The minimum pump rate should be 40 gpm. Contractor responsible for routing power.
8. The cationic polymer IBC totes should connect to the existing cationic polymer transfer pump downstream of the existing bulk tank.
9. Submit all information at least 30 days prior to when temporary system is scheduled to be installed for review and comment by Owner and Engineer.
10. Final system to be performance tested and approved by Owner and Engineer before demolition of existing chemical storage tanks.
11. Any damage to the floor by chemicals to be repaired upon removing temporary chemical system.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 60 00 – PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Products.
 - 2. Product delivery requirements.
 - 3. Product storage and handling requirements.
 - 4. Product options.

1.2 PRODUCTS

- A. At minimum, comply with specified requirements and reference standards.
- B. Specified products define standard of quality, type, function, dimension, appearance, and performance required.
- C. Furnish products of qualified manufacturers that are suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise. Confirm that manufacturer's production capacity can provide sufficient product, on time, to meet Project requirements.
- D. Domestic Products:
 - 1. Except where specified otherwise, domestic products are required and interpreted to mean products mined, manufactured, fabricated, or produced in United States or its territories.
- E. DO NOT use materials and equipment removed from existing premises except as specifically permitted by Contract Documents.
- F. Furnish interchangeable components from same manufacturer for components being replaced.
- G. Special Tools and Accessories:
 - 1. Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are NOT limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, hand wheels, chain operators, special tools, and other spare parts as required for maintenance.
- H. Lubricant:
 - 1. Provide initial lubricant recommended by equipment Manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.
- I. Equipment Finish:
 - 1. Provide Manufacturer's standard finish and color, except where specific color is indicated.
 - 2. If Manufacturer has NO standard color, provide equipment with gray finish as approved by Engineer.

1.3 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products as specified in manufacturer's instructions.

- B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products; use methods to prevent soiling, disfigurement, or damage.
- D. Deliver products as specified in accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.
- E. Unload products as specified in Manufacturer's instructions for unloading or as specified, and record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.
- F. Remove damaged products from Site, and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as NOT to delay progress of the Work.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products as specified in manufacturer's instructions.
- B. Store products with seals and labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.
- C. Store sensitive products in weathertight, climate-controlled enclosures in an environment suitable to product.
- D. For exterior storage of fabricated products, place products on sloped supports aboveground.
- E. Provide bonded offsite storage and protection when Site does NOT permit onsite storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
- H. Provide equipment and personnel to store products; use methods to prevent soiling, disfigurement, or damage.
- I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.
- J. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60°F. Protect electrical, instrumentation, and control products, and insulation against moisture, water, and dust damage. Connect and operate continuously all space heaters furnished in electrical equipment.
- K. Store finished products that are ready for installation in dry and well-ventilated areas. DO NOT subject to extreme changes in temperature or humidity.
- L. Hazardous Materials:

1. Prevent contamination of personnel, storage building, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

1.5 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only:
 1. Products complying with specified reference standards or description.
- B. Products Specified by Naming One or More Manufacturers:
 1. Products of one of manufacturers named and complying with Specifications; NO options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions:
 1. Submit Request for Substitution for any manufacturer NOT named, as specified in Section 01 25 00 – Substitution Procedures.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 70 00 – EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Examination.
 - 2. Preparation.
 - 3. Coordination of Owner's portion of the Work.
 - 4. Survey control.
 - 5. Execution.
 - 6. Indoor air quality procedures.
 - 7. Cutting and patching.
 - 8. Protecting installed construction.
 - 9. Work within public right-of-way.

1.2 EXAMINATION

- A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual Specification Sections.
- D. Verify that utility services are available with correct characteristics and in correct locations.

1.3 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance as specified in manufacturer's instructions.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer-required or manufacturer-recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

1.4 COORDINATION OF OWNER'S PORTION OF THE WORK

- A. Site Access: Provide access to Project site for Owner's construction personnel.
 - 1. Provide temporary facilities required for Owner-furnished, Contractor-installed or Owner-furnished, Owner-installed products.
 - 2. See Section 01 10 00 – Summary for other requirements for Owner-furnished, Contractor-installed or Owner-furnished, Owner-installed products.
- B. Coordination: Coordinate construction and operations of the Work with Work performed by Owner's construction personnel.
 - 1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 - 2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's Work. Attend

preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

1.5 SURVEY CONTROL

- A. Employ land surveyor registered in State of Work and acceptable to Engineer and Owner.
- B. Coordinate locate with Engineer and Owner and protect survey controls and reference points. Promptly notify Engineer of discrepancies discovered.
- C. Control datum for survey is as specified in Drawings.
- D. Prior to beginning Work, verify and establish floor elevations of existing facilities, where applicable, to ensure that new Work will meet existing elevations in smooth and level alignment except where specifically detailed or indicated otherwise.
- E. Verify setbacks and easements; confirm Drawing dimensions and elevations.
- F. Provide field engineering services. Establish elevations, lines, and levels using recognized engineering survey practices. Accuracy of stakes, alignments, and grades may be checked randomly by Engineer; notice will be given for when checking will be conducted. When notice of checking is given, postpone parts of the Work affected by stakes, alignments or grades until checked.
- G. Submit copy of Site drawing signed by land surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.
- H. Maintain complete and accurate log of control and survey Work as Work progresses.
- I. On completion of foundation walls and major Site improvements, prepare certified survey illustrating dimensions, locations, angles, and elevations of construction.
- J. Protect survey control points prior to starting Site Work; preserve permanent reference points during construction.
- K. Promptly report to Engineer loss or destruction of reference point or relocation required because of changes in grades or other reasons.
- L. Replace dislocated survey control points based on original survey control. Make NO changes without prior written notice to Engineer.
- M. Final Property Survey: Prior to Substantial Completion, prepare final property survey illustrating locations, dimensions, angles, and elevations of buildings and Site Work that have resulted from construction indicating their relationship to permanent bench marks and property lines.
 - 1. Show significant features (real property) for Project.
 - 2. Include certification on survey, signed by surveyor, that principal metes, bounds, lines, levels, and elevations of Project are accurately shown.

1.6 EXECUTION

- A. Comply with manufacturer's installation instructions, performing each step in sequence. Maintain one set of manufacturer's installation instructions at Project Site during installation and until completion of construction.

- B. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.
- D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
 - 1. Secure Work true to line and level and within specified tolerances, or if NOT specified, industry-recognized tolerances.
 - 2. Physically separate products in place and provide electrical insulation or protective coatings to prevent galvanic action or corrosion between dissimilar metals.
 - 3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual effect choices to Engineer for final decision.
- E. Allow for expansion of materials and building movement.
- F. Climatic Conditions and Project Status: Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.
 - 1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
 - 2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.
- G. Mounting Heights: Where NOT indicated, mount individual units of Work at industry-recognized standard mounting heights for particular application indicated.
 - 1. Refer questionable mounting height choices to Engineer for final decision.
 - 2. Elements Identified as Handicap Accessible: Comply with applicable codes and regulations.
- H. Adjust operating products and equipment to ensure smooth and unhindered operation.
- I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by manufacturer.

1.7 INDOOR AIR QUALITY PROCEDURES

- A. Prevent indoor air quality problems resulting from construction and renovation process.
- B. Protect HVAC system during construction and renovation, control pollutant sources, and interrupt contamination pathways.
- C. Sequence material delivery and installation to avoid exposing insulation, carpeting, acoustical ceilings, gypsum board, and other absorptive materials to contamination and moisture.
- D. Enclose buildings before storing and installing moisture-sensitive products within building under construction.
- E. Install construction return filter at each return grille before operating permanent air handlers during construction.
- F. Replace filters after completing construction.
- G. Conduct building flush-out after construction ends.

1.8 ALTERATION PROCEDURES

- A. Existing facilities may be occupied for normal operations during progress of construction. Cooperate with Owner in scheduling operations to minimize conflict and to permit continuous usage.
 - 1. Perform Work NOT to interfere with operations of occupied areas.
 - 2. Keep utility and service outages to a minimum and perform only after written approval of Owner.
 - 3. Clean Owner-occupied areas daily. Clean spillage, overspray, and heavy collection of dust in Owner-occupied areas immediately.
- B. Materials: As specified in product Sections; match existing products with new products for patching and extending Work.
- C. Employ skilled and experienced installer to perform alteration and renovation Work.
- D. Cut, move, or remove items as necessary for access to alterations and renovation Work. Replace and restore at completion.
- E. Remove unsuitable material NOT marked for salvage, including rotted wood, corroded metals, and deteriorated masonry and concrete. Replace materials as specified for finished Work.
- F. Remove debris and abandoned items from area and from concealed spaces.
- G. Prepare surface and remove surface finishes to permit installation of new Work and finishes.
- H. Close openings in exterior surfaces to protect existing Work from weather and extremes of temperature and humidity.
- I. Remove, cut, and patch Work to minimize damage and to permit restoring products and finishes to specified condition.
- J. Refinish existing visible surfaces to remain in renovated rooms and spaces, to specified condition for each material, with neat transition to adjacent finishes.
- K. Where new Work abuts or aligns with existing Work, provide smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.
- L. When finished surfaces are cut so that smooth transition with new Work is NOT possible, terminate existing surface along straight line at natural line of division and submit recommendation to Engineer for review.
- M. Where change of plane of 1/4 in. or more occurs, submit recommendation for providing smooth transition to Engineer for review and request instructions from Engineer.
- N. Trim existing doors to clear new floor finish. Refinish trim to specified condition.
- O. Patch or replace portions of existing surfaces that are damaged, lifted, discolored, or showing other imperfections.
- P. Finish surfaces as specified in individual product Sections.

1.9 CUTTING AND PATCHING

- A. Employ skilled and experienced Installers to perform cutting and patching.

- B. Submit written request in advance of cutting or altering elements affecting:
 - 1. Structural integrity of element.
 - 2. Integrity of weather-exposed or moisture-resistant elements.
 - 3. Efficiency, maintenance, or safety of element.
 - 4. Visual qualities of sight-exposed elements.
 - 5. Work of Owner or separate Contractor.
 - C. Execute cutting, fitting, and patching to complete Work and to accomplish:
 - 1. Fit the several parts together, to integrate with other Work.
 - 2. Uncover Work to install or correct ill-timed Work.
 - 3. Remove and replace defective and nonconforming Work.
 - 4. Remove samples of installed Work for testing.
 - 5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
 - D. Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing.
 - E. Cut masonry and concrete materials using masonry saw or core drill.
 - F. Restore Work with new products as specified in requirements of Contract Documents.
 - G. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.
 - H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
 - I. At penetrations of fire-rated walls, partitions, ceiling, or floor construction, completely seal voids with fire-rated material to full thickness of penetrated element to maintain fire rating of complete assembly.
 - J. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.
 - K. Identify the hazardous substances or conditions exposed during the Work to Engineer for decision or remedy.
- 1.10 PROTECTING INSTALLED CONSTRUCTION
- A. Protect installed Work and provide special protection where specified in individual Specification Sections.
 - B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.
 - C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
 - D. Use durable sheet materials to protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.
 - E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
 - F. Prohibit traffic from landscaped areas.

1.11 WORK WITHIN PUBLIC RIGHT-OF-WAY

- A. All work within public right-of-way shall be as specified in requirements and standards of the State of Oklahoma Department of Transportation.
- B. Except where otherwise specified, specified in Drawings, or accepted in writing by the Engineer, the maximum length of open trench, where construction is in any stage of completion, SHALL NOT exceed the linear footage as set forth below. Descriptions under following area designations are general in nature and may be amended in writing by the Engineer due to particular or peculiar field conditions:
 - 1. Business District Areas C 100 LF: Store front areas
 - 2. Commercial Areas C 400 LF: Industrial, shopping centers, churches, schools, hotels, motels, markets, gas stations, government and private office buildings, hospitals, fire and police stations, and nursing homes.
 - 3. Residential Areas C 1 Block or 600 LF, whichever is the Least: Single and multi-family residences, apartments, and condominiums.
 - 4. Undeveloped Areas C 1,000 LF: Parks, golf courses, farms, undeveloped subdivided land.
- C. Completely backfill trenches across streets and install temporary or permanent pavement as soon as possible after pipe laying.
- D. Use substantial steel plates with adequate trench bracing to bridge across trenches at street and alley crossings, commercial driveways, and residential driveways where trench backfill and temporary patch have NOT been completed during regular working hours.
- E. Provide safe and convenient passage for pedestrians.
- F. Maintain access to critical facilities at all times including fire stations, fire hydrants, and hospitals.
- G. Provide traffic control devices, barricades, and signage as required by the regulating agency.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 75 00 – STARTUP TESTING AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Factory testing.
 - 2. Manufacturer's services.
 - 3. Startup plan.
 - 4. Pre-startup testing.
 - 5. Functional testing.
 - 6. Site Acceptance Test.
 - 7. Demonstration and Training

1.2 FACTORY TESTING

- A. Test equipment for proper performance at point of manufacture or assembly when specified.
 - 1. Demonstrate equipment meets specified performance requirements.
 - 2. Perform testing as specified in the equipment specification sections.
 - 3. Provide certified copies of test results. DO NOT ship equipment until receiving written approval of test results.
- B. Factory testing may require witnessing by the Owner or Engineer as specified in the equipment specification sections. When required, provide or reimburse the cost for travel, lodging, and meals for up to two (2) representatives, or quantity as specified in the equipment specification section.

1.3 MANUFACTURER'S SERVICES

- A. Execute testing and startup under supervision of manufacturer's representative as specified in manufacturer's instructions. Schedule services to avoid conflict with other testing and startup activity.
- B. Comply with requirements of individual equipment specification sections, including requirements for an onsite manufacturer's representative to inspect, check, and approve equipment or system installation prior to startup and supervise placing equipment or system in operation.
- C. Manufacturer's representative shall maintain a log of activities, prepare startup and testing forms, and submit records generated during startup and testing phase of Project.
- D. Manufacturer's Certificate of Proper Installation: Provide a written report prepared and signed by Manufacturer's representative certifying that equipment:
 - 1. Has been properly installed, adjusted, aligned, and lubricated.
 - 2. Is free of any stresses imposed by connecting piping or anchor bolts.
 - 3. Is suitable for satisfactory full-time operation under full load conditions.
 - 4. Operates within the allowable limits for vibration.
 - 5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
 - 6. Control logic for startup, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.

1.4 STARTUP PLAN

- A. Provide a startup plan for each piece of equipment and each system NOT less than 2 weeks prior to planned initial startup of equipment or system. At a minimum, provide:
 - 1. Step-by-step instructions for startup of each piece of equipment or system.
 - 2. Description of the process, including equipment numbers/nomenclature of each item and all included devices.
 - 3. Detail procedure for startup including valves to be opened/closed, sequence of startup, etc.
 - 4. Startup requirements including water, power, chemicals, etc.
 - 5. Provide testing plan with test logs for each item and system when specified. Include testing of alarms, control circuits, capacities, ratings, speeds, flows, pressures, vibrations, sound level, and other specified performance parameters.
 - 6. Provide a summary of shutdown requirements for existing systems, if any, which are necessary to complete startup of new equipment and systems.
- B. Coordinate schedule for startup of various equipment and systems. Allow realistic durations in the Progress Schedule for testing and startup activities, including:
 - 1. Manufacturer's services
 - 2. Pre-startup testing
 - 3. Functional testing
 - 4. Site Acceptance Test
- C. Revise and update startup plan based upon review comments or to accommodate changes in startup sequence.

1.5 PRE-STARTUP TESTING

- A. Prior to startup of any piece of equipment, perform all checks and adjustments required to make the equipment ready for safe and proper operation.
- B. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing all pre-startup testing.
- C. Perform pre-startup testing and checks as indicated in the individual equipment specification sections and as required by manufacturer's literature.
- D. Mechanical Systems
 - 1. Remove rust preventatives and oils applied to protect equipment during construction.
 - 2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.
 - 3. Flush fuel system and provide fuel for testing and startup.
 - 4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
 - 5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
 - 6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
 - 7. Perform cold alignment and hot alignment to manufacturer's tolerances.
 - 8. Adjust V-belt tension and variable pitch sheaves.
 - 9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to insure NO leakage, but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.
 - 10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
 - 11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to functional testing.

- E. Electrical Systems
 - 1. Perform testing as indicated in Division 26 including insulation testing, continuity testing, ground testing, circuit breaker testing, and motor testing.
 - 2. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer.
- F. Instrumentation and Control Systems
 - 1. Perform testing as indicated in Division 40 including instrumentation calibration and adjustment, point-to-point wiring checks, signal range testing, and input/output testing.
 - 2. Verify that tests agree with those required by equipment or system manufacturer.
- G. Document results of pre-startup testing on test forms and reports, and submit upon completion of testing. Acceptance of pre-startup testing results is required prior to performing functional testing.

1.6 FUNCTIONAL TESTING

- A. Functionally test mechanical, electrical, and instrumentation and control equipment for proper operation after pre-startup testing and adjusting is completed.
- B. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing all functional testing.
- C. Functional testing of equipment shall be performed for all possible operational scenarios from NO load to full load conditions. The various tests performed during functional testing shall be designed to demonstrate that systems fulfill all the requirements of the Contract Documents.
- D. Functional testing shall be performed utilizing water, air, electricity, chemicals, or other mediums to simulate permanent operating conditions.
 - 1. Some processes may require the use of temporary clean water for functional demonstration testing.
 - 2. Contractor shall coordinate with the Owner for availability of water source. Contractor shall be responsible for all temporary piping, pumping, and power to convey clean water to the facility for testing.
 - 3. Coordinate with Owner removal of test water from process after satisfactory completion of functional testing. DO NOT discharge test water in a manner to cause upset or disruption to plant operations.
- E. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration.
- F. Demonstrate that equipment meets performance requirements specified.
- G. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation, and other equipment functions. Where required, generate signals with test equipment to simulate operating conditions in each control mode.
- H. Document results of functional testing on test forms and reports, and submit upon completion of testing. Acceptance of functional testing results is required prior to performing the Site Acceptance Test.

1.7 SITE ACCEPTANCE TEST

- A. After all systems have been functionally tested and are operating as specified in the Contract Documents, the Contractor shall perform a Site Acceptance Test of the comprehensive completed installation.
- B. During the testing period, the Owner shall have full use of the system. The Owner will provide operations, personnel, power, fuel, and other consumables for the duration of the site acceptance test.
- C. The complete installation must meet all performance requirements for the duration of the Site Acceptance Test.
- D. Contractor personnel shall be readily available to address issues onsite during the test. Immediately correct defects in materials, workmanship, or equipment which become evident during the test.
- E. The Site Acceptance Test period shall be 30 days, during which time the completed installation must meet specified operation without significant interruption. A significant interruption may include:
 - 1. Failure to meet specified functional or performance requirements for more than 2 consecutive hours.
 - 2. Failure of any critical component that is NOT corrected within 8 hours after failure.
 - 3. Other failures or interruptions as defined by the Engineer.
- F. A significant interruption will require restarting of the Site Acceptance Test after the problem is corrected and when directed by the Owner/Engineer. Restarting and satisfactory completion of the Site Acceptance Test shall be conducted at NO additional cost to the Owner.

1.8 DEMONSTRATION AND TRAINING

- A. Demonstrate operation and maintenance of products to Owner's personnel prior to date of Substantial Completion.
- B. Provide a training schedule for all training sessions required for the project. Allow for multiple sessions of each training to accommodate multiple operator shifts. Submit training schedules for approval by Owner.
- C. Demonstrate Project equipment and instruct in classroom environment located at the Site and instructed by qualified manufacturer's representative who is knowledgeable about the equipment.
- D. Provide a lesson plan for each required course, containing, at minimum:
 - 1. Title and objectives.
 - 2. Recommended attendees.
 - 3. Course description and outline.
 - 4. Instructional materials and equipment requirements.
 - 5. Instructor resumes.
- E. Use operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- F. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at agreed time at designated location.

- G. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- H. Allot the required instruction time for each item of equipment and system as specified in individual equipment specification sections.
- I. Video Recordings
 - 1. Provide high-quality color video recordings of demonstration and instructional sessions. Engage commercial videographer to record sessions. Include classroom instructions, demonstrations, board diagrams, and other visual aids. Include menu navigation.
- J. Submit video recording digital files through web-based project management software and provide three DVD copies.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER: _____ EQUIP. SERIAL NO: _____
EQUIP. TAG NO: _____ EQUIP. SYSTEM: _____
PROJECT NO: _____ SPEC. SECTION: _____

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

(Check Applicable)

☐	Installed in accordance with Manufacturer's recommendations.
☐	
☐	Inspected, checked, and adjusted.
☐	
☐	Serviced with proper initial lubricants.
☐	
☐	Electrical and mechanical connections meet quality and safety standards.
☐	
☐	All applicable safety equipment has been properly installed.
☐	
☐	Functional tests.
☐	
☐	System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments:

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

Date: _____, 20____.

Manufacturer: _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

UNIT PROCESS STARTUP FORM

OWNER: _____ PROJECT: _____

Unit Process Description: (Include description and equipment number of all equipment and devices):

Startup Procedure: (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

Startup Requirements (Water, power, chemicals, etc.):

Evaluation Comments:

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER: _____ PROJECT: _____

Unit Process Description: (List unit processes involved in facility startup):

Unit Processes Startup Sequence: (Describe sequence for startup, including computerized operations if any):

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: _____ Date: _____, 20 ____

Engineer: _____ Date: _____, 20 ____

SECTION 01 77 00 – CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Closeout procedures.
 - 2. Project record documents.
 - 3. Operation and maintenance data.
 - 4. Manual for materials and finishes.
 - 5. Manual for equipment and systems.
 - 6. Spare parts and maintenance products.
 - 7. Product warranties and product bonds.
 - 8. Maintenance service.
 - 9. Final cleaning.

1.2 CLOSEOUT PROCEDURES

- A. Prerequisites to Substantial Completion:
 - 1. Complete items below before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:
 - a. Submit maintenance manuals, Project record documents, digital images of construction photographs, video recordings, and other similar final record data in compliance with this Section.
 - b. Complete facility startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance with this Section and 01 75 00 – Startup Testing and Training.
 - c. Complete demonstration and training to Owner's operating and maintenance personnel as specified in compliance with this Section and 01 75 00 – Startup Testing and Training.
 - d. Conduct inspection to establish basis for request that Work is substantially complete. Create comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reason for being incomplete, and date of anticipated completion for each item. Include copy of list with request for Certificate of Substantial Completion.
 - e. Obtain and submit releases enabling Owner's full, unrestricted use of Project and access to services and utilities. Include certificate of occupancy, operating certificates, and similar releases from authorities having jurisdiction and utility companies.
 - f. Deliver tools, spare parts, extra stocks of material, and similar physical items to Owner.
 - g. Make final change-over of locks and transmit keys directly to Owner. Advise Owner's personnel of change-over in security provisions.
 - h. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.
 - i. Perform final cleaning according to this Section.
- B. Substantial Completion Inspection:
 - 1. When Contractor considers Work to be substantially complete, submit to Engineer and Owner:
 - a. Written certificate that Work, or designated portion, is substantially complete.
 - b. List of items to be completed or corrected (initial punch list).
 - 2. After receipt of request for Substantial Completion, Engineer or Owner will make inspection to determine whether Work or designated portion is substantially complete.

3. Should Engineer or Owner determine that Work is NOT substantially complete:
 - a. Engineer or Owner will promptly notify Contractor in writing, stating reasons for its opinion.
 - b. Contractor shall remedy deficiencies in Work and send second written request for Substantial Completion.
 - c. Engineer or Owner will reinspect Work.
 - d. Redo and Inspection of Deficient Work: Repeated until Work passes Engineer or Owner inspection.
 4. When Engineer or Owner finds Work to be substantially complete, they will:
 - a. Prepare Certificate of Substantial Completion, accompanied by Contractor's list of items to be completed or corrected as verified and amended by Engineer and Owner (final punch list).
 - b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in Certificate.
 5. After Work is substantially complete, Contractor shall:
 - a. Allow Owner occupancy of Project under provisions stated in Certificate of Substantial Completion.
 - b. Complete Work listed for completion or correction within period stipulated.
- C. Final Completion Prerequisites: Complete items below before requesting final acceptance and final payment.
1. When Contractor considers Work to be complete, submit written certification that:
 - a. Contract Documents have been reviewed.
 - b. Work has been examined for compliance with Contract Documents.
 - c. Work has been completed according to Contract Documents.
 - d. Work is completed and ready for final inspection.
 2. Submittals:
 - a. Final punch list indicating all items have been completed or corrected.
 - b. Final payment request with final releases and supporting documentation NOT previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
 - c. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
 - d. Accounting statement for final changes to Contract Sum.
 - e. Contractor's affidavit of payment of debts and claims.
 - f. Contractor affidavit of release of liens.
 - g. Consent of surety to final payment.
 3. Perform final cleaning for Contractor-soiled areas according to this Section.
- D. Final Completion Inspection:
1. After receipt of request for final inspection, Engineer or Owner will make inspection to determine whether Work or designated portion is complete.
 2. Should Engineer or Owner consider Work to be incomplete or defective:
 - a. Engineer or Owner will promptly notify Contractor in writing, listing incomplete or defective Work.
 - b. Contractor shall remedy stated deficiencies and send second written request to Engineer or Owner that Work is complete.
 - c. Engineer or Owner will reinspect Work.
 - d. Redo and Inspection of Deficient Work: Repeated until Work passes Engineer or Owner inspection.

1.3 PROJECT RECORD DOCUMENTS

- A. Maintain onsite one set of the following record documents; record actual revisions to the Work:
1. Drawings.
 2. Specifications.

3. Addenda.
 4. Change Orders and other modifications to the Contract.
 5. Reviewed Shop Drawings, product data, and Samples.
 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress, NOT less than weekly.
- E. Specifications: Legibly mark and record, at each product Section, description of actual products installed, including the following:
1. Manufacturer's name and product model and number.
 2. Product substitutions or alternates used.
 3. Changes made by Addenda, bulletin, Change Order, and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction as follows:
1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders.
 2. Include locations of concealed elements of the Work.
 3. Identify depth of buried utility lines and provide dimensions showing distances from permanent facility components that are parallel to utilities.
 4. Dimension ends, corners, and junctions of buried utilities to permanent facility components using triangulation.
 5. Identify and locate existing buried or concealed items encountered during Project.
 6. Measured depths of foundations in relation to finish first floor datum.
 7. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 8. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 9. Field changes of dimension and detail.
 10. Details NOT on original Drawings.
- G. Submit PDF electronic files of marked-up documents to Engineer within 10 days after the date of Substantial Completion and prior to final Application for Payment.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit in PDF composite electronic indexed file.
- B. Contents: Prepare table of contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
 2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Include the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.

- f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
 - g. Safety precautions to be taken when operating and maintaining or working near equipment.
- 3. Part 3: Project documents and certificates, including the following:
 - a. Shop Drawings and product data.
 - b. Air and water balance reports.
 - c. Certificates.
 - d. Executed and notarized duplicates of warranties and bonds.

1.5 MANUAL FOR MATERIALS AND FINISHES

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.
- B. For equipment or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes before Substantial Completion. Completed volumes, with Engineer comments, will be returned after Substantial Completion. Revise content of document sets as required prior to final submission.
- D. Submit two sets of revised final volumes within 10 days after final inspection.
- E. Submit in PDF composite electronic indexed file of final volumes within 10 days after final inspection.
- F. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Include information for reordering custom-manufactured products.
- G. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- H. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.
- I. Additional Requirements: As specified in individual product Specification Sections.
- J. Include listing in table of contents for design data, with tabbed fly sheet and space for insertion of data.

1.6 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.
- B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes before Substantial Completion. Completed volumes, with Engineer comments, will be returned after Substantial Completion. Revise content of document sets as required prior to final submission.

- D. Submit two sets of revised final volumes within 10 days after final inspection.
 - E. Submit in PDF composite electronic indexed file of final volumes within 10 days after final inspection.
 - F. Equipment and Systems: Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.
 - G. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
 - H. Include color-coded wiring diagrams as installed.
 - I. Operating Procedures: Include startup, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and special operating instructions.
 - J. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
 - K. Include servicing and lubrication schedule and list of lubricants required.
 - L. Include manufacturer's printed operation and maintenance instructions.
 - M. Include sequence of operation by controls manufacturer.
 - N. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
 - O. Include control diagrams by controls manufacturer as installed.
 - P. Include Contractor's coordination drawings indicating installed color-coded piping diagrams.
 - Q. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
 - R. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
 - S. Include test and balancing reports as specified in Section 01 40 00 – Quality Requirements.
 - T. Additional Requirements: As specified in individual product Specification Sections.
 - U. Include listing in table of contents for design data with tabbed dividers and space for insertion of data.
- 1.7 SPARE PARTS AND MAINTENANCE PRODUCTS
- A. Furnish spare parts, maintenance, and extra products in quantities specified in individual Specification Sections.

- B. Deliver to Project Site and place in location as directed by Owner; obtain receipt prior to final payment.

1.8 PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Obtain warranties and bonds executed in duplicate by responsible Subcontractors, suppliers, and manufacturers within ten days after completion of applicable item of Work.
- B. Execute and assemble transferable warranty documents and bonds from Subcontractors, suppliers, and manufacturers.
- C. Verify documents are in proper form, contain full information, and are notarized.
- D. Co-execute submittals when required.
- E. Submit prior to final Application for Payment.
- F. Time of Submittals:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within ten days after acceptance.
 - 2. Make other submittals within ten days after date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Substantial Completion, submit within ten days after acceptance, listing date of acceptance as beginning of warranty or bond period.
- G. Refer to Section 01 78 36 – Warranties and Bonds for additional requirements.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of components indicated in specification sections during warranty period.
- B. Examine system components at frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by manufacturer of original component.
- D. DO NOT assign or transfer maintenance service to agent or Subcontractor without prior written consent of Owner.

1.10 FINAL CLEANING

- A. Execute final cleaning prior to final Project assessment.
 - 1. Employ experienced personnel or professional cleaning firm.
- B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces; and vacuum carpeted and soft surfaces.
- C. Clean equipment and fixtures to sanitary condition with appropriate cleaning materials.
- D. Clean or replace filters of operating equipment.

- E. Clean debris from roofs, gutters, downspouts, and drainage systems.
- F. Clean Site; sweep paved areas, rake clean landscaped surfaces.
- G. Remove waste and surplus materials, rubbish, and construction facilities from Site.

1.11 DISINFECTION OF POTABLE WATER SYSTEMS

- A. Disinfect piping and tanks intended to carry potable water as described in Specification 33 13 00 – Disinfection of Water Systems, and in accordance with American Water Works Association Standards.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 78 36 – WARRANTIES AND BONDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. General administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers' standard warranties on products and special warranties.

1.2 RELATED WORK

- A. Refer to Conditions of Contract for the general requirements relating to warranties and bonds.
- B. General closeout requirements are included in Section 01 77 00 – Closeout Procedures.
- C. Specific requirements for warranties for the Work and products and installations that are specified to be warranted, are included in Division 2 – Division 46.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Submit written warranties to the Owner prior to the date fixed by the Engineer for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Owner.
- C. See Division 2 – Division 46 for specific content requirements, and particular requirements for submittal of special warranties.
- D. Contractor shall submit digital copies and a 3-ring binder of warranties for each piece of equipment installed coupled with an overall project summary spreadsheet listing of all equipment items and date warranty starts and expires, etc.

1.4 WARRANTY REQUIREMENT

- A. Warranty Period:
 - 1. Warranties shall commence on the date of Substantial Completion.
 - 2. Warranties shall be in force from the date of Substantial Completion through the date of Final Acceptance.
 - 3. Warranties shall be in force for one year following the date of Final Acceptance.
 - a. Warranty periods defined in Division 02 – Division 46, longer than the warranty period defined in this section, shall prevail over the requirements in this section.
 - b. Warranty periods defined in Division 02 – Division 46, shorter than the warranty period defined in this section, shall be required to meet the warranty period requirements in this section.
- B. Related Damages and Losses:
 - 1. When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- C. Reinstatement of Warranty:

1. When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement.
 - D. Warranties shall stipulate that Work furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty period.
 - E. Replacement Cost:
 1. Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life. Spare parts shall NOT be used to address warranty repairs.
 - F. Owner's Recourse:
 1. Written warranties made to the Owner are in addition to implied warranties, and SHALL NOT limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
 - G. Rejection of Warranties:
 1. The Owner reserves the right to reject warranties and to limit selections to products with warranties NOT in conflict with requirements of the Contract Documents.
 - H. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
 - I. Disclaimers and Limitations:
 1. Manufacturer's disclaimers and limitations on product warranties DO NOT relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- 1.5 DEFINITIONS
- A. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the Manufacturer to the Owner.
 - B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

DIVISION 2
EXISTING CONDITIONS

SECTION 02 41 00 – DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Portions of buildings and other areas, equipment and materials selective demolition, and partial demolition work are as specified in Drawings.
 - 2. Equipment and materials to be removed for construction and reinstalled for reuse or continued operation are as specified in Drawings.

- B. Related Sections:
 - 1. None

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Plans specifying all equipment and materials to be removed and reinstalled for reuse on continued operation including interim storage plans for each item.
- C. Quality requirements Submittals:
 - 1. Schedule of demolition, as part of and consistent with the progress schedule specified in Section 01 32 16 – Construction Progress Schedule.
 - 2. Methods of demolition and equipment proposed to demolish each structure.
 - 3. Copies of any authorizations and permits required to perform Work.
- D. Tank Pad Inspection Requests for Information:
 - 1. Upon removal of tanks, inspect tank pads for cracking or spalling of concrete. Submit an RFI, with photographs and measurements of the cracks and spalling to allow Owner and Engineer to determine if the pad will be repaired or replaced.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Utilities:
 - 1. Notify Owner and appropriate utilities 72 hrs. prior to turning off affected services before starting demolition or alterations.
 - 2. Remove utility lines exposed by demolition excavation.
 - 3. Remove electric, sanitary, and storm drainage adjacent to buildings to be demolished.
 - 4. Excavate utility lines serving buildings to be demolished and provide a permanent leak-proof closure for water and gas lines.
 - 5. Plug sewer lines at locations shown or at limits of excavation if NOT shown with min. 2,000 psi compressive strength concrete plug to prevent groundwater infiltrating sewer systems. Length of plug shall be 5 ft minimum.
- B. Removal and Storage of Equipment for Reuse:
 - 1. DO NOT remove equipment and materials without approval of Engineer.
 - 2. Properly store and maintain equipment and materials in same condition as when removed.

3. Engineer shall determine condition of equipment and materials prior to removal.

3.2 DEMOLITION

- A. Drawings define minimum portion of equipment to be removed and structures to be modified. Unless otherwise specified, rough cuts or breaks may be made exceeding limits of demolition shown.
- B. Provide all demolition, removal, temporary storage, and reinstallation of existing equipment as required for implementation of the work.
- C. Core drill floor slabs, catch basins, and other concrete improvements to remain in place below ground, or break holes at structure's lowest point to allow water to freely migrate through.
- D. Remove piping from areas to be backfilled. Pipe, valves, and fittings adjacent to those to be removed may also be removed as salvage.
- E. Remove all materials associated with existing equipment that is to be removed or relocated.
- F. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 in. below final finished surface.
- G. Cut off drilled piers a minimum of 6 in. below bottom of new foundations.
- H. Demolish existing concrete structure to 18 in. below grade.

3.3 DISPOSAL

- A. Dispose of debris and other non-salvaged materials offsite in licensed landfills.

3.4 BACKFILLING

- A. Demolished Areas:
 - 1. Backfill to existing ground level, elevations shown, or foundation level of new construction.
- B. Backfill Material and Compaction:
 - 1. DO NOT use demolition debris as backfill material.

3.5 SALVAGE

- A. Equipment and materials NOT reused or reinstalled, including all metals and piping within the limits of demolition, unless otherwise specified, shall be removed by the Contractor.

END OF SECTION

DIVISION 3
CONCRETE

SECTION 03 01 00 – MAINTENANCE OF CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Repair and resurfacing of new and existing concrete surfaces in preparation for finish materials and final use.
- B. Related Sections:
 - 1. Section 03 20 00 – Concrete Reinforcing
 - 2. Section 03 30 00 – Cast-In-Place Concrete.

1.2 REFERENCES

- A. AASHTO:
 - 1. T277 – Standard Method of Test for Rapid Determination of the Chloride Permeability of Concrete.
- B. ASTM International:
 - 1. A82 – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - 2. A185 – Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
 - 3. A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 4. C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 5. C78 – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
 - 6. C109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
 - 7. C157 – Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - 8. C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - 9. C348 – Standard Test Method for Flexural Strength of Hydraulic Cement Mortars.
 - 10. C469 – Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
 - 11. C496 – Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
 - 12. C531 – Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes.
 - 13. C596 – Standard Test Method for Drying Shrinkage of Mortar Containing Portland Cement.
 - 14. C666 – Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - 15. C779 – Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
 - 16. C882 – Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 - 17. C928 – Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repair.
 - 18. C1012 – Standard Test Method for Length Change of Hydraulic Cement Mortars Exposed to a Sulfate Solution.
 - 19. C1202 – Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetration.

20. C1583 – Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
21. D638 – Standard Test Method for Tensile Properties of Plastics.
22. D695 – Standard Test Method for Compressive Properties of Rigid Plastics.
23. D4258 – Standard Practice for Surface Cleaning Concrete for Coating.
24. D4259 – Standard Practice for Abrading Concrete.
25. E699 – Criteria for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee.

- C. NSF International:
 1. 61 – Standard for Drinking Water System Components – Health Effects.

1.3 DEFINITIONS

- A. Low Pressure Spray Mortar:
 1. Mortar designated by “S” before the product number, applied by low pressure spraying, or in small areas by hand troweling.
- B. Defective Area:
 1. As defined in Section 03 30 00 – Cast-In-Place Concrete.
- C. High-Pressure Water Blasting (sometimes referred to as water demolition):
 1. Water projected under pressure and at high velocity which may or may NOT use an abrasive medium. Used for preparation of concrete surfaces including cleaning, removal of existing coatings and roughening.
- D. New Concrete:
 1. As defined in Section 03 30 00 – Cast-In-Place Concrete.
- E. Rebound:
 1. Shotcrete material that bounces off the surface against which shotcrete is being applied.
- F. Shotcrete:
 1. Mortar pumped through a hose and projected at a high velocity against a surface as a construction technique.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Action Submittal:
 1. Product data sheets for each material supplied.
- C. Information Submittals:
 1. Mortar System:
 - a. Manufacturer’s installation instructions.
 - b. Manufacturer’s recommended fabric size for mesh reinforcement.
 2. Written description of equipment proposed for hydro-demolition surface preparation.
 3. Certificates:
 - a. Certificate of Compliance that proposed product systems meet or exceed the requirements of ASTM C928 and specified performance criteria when tested as specified in Article FIELD QUALITY REQUIREMENTS.
 - b. Mortar system Manufacturer’s Certificate of Proper Installation.

- c. Confirmation that mortar materials meet requirements of NSF 61, where applicable.
- 4. Statements of Qualification:
 - a. Independent testing laboratory.
 - b. Mortar system Manufacturer's representative.
 - c. Repair mortar system applicator.
- 5. Mortar system Manufacturer's proposed modified test procedures for ASTM C109 and ASTM C882 test methods.
- 6. Independent testing laboratory test report.

1.5 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Independent Testing Laboratory: Based on evaluation of laboratory submitted criteria as specified in ASTM E699.
 - 2. Mortar System Applicator: For low pressure spray mortar system in lieu of endorsement, complete mortar system manufacturer's demonstration as specified in Article MANUFACTURER'S SERVICES. For Shotcrete Mortar, a trained and experienced applicator certified by the repair mortar manufacturer.
- B. Pre-repair Conference:
 - 1. Required Attendees: Contractor, repair Subcontractor, repair material representative.
 - 2. Schedule and conduct prior to incorporation of repair products.
 - 3. Agenda:
 - a. Review field conditions.
 - b. Confirm material selection.
 - c. Repair material representative shall review proposed preparation, application, finishing and curing of the materials.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver repair mortar in moisture-resistant packaging.
- B. Handle as specified in manufacture's written instructions.

1.7 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 LOW PRESSURE SPRAY MORTAR SYSTEM (FOR VERTICAL AND OVERHEAD REPAIRS)

- A. Mortar:
 - 1. One component, rheoplastic, cement based, fiber reinforced, shrinkage compensated, gray in color, with a minimum 30-minute working time.
 - 2. Cured materials mixed to a flow of 70%, at five drops shall be as specified:
 - a. Minimum Slant Shear Bond Strength: 3,000 psi in 28 days as specified in "modified" ASTM C882 test method.
 - b. Minimum Compressive Strength: 11,000 psi at 28 days as specified in ASTM C109.
 - c. Minimum Direct Shear Bond Strength: 650 psi in 28 days.
 - d. Minimum Tensile Bond Strength (MBT In-House Test): 300 psi. in 28 days.
 - e. Minimum Flexural Properties: 1,250 psi in 28 days as specified in ASTM C348.
 - f. Modulus of Elasticity: 4.1 to 4.5 by 106 psi as specified in ASTM C469.

- g. Maximum Permeability: 1,000 coulombs as specified in AASHTO T 277.
 - h. System shall NOT produce a vapor barrier.
 - B. Sprayable, extremely low permeability, sulfate resistant, easy to use, and requiring only the addition of water.
 - C. Free of chlorides and other chemicals causing corrosion.
 - D. Manufacturer and Product:
 - 1. BASF Building Systems, MasterEmaco S 488CI.
 - 2. Sika Corp., Lyndhurst, NJ; SikaRepair 224.
- 2.2 SHOTCRETE MORTAR (FOR VERTICAL AND OVERHEAD REPAIRS)
- A. Mortar:
 - 1. Blend of Portland cements, microsilica, aggregates and fibers designed for the repair of vertical and overhead surfaces.
 - 2. Workable down to 1/4 in. thickness.
 - 3. Shall NOT contain chlorides, nitrates, or high aluminum cements.
 - B. Properties:
 - 1. Working time: 5 – 10 minutes, Finishing time: 10 – 20 minutes, Color: dark gray.
 - 2. Compressive strength per ASTM C109:
 - a. 6,000 psi min at 7 days.
 - b. 7,000 psi min at 28 days.
 - 3. Flexural Strength per ASTM C78: 1,100 psi min at 28 days.
 - 4. Splitting Tensile Strength per ASTM C496: 400 psi min at 28 days.
 - 5. Certified to meet NSF 61 for potable water projects.
 - C. Manufacturers and Products:
 - 1. BASF Building Systems, MasterEmaco S 211 SP.
 - 2. Sika Corp., SIKACHEM 103F.
- 2.3 POLYMER-MODIFIED REPAIR MORTAR (HORIZONTAL SURFACE REPAIR)
- A. Mortar:
 - 1. One component, polymer-modified, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum, surface renovation mortar.
 - 2. Bond strength as specified in ASTM C1042 Test Method at 7 days:
 - a. Minimum 1,750 psi.
 - 3. Modules of Elasticity: ASTM C469, minimum 2.0 by 10⁶ psi.
 - 4. Compressive Strength:
 - a. ASTM C109 at 1 day: minimum 2,500 psi.
 - b. ASTM C109 at 28 days: minimum 7,500 psi.
 - 5. Flexural Properties, ASTM C348 at 28 days: minimum 1,200 psi.
 - 6. Permeability, AASHTO T 277: 800 coulombs maximum.
 - 7. Splitting Tensile Strength: ASTM C496 at 7 days, minimum 450 psi.
 - 8. Drying Shrinkage, ASTM C596 at 28 days: (-0.090)%.
 - 9. Freeze Thaw Resistance, ASTM C666, at 300 cycles: 95% RDF.
 - 10. Abrasion Resistance: ASTM C799, 60 minutes, 0.0165 in.
 - B. Manufacturers and Products:
 - 1. BASF Building Systems, MasterEmaco T 310 CI (NOT for potable water structures).
 - 2. Sika Corp, SikaTop 111 Plus (for potable water structures).

2.4 HIGH EARLY STRENGTH REPAIR MORTAR (HORIZONTAL SURFACE REPAIR)

- A. Mortar:
 - 1. One or two component, fast-setting, high early strength repair mortar.
- B. Properties:
 - 1. Compressive Strength per ASTM C109:
 - a. 1,500 psi min at 2 hours.
 - b. 4,500 psi min at 1 day.
 - c. 8,000 psi min at 7 days.
 - d. 9,000 psi min at 28 days.
 - 2. Flexural Strength per ASTM C348:
 - a. 850 psi min at 1 day.
 - b. 1,000 psi min at 7 days.
 - c. 1,100 psi min at 28 days.
 - 3. Slant Shear Bond Strength per ASTM C882:
 - a. 2,500 psi min at 1 day.
 - b. 2,900 psi min at 7 days.
 - c. 3,100 psi min at 28 days.
 - 4. Splitting Tensile Strength per ASTM C496:
 - a. 850 psi min at 1 day.
 - b. 1,200 psi min at 7 days.
 - c. 1,300 psi min at 28 days.
 - 5. Chloride Ion Permeability per AASHTO T277:
 - a. 960 coulombs max at 28 days.
- C. Manufacturers and Products:
 - 1. BASF Building Systems, MasterEmaco T 415 (NOT for potable water structures).
 - 2. Euclid Chemical Co, Versaspeed (NOT for potable water structures).

2.5 WATER

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.6 REINFORCEMENT

- A. As specified in Section 03 20 00 – Concrete Reinforcing.

2.7 ACCESSORIES

- A. Finishing Aid Manufacturer and Product:
 - 1. BASF Building Systems, MasterKure ER 50.
- B. Flexible Cementitious Rebar Coating Manufacturer and Product:
 - 1. BASF Building Systems, MasterEmaco P 124.
 - 2. Sika Corp., Armathec 110 EpoCem.

PART 3 - EXECUTION

3.1 GENERAL

- A. Where required because of deficiencies, concrete surface repair system shall be appropriate for the surface type and allowable schedule.

3.2 PREPARATION

- A. Remove unsound and deteriorated concrete from Work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16 in. or as specified. Remove to provide for maximum thickness specified for mortar.
- B. High pressure water blasting machines with 8,000 psi minimum.
- C. Collect and dispose of water from removal operations in manner and location acceptable to Owner.
- D. DO NOT use power-driven jackhammers and chipping hammers, unless water blasting is prohibited due to potential damage to installed equipment.
- E. Remove concrete minimum of 1 in. clearance around rebar for application and bonding of new mortar to entire periphery of exposed rebar if these surface conditions exist:
 - 1. 50% or more of periphery around rebar is exposed during removal of concrete.
 - 2. 25% or more of periphery around rebar is exposed during removal of concrete and corrosion has eventuated to the extent that loss of section has occurred.
 - 3. Bond between existing concrete and reinforcement has deteriorated.
- F. Clean exposed reinforcing bars of rust and concrete, and coat with flexible cementitious rebar coating.
- G. Maintain surface areas free of slurry where concrete has been removed. Remove slurry from prepared areas before new mortar is applied.
- H. Square edges of repair area by sawing or chipping to avoid feathered edges.
- I. Clean surface areas to be filled with new mortar of laitance and contamination by high pressure water blasting NOT more than 24 hours before applying bonding agent, Saturated Surface Dry (SSD) existing concrete at time of application of mortar.

3.3 LOW PRESSURE SPRAY MORTAR APPLICATION

- A. Mix mortar in mortar-concrete mixer attached to pump-spray equipment for spray application. Mix with a slow speed drill and jiffier-type paddle or small mortar type mixer for hand trowel application.
- B. Apply mortar by low pressure spraying with a machine such as Moynotype, MEYCO DEQUNA Model 20.
- C. Finish mortar with a hand float application to smooth even surface matching adjacent concrete. Provide finishing aid at full strength.
- D. Bonding Agent:
 - 1. Hand apply bonding agent within 20 minutes of troweling on mortar. Prevent bonding agent from drying by reapplying bonding agent to maintain surface tackiness of coat.
 - 2. Work mortar firmly and quickly into area and compact with firm trowel stroke. Finish smooth with finishing aid at full strength.

3.4 SHOTCRETE MORTAR APPLICATION

- A. Apply mortar as specified in ACI 506.2 and per manufacturer's instructions.

- B. DO NOT reuse rebound materials.
- C. Mortar shall be applied in a steady, uninterrupted flow. Hold nozzle at right angles to the surface.
- D. Apply at minimum thickness of 2 in. of cover over existing reinforcement or to level of surrounding concrete, whichever is thicker.
- E. Apply finish to mortar to match existing concrete finish.

3.5 POLYMER-MODIFIED REPAIR MORTAR APPLICATION FOR REPAIR OF HORIZONTAL SURFACES

- A. Mix mortar in mortar-concrete mixer.
- B. Hand Troweling:
 - 1. Apply (scrub in) a bond coat slurry of the repair mortar to the SSD prepared substrate before application of the mortar. DO NOT apply more of the bond coat than can be covered with mortar before the bond coat dries. DO NOT retemper this bond coat.
- C. Place mortar into prepared area from one side to the other.
- D. Work material firmly into the side and bottom of patch to assure a good bond. Level repair mortar and screed to elevation of existing concrete.
- E. Finish to same texture as existing concrete around patch.
- F. Use self-leveling mixture where appropriate to obtain uniform or plane surface.

3.6 HIGH EARLY STRENGTH MORTAR APPLICATION

- A. Remove standing water from application area.
- B. Apply bond scrub mortar coat per manufacturer's instructions.
- C. Work material into bottom and sides of the patch to ensure good continuous bond.
- D. Level mortar to match elevation of existing concrete.
- E. Finish to same texture as existing concrete.

3.7 CURING

- A. Water fog nozzle all of the mortar systems prior to curing as specified in mortar system Manufacturer's instructions.
- B. Commence water curing after mortar system application and when curing shall NOT cause erosion of mortar.
- C. Continuously cure mortar system for a period of 7 days.
- D. DO NOT membrane cure, unless method is part of mortar system Manufacturer's instructions and approval has been obtained.
- E. Cure intermediate layers of mortar as specified in manufacturer's instructions.

3.8 FIELD QUALITY REQUIREMENTS

- A. Independent testing laboratory shall perform:
 - 1. Secure production samples of mixed materials during construction and test for compliance with the Specifications.
 - 2. Obtain actual core samples from the completed repair Work and test, where required.
 - 3. Perform "modified" ASTM C109 and ASTM C882 test methods as specified in manufacturer's approved modifications of testing procedures.
- B. Construction Testing:
 - 1. Production Samples:
 - a. Obtain mixed mortar material from shotcrete or spray equipment and produce samples, and cure samples prior to testing.
 - b. Provide minimum of three samples each test for each 1,000 ft² or portion thereof of mortar repair to be installed.
 - 2. Core Samples of In-Place Repair:
 - a. Obtain two core samples and test samples for each 2,000 ft² or portion thereof for actual repair Work.
 - b. Cores shall be either 2 1/2 in. or 3 in. in diameter and shall be cored through cured mortar repair and into base concrete to total depth equal to at least 2.5 times repair mortar thickness.
 - c. Sawcut the cores after removal to trim base concrete thickness to same thickness as mortar so that bond line is at center of repaired sample.
 - d. Samples shall be epoxy bonded to steel plates at each end using a bonding agent to prevent failure in bond to steel plates.
 - e. Sustain bond line without failure or movement with a minimum of 300 psi in direct tension. The tension test shall use eyebolts or threaded connectors tapped and threaded into base plate so that tension load is concentric with center of core sample.
- C. Repair and fill holes where core samples have been removed using same mortar used in repair.
- D. If possible, use Direct Tension Bond Test per ASTM C1583 in place of core sampling.

3.9 MANUFACTURER'S SERVICES

- A. Provide mortar system manufacturer's representative at site for installation assistance, inspection and certification of proper installation, and training of mortar system applicators.
- B. Mortar System Manufacturer's Demonstration:
 - 1. Schedule a time for Manufacturer's demonstration of repair system proposed for the Project. Prepare mortar, to specified consistency, for testing and placement. Initiate curing on portions of each type of surface to be repaired to include overhead and vertical applications.
 - 2. Prepare surface area in advance of demonstration and obtain manufacturer's acceptance of preparation for each type of application.
 - 3. Demonstrate:
 - a. Mixing and application equipment capabilities and procedures, including the flow of material from nozzle or sprayer.
 - b. Nozzle operator and person in charge of low-pressure sprayer, capabilities, and ability to follow prescribed application procedures and properly operate equipment and apply surface repair materials.
 - 4. Make compression test samples during demonstration and deliver to an independent testing laboratory for testing at 1, 7, and 28 days. Take a core of the demonstration placement, or demonstrate Direct Bond Tensile test, and test for tensile bond at 1 day.

3.10 PROTECTION

- A. Protect adjacent surfaces, and equipment, from being damaged by overshooting of low-pressure spray mortar.

3.11 CLEANING

- A. Remove overshot mortar and deposited rebound materials as Work proceeds. Remove from Work, waste materials, unsound material from concrete surfaces, material chipped from walls, water used in preparation of application and finishing.

END OF SECTION

SECTION 03 10 00 – CONCRETE FORMING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work required for furnishing Concrete Forming.
- B. Related Sections:
 - 1. Section 03 35 00 – Concrete Finishing
 - 2. Section 03 62 00 – Non-Shrink Grouting

1.2 REFERENCES

- A. ACI:
 - 1. 117 – Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 2. 350 – Code Requirements for Environmental Engineering Concrete Structures
 - 3. 347 – Formwork for Concrete.
- B. NSF International:
 - 1. 61 – Drinking Water System Components – Health Effects.

1.3 DESIGN REQUIREMENTS

- A. Design formwork as specified in ACI 301, ACI 347, and ACI 350 to provide concrete finishes specified in Section 03 30 00 – Cast-In-Place Concrete.
- B. When high range water reducer (superplasticizer) is used in concrete mix, forms shall be designed for full hydrostatic pressure per ACI 347.
- C. Make joints in forms watertight.
- D. Limit panel deflection to 1/360th of each component span to achieve tolerances specified.
- E. Ensure compatibility between form liner and concrete mixture with manufacturer and concrete producer.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Action Submittals:
 - 1. Shop Drawings:
 - a. Form Ties-Tapered Through-Bolts:
 - 1) Proposed method of sealing form tie hole.
 - 2) Coordinate with details shown.
 - b. Manufacturer's Data for:
 - 1) Form-release agent.
 - 2) Form liners.
 - 2. Samples:
 - a. Form ties.
- C. Information Submittals:
 - 1. Statement of qualification for formwork designer.

2. Statement of qualification for form liner designer and installer.
3. Mockup Panel – for each form liner type.

1.5 QUALIFICATIONS

- A. Formwork Designer:
 1. Formwork, falsework, and shoring design shall be by an Engineer licensed in the State of the project site.
- B. Form liner designer shall have previous experience with the design and installation of similar form liners.
- C. Form liner installer shall be approved by the manufacturer.

1.6 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Wall Forms and Underside of Slabs:
 1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in “new and undamaged” condition, of sufficient strength and surface smoothness to produce specified finish.
 2. Circular Structures:
 - a. Conform forms to circular shape of structure.
 - b. Straight panels may be substituted for circular forms provided panels DO NOT exceed 2 ft in horizontal width and angular deflection is no greater than 3 1/2 degrees per joint.
- B. Painted Surface Forms:
 1. High density overlay plywood for flat concrete surfaces to be painted.
- C. Form Liners:
 1. Elastomeric FRP, ABS or PVC.
- D. All Other Forms:
 1. Materials as specified for wall forms.
- E. Form-Release Agent:
 1. Material: Release agent shall NOT bond with, stain, or adversely affect concrete surfaces, and shall NOT impair subsequent treatments of concrete surfaces when applied to forms or form liners. A “ready to use” water-based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations and can be used in potable water facilities. Certified as complying with NSF 61.
 2. Manufacturers and Products:
 - a. Atlas Construction Supply; Bio-Guard
 - b. Cresset Chemical Company; Crete-Lease 20-VOC.
 - c. Hill and Griffith; Grifcote LV-50 Plus
- F. Rustication Grooves and Beveled Edge Corner Strips:

1. Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.
- G. Form Ties:
1. Material: Steel
 2. Spreader Inserts:
 - a. Conical or spherical type.
 - b. Design to maintain positive contact with forming material.
 - c. Furnish units that shall leave no metal closer than 1" to concrete surface when forms, inserts, and tie ends are removed.
 3. Wire ties NOT permitted.
 4. Flat bar ties for panel forms furnish plastic or rubber inserts with minimum 1" depth and sufficient dimensions to permit patching of tie hole.
 5. Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
 - a. Integral steel water stop 0.103 in. thick and 0.625 in. in diameter tightly and continuously welded to tie.
 - b. Neoprene water stop 3/16 in. thick and 15/16 in. diameter whose center hole is 1/2 the diameter of tie, or molded plastic water stop of comparable size.
 - c. Orient water stop perpendicular to tie and symmetrical about center of tie.
 - d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.
 6. Through-Bolts: Tapered minimum 1 in. diameter at smallest end.
 7. Elastic Vinyl Plug:
 - a. Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length, and diameter upon removal forming watertight seal.
 - b. Manufacturer and Product:
 - 1) Dayton/Richmond Co.
Miamisburg, OH
A58 Sure Plug.
 - c. Sika Corporation
X-Plug
 - d. Recess plug 1 in. minimum and grout over hole. See Section 03 62 00 – Non-Shrink Grouting.

PART 3 - EXECUTION

3.1 FORM SURFACE PREPARATION

- A. Thoroughly clean form surfaces that shall be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants prior to coating surface.
- B. Exposed Wood Forms in Contact with Concrete:
 1. Apply form-release agent as recommended by the manufacturer.
- C. Steel Forms:
 1. Apply form-release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.
- D. Form Liner Forms:
 1. Prepare forms as recommended by the manufacturer.
 2. Provide liners in full sheets and locate seams as specified on approved shop drawings.
 3. Clean form liner after each use and use only form-release agents approved by the manufacturer.

3.2 ERECTION

- A. General:
 - 1. Unless specified otherwise, follow applicable recommendations of ACI347.
- B. Beveled Edges (Chamfer):
 - 1. Form 3/4" bevels at concrete edges, unless otherwise shown.
 - 2. Where beveled edges on existing adjacent structures are other than 3/4", obtain Engineer's approval of size prior to placement of beveled edge.
- C. Wall Forms:
 - 1. DO NOT reuse forms with damaged surfaces.
 - 2. Locate form ties and joints in an uninterrupted uniform pattern.
 - 3. Inspect form surfaces prior to installation to assure conformance with specified tolerances.
- D. Forms Supporting Form Liners:
 - 1. Construct to withstand the high hydraulic pressures associated with rapid filling and heavy high-frequency vibration.
- E. Form Liner Installation:
 - 1. Protect form liners from extended exposure to sunlight and high surface temperatures during installation.
 - 2. Install form liners per manufacturer's written instructions.
 - 3. Place form liners in accordance with specified patterns and joints.
 - 4. Maintain required concrete cover between form liner and reinforcement.
- F. Forms for Curbs and Sidewalks:
 - 1. Provide standard steel or wood forms.
 - 2. Set forms to true lines and grades, and securely stake in position.
- G. Form Tolerances:
 - 1. Provide forms in accordance with ACI 117, 347 and 318.
 - 2. Wall Tolerances:
 - a. Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
 - b. Wall Type W-A:
 - 1) Plumb within 1/4 in. in 10 ft or within 1 in. from top to bottom for walls over 40 ft high.
 - 2) Depressions in Wall Surface: Maximum 5/16 in. when 10 ft straightedge is placed on high points in all directions.
 - c. Wall Type W-B:
 - 1) Plumb within 1/8 in. in 10 ft or within 1/2 in. from top to bottom for walls over 40 ft high.
 - 2) Depressions in Wall Surface: Maximum 1/8 in. when 10 ft straightedge is placed on high points in all directions.
 - 3. Thickness: Maximum minus 1/4 in. or plus 1/2 in. from dimension shown.
 - 4. Form Offset: Between adjacent pieces of form work, facing material shall NOT exceed 1/8 in. where exposed to public view and 1/4 in. maximum for all other conditions.

3.3 ADDITIONAL REQUIREMENTS

- A. Construct forms tight enough to prevent loss of concrete mortar.

- B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses and the like for easy removal.
 - 2. DO NOT use rust-stained steel form-facing material.
 - 3. Use only form or form-tying methods which DO NOT cause spalling of the concrete upon form stripping or tie removal.
- C. Elevated Structural Slabs and Beams:
 - 1. DO NOT strip forms until concrete has reached 80% of the specified 28-day strength as determined by test cylinder breaks.
- D. Forms with Form Liners:
 - 1. Remove per manufacturer's recommendations.
 - 2. Use consistent removal timing to avoid variations in concrete color.
 - 3. Avoid damaging formed profiles.
- E. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- F. Provide temporary 12 in. wide by 18 in. high openings for cleanouts and inspection ports every 7 ft at the bottom of each lift form and where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations, where possible.
- G. Chamfer exterior corners and edges of permanently exposed concrete.
- H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds and bulkheads required in the Work.
 - 1. Determine sizes and locations from trades providing such items.
 - 2. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide openings with continuous keyways and waterstops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with reinforcement as indicated in the typical structural details. Reinforcing shall be at least 2 in. clear from the opening surfaces and encased items.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions before placing reinforcement.
- L. Embedded Items:
 - 1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts/rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles and other conditions.
 4. Check special castings, channels or other metal parts that are to be embedded in the concrete prior to and again after placing the concrete.
 5. Check nailing blocks, plugs and strips necessary for the attachment of trim, finish, and similar work prior to placing the concrete.
- M. Pipes and wall spools cast in concrete:
1. Install wall spools, wall flanges, and wall anchors before placing concrete. DO NOT weld, tie or otherwise connect the wall spools or anchors to the reinforcing steel.
 2. Support pipe and fabricated fittings to be encased in concrete-on-concrete piers or pedestals. Carry concrete supports to firm foundations so that no settlement shall occur during construction.
 3. Pipes or spools located below operating water level shall have waterstop ring collars and shall be cast in place. DO NOT block out such piping and grout after the concrete section is cast. Pipes fitted with thrust rings shall be cast in place.
- N. Removing and reusing forms:
1. DO NOT remove forms from concrete which has been placed with outside temperature below 50°F without first determining and verifying with Engineer if the concrete has properly set without regard for time. DO NOT apply loading on green concrete. Immediately after forms are removed, the surface of the concrete shall be carefully examined and any irregularities in the surface shall be repaired and finished as specified.
 2. Leave formwork for beam soffits, joists, structural slabs, beams, girders, and other structural elements that support weight of concrete in place until concrete has achieved 100 percent its 28-day design compressive strength.
 3. Formwork for sides of beams, walls, columns, and similar parts of the Work that does NOT support weight of concrete may be removed after cumulatively curing at NOT less than 50°F (10°C) for 48 hours after placing concrete, if concrete is hard enough to NOT be damaged by form-removal operations and curing and protection operations are maintained.
 4. Leave bracing for walls until the top or roof slab concrete reaches 100% of its 28-day design compressive strength.
 5. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
 6. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material shall NOT be acceptable for exposed surfaces. Apply new form-release agent.
 7. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. DO NOT use patched forms for exposed concrete surfaces.
- O. Aluminum surfaces in contact with concrete:
1. Aluminum surfaces in contact with concrete or grout or dissimilar metals shall be protected with a Mylar isolator, bituminous paint or other material approved by Engineer.
- P. Shores and reshores:
1. Comply with ACI 318 and ACI 301 for design, installation and removal of shoring and reshoring.
 - a. DO NOT remove shoring or reshoring until measurement of slab tolerances is complete.
 2. In multistory construction, extend shoring or reshoring over enough stories to distribute loads in such a manner that no floor or member shall be excessively loaded or shall induce tensile stress in concrete members without sufficient steel reinforcement.

3. For multi-storied structures, the shoring and reshoring diagrams and procedures shall be signed and sealed by a Registered Professional Engineer in the state where the construction is being undertaken. These diagrams and procedures shall consider the effect of the loads on the uncured concrete and the construction load on each floor.
4. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

END OF SECTION

SECTION 03 20 00 – CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Reinforcing steel and related items required for cast-in-place concrete.
- B. Related Sections:
 - 1. Section 03 10 00 – Concrete Forming.
 - 2. Section 03 30 00 – Cast-In-Place Concrete.

1.2 REFERENCES

- A. ACI (American Concrete Institute):
 - 1. SP-66 – Detailing Manual.
 - 2. 318 – Building Code Requirements for Structural Concrete.
 - 3. 350 – Code Requirements for Environmental Engineering Concrete Structures.
- B. ASTM International:
 - 1. A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 2. A1064 – Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- C. CRSI (Concrete Reinforcing Steel Institute):
 - 1. Manual of Standard Practice.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Shop drawings shall be prepared for all reinforcement required by the project. Shop drawings shall be logically and legibly prepared to permit reasonable ease of sorting, selecting, placing reinforcement as well as checking drawings. Preparer and fabricator shall be identified on the drawings.
 - 2. Reinforcement shall NOT be fabricated until the shop drawings have been processed, approved, and returned.
 - 3. Check all shop drawings to verify reinforcement dimensions required by drawings are satisfied.
 - 4. Provide bar sizes, bar lengths, bar material, bar grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and lap lengths, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- C. Reinforcement h m 0:
 - 1. Review of reinforcement shop drawings by the Engineer shall be limited to general compliance with the Contract Documents.
 - 2. Submit reinforcement shop drawings in a complete package for each specific structure. Partial submittals shall be rejected.
- D. Changes to Reinforcing Steel Contract Drawing Requirements:
 - 1. Specify in separate letter submitted with shop drawings any changes of requirements specified in Drawings for reinforcing steel.

2. Such changes shall NOT be acceptable unless the Engineer has accepted such changes in writing.

1.4 SUPERVISION

- A. Workmanship:
 1. Always provide qualified supervision reinforcing work is in progress. Workmen shall be experienced iron workers.
- B. Codes:
 1. Reinforcement placement and detailing shall comply with practice specified in the ACI SP-66 – Detailing Manual – latest edition of the American Concrete Institute or its latest revision, unless otherwise specified in this section.

1.5 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 CONCRETE REINFORCEMENT

- A. General:
 1. All reinforcement shall be free from rust, loose mill scale, and other contaminants.
- B. All bars shall be billet steel bars for concrete reinforcement ASTM A615 Grade 60.
- C. Wire bar supports located between reinforcing bars and face of concrete:
 1. Stainless steel. Type 304 stainless steel bar supports.
 2. Support reinforcing for concrete placed on ground using bar support chairs with Type 304 stainless steel plates for resting on ground welded to the chairs.
- D. Concrete Bar Supports Located Between Reinforcing Bars and Face of Concrete:
 1. Manufactured expressly for supporting reinforcing bars.
 2. Manufactured with two annealed steel wires to securely tie concrete bar support to reinforcing steel.
 3. Manufactured with minimum $f'_c = 5,000$ psi concrete.

2.2 WWR (WELDED WIRE REINFORCEMENT):

- A. See ASTM A185 (withdrawn in 2013, replaced by A1064), 75 ksi minimum tensile strength.
- B. WWR may NOT be used in place of reinforcing bars unless accepted in writing by the Engineer.
- C. Provide WWR in flat sheet form.
- D. If WWR is used, provide WWR having cross-sectional area per linear foot of NOT less than cross-sectional area per linear foot of reinforcing bars specified in Drawings.

2.3 ACCESSORIES

- A. General:
 1. Accessories shall be subject to Engineer's approval.
 2. Tie wire – 18 GA annealed steel wire.
 3. Number of chairs shall be adequate to prevent sag during steel and concrete placement.

4. Wall layer spacers shall be 1/4 in. round "Z" bar.
5. Horizontal layer spacers shall be wire bar supports or reinforcing bars bent to support top layer.
6. Dowel bar splicer:
 - a. Dowel bar splicer shall be Richmond or approved equal, manufactured from standard specified rebar material, with NC threads and shop fabricated to specified dowel configurations.
7. Mechanical Connectors:
 - a. Approved Manufacturers: Dayton Superior, Erico, or approved equal.
 - b. The mechanical connection shall meet the code requirements of developing in tension and compression as required by the referenced codes. Install per the manufacturer's approved procedures.

PART 3 - EXECUTION

3.1 GENERAL

- A. Reinforcing bars and welded wire fabric reinforcement:
 1. Verify that reinforcement is new stock free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings which adversely affect bonding capacity when placed in the work.
- B. Other trades:
 1. Coordinate all work of other trades to avoid conflict with reinforcement.
- C. Shop Drawings:
 1. Check all shop drawings to verify dimensions required.

3.2 FABRICATING

- A. General:
 1. Fabricate steel reinforcement as specified in CRSI's "Manual of Standard Practice."
 2. Reinforcement shall be shop fabricated except where straight bars No. 5 or smaller are required.
- B. Bending:
 1. All bending shall be by using bending jigs and mandrels. All bars shall be bent cold.
- C. Cutting:
 1. Bars shall be cut by cold shearing. Torch cutting in the field may be permitted in special situations.

3.3 PREPARATION

- A. Surface Preparation:
 1. Reinforcing bars: thin coating of red rust resulting from short exposure shall NOT be considered objectionable. Thoroughly clean any bars having rust scale, loose mill scale, or thick rust coat.
 2. Cleaning of reinforcement materials: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placement.

3.4 PLACING

- A. General:

1. Accurately place all bars to meet tolerances as outlined in ACI 318 and tie in place before placing concrete, include dowels. Tie with 18 GA steel wire.
2. Corner bars required for horizontal reinforcing. Unless otherwise noted on plans corner bars shall be same size and spacing as horizontal bar.
3. No field bending of bars shall be allowed.

B. Clearance:

1. Preserve clearance between bars of 1 in. minimum, NOT less than one bar diameter or 1 1/3 times large aggregate, whichever is larger.
2. Provide concrete coverage over reinforcing steel unless otherwise specified on plans:
 - a. 3 in. above subgrade – in excavation.
 - b. 2 in. above subgrade – slab on fill.
 - c. 2 in. from form – walls exposed to water or earth and for slab over water.
 - d. 1 1/2 in. from form – normal cover interior walls, beams, columns, etc.
 - e. 3/4 in. on top steel – interior slabs.
 - f. 1 1/2 in. on top and bottom – exterior slab.
3. Lap all reinforcing bars as required by ACI 318-latest edition Class B as specified in Drawings except where otherwise required by ACI.
4. Stagger splices except where otherwise specified.
5. Welded splices are NOT permitted.
6. Lap welded wire reinforcement a minimum of two spaces.

C. Dowels:

1. All dowels shall be placed and securely anchored before placing concrete.

D. Supports:

1. Provide enough to prevent sagging, to prevent shifting, and to support loads during construction; but in no case less than quantities and at locations as specified in ACI 315 (SP-66).
2. DO NOT use brick, broken concrete masonry units, spalls, rocks, wood, or similar materials for supporting reinforcing steel.
3. DO NOT use reinforcing bars that have less cover than required by the Contract Documents.
4. DO NOT adjust location of reinforcement required by the Contract Documents to provide cover to these bars.
5. Wire chairs shall NOT be accepted to hold reinforcing clearance on walls.

E. Tying of bar reinforcement:

1. Fasten bars securely in place with wire ties.
2. Tie bars sufficiently often to prevent shifting.
3. Provide at least 3 ties in each bar length.
4. DO NOT apply to dowel lap splices or to bars shorter than 4 ft, unless necessary for rigidity.
5. Tie slab bars at every intersection around periphery of slab.
6. Tie wall bars and slab bar intersections other than around periphery at NOT less than every fourth intersection, but at NOT greater than following maximum spacings:

Bar Size	Slab Bar Spacing (in.)	Wall Bar Spacing (in.)
Bars Number 5 and Smaller	60	48
Bars Number 6 – Number 9	96	60
Bars Number 10 – Number 11	120	96

7. After tying wire ties, bend ends of wire ties in towards the center of the concrete section.

- a. The cover for wire ties shall be the same as the cover requirements for reinforcing bars.
- F. Openings and Obstructions:
 - 1. Place additional reinforcing around openings as shown on the drawings and standard details.
 - 2. Bend reinforcing around obstructions. Place extra reinforcing where cutting is authorized. Engineer's approval required before cutting steel.
 - 3. Consult Engineer on special situations.
- G. Welded Wire Reinforcement:
 - 1. Install necessary wiring, spacing chairs, or supports to keep welded wire fabric in place while concrete is being placed.
 - 2. Bend fabric as specified in Drawings or required to fit work.
 - 3. Unroll or otherwise straighten fabric to make flat sheet before placing in the Work.
 - 4. Lap splice welded wire fabric as specified in Drawings.
 - 5. If lap splice length is NOT specified in Drawings, splice fabric as specified in ACI 318 and ACI 350.
- H. Certification:
 - 1. Certify material and type of deformation.
- I. Condition:
 - 1. All reinforcement shall be free from loose rust, dirt coating, oil, paint, or any foreign substance.

END OF SECTION

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Hydraulic (liquid containing) structures.
 - 2. Beams and columns.
 - 3. Building walls.
 - 4. Retaining walls.
 - 5. Foundation walls.
 - 6. Footings.
 - 7. Suspended slabs.
 - 8. Slabs on grade.
 - 9. Equipment pads.
- B. Related Sections:
 - 1. Section 03 01 00 – Maintenance of Concrete
 - 2. Section 03 15 00 – Concrete Joints and Accessories
 - 3. Section 03 35 00 – Concrete Finishing
 - 4. Section 03 39 00 – Concrete Curing
 - 5. Section 03 64 00 – Concrete Repair Crack Injection

1.2 REFERENCES

- A. ACI (American Concrete Institute):
 - 1. ACI 117 – Specification for Tolerances for Concrete Construction and Materials
 - 2. ACI 301 – Specifications for Structural Concrete
 - 3. ACI 305R – Guide to Hot Weather Concreting
 - 4. ACI 306.1 – Standard Specification for Cold Weather Concreting
 - 5. ACI 308.1 – Specification for Curing Concrete
 - 6. ACI 318 – Building Code Requirements for Structural Concrete
 - 7. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures
 - 8. ACI 350.1 – Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures
 - a. Manual of Concrete Practice
- B. ASTM International:
 - 1. C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
 - 2. C33 – Standard Specification for Concrete Aggregates
 - 3. C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - 4. C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
 - 5. C94 – Standard Specification for Ready-Mixed Concrete
 - 6. C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete
 - 7. C150 – Standard Specification for Portland Cement
 - 8. C172 – Standard Practice for Sampling Freshly Mixed Concrete
 - 9. C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - 10. C227 – Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
 - 11. C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - 12. C260 – Standard Specification for Air-Entraining Admixtures for Concrete

13. C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
14. C330 – Standard Specification for Lightweight Aggregates for Structural Concrete
15. C494 – Standard Specification for Chemical Admixtures for Concrete
16. C595 – Standard Specification for Blended Hydraulic Cements
17. C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
18. C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
19. C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars
20. C1012 – Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
21. C1017 – Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
22. C1064 – Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
23. C1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
24. C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)
25. C1116 – Standard Specification for Fiber-Reinforced Concrete
26. C1218 – Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
27. C1240 – Standard Specification for Silica Fume Used in Cementitious Mixtures
28. C1260 – Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
29. C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
30. D994 – Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
31. D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-Extruding and Resilient Bituminous Types)
32. D1752 – Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
33. E96 – Standard Test Methods for Water Vapor Transmission of Materials
34. E329 – Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
35. E1155 – Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers
36. E1643 – Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
37. E1745 – Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

1.3 DEFINITIONS

- A. Cementitious Materials:
 1. Portland cement alone or in combination with one or more of:
 - a. Blended hydraulic cement
 - b. Fly ash and other pozzolans
 - c. Ground granulated blast-furnace slag
 - d. Silica fume
 2. Subject to requirements.
- B. Cold Weather:
 1. Ambient temperature below 40°F or approaching 40°F and falling.
- C. Defective Area:
 1. Surface defects, Including:

- a. Honeycomb
 - b. Rock pockets
 - c. Indentations
 - d. Surface voids greater than 3/16 in. deep
- 2. Surface voids greater than 3/4 in. diameter
- 3. Cracks in liquid containment structures and below-grade habitable spaces that are 0.010 in. wide and wider.
- 4. Cracks in other structures that are 0.015 in. wide and wider.
- 5. Spalls, chips, embedded debris, lift lines, sand lines, deviations that exceed specified tolerances and include, but are NOT limited to, fins, form popouts, and other projections, stains, and other color variations that can NOT be removed by cleaning.
- D. Exposed Concrete:
 - 1. Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when the structure is drained.
- E. Hot Weather:
 - 1. As defined in ACI 305R.
- F. Hydraulic Structure:
 - 1. Liquid containment structure.
- G. New Concrete:
 - 1. Less than 60 days old.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit data for each type of product indicated.
- C. Design Data:
 - 1. Submit concrete mix design for each mix included in the Supplement at the end of this Section.
 - a. Proportions of all materials in the mix, signed by the mix designer.
 - b. Average strength per ACI 301.
 - c. Manufacturer's Certificate of Compliance as specified in Section 01 60 00 – Product Requirements.
 - d. Cementitious materials.
 - e. Admixtures.
 - f. Test Reports – chemical analysis, chloride-ion content, shrinkage test results.
 - g. Coarse and fine aggregate gradations.
 - h. Water to be withheld for later addition at Project site.
 - 2. Detailed plan for placing and curing concrete in cold weather.
 - 3. Detailed plan for placing and curing concrete in hot weather.
 - a. Thermal control plan for concrete sections greater than 2 ft 6 in.
 - b. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
 - c. Manufacturer Instructions: Submit installation procedures and interfacing required with adjacent Work.
 - d. Field Quality requirements Submittals: Indicate results of Contractor-furnished tests and inspections, including tightness test results and floor surface flatness and levelness measurements.

- D. Ready-Mix Concrete Delivery Tickets
 - a. Record the amount of water added at the Project site on the delivery ticket.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 77 00 – Closeout Procedures specifies requirements for closeout submittals.
- B. Project Record Documents:
 - 1. Record actual locations of embedded utilities and components concealed from view in finished construction.

1.6 QUALITY ASSURANCE

- A. Include this Article to specify compliance with overall reference standards affecting products and installation included in this Section.
- B. Perform Work as specified in ACI 301 and ACI 117.
- C. See ACI 305R when placing concrete during hot weather.
- D. See ACI 306.1 when placing concrete during cold weather.
- E. Obtain each type or class of cementitious material from a single source, obtain aggregate from a single source and obtain admixtures from a single supplier for the Project. If any of these sources need to, by necessity, change, notify the Engineer.
- F. Installer Qualifications:
 - 1. Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician. If an ACI-certified Technician is NOT available, submit flatwork installer qualifications to the Engineer.
- G. Manufacturer Qualifications:
 - 1. A firm with a minimum of 5 years of experience in manufacturing ready-mix concrete products and that complies with ASTM C94 requirements for production facilities and equipment.
 - 2. Manufacturer certified as specified in NRMCA – “Certification of Ready-Mixed Concrete Production Facilities” or equivalent program.
 - 3. Mix Designer: Certified as NRMCA Concrete Technologist Level 2 or Licensed Engineer. If neither, the Mix Designer’s qualifications shall be submitted to the Engineer.
- H. Testing Agency Qualifications:
 - 1. An independent agency, acceptable to the Authority Having Jurisdiction, qualified as specified in ASTM C1077 and ASTM E329 for the testing indicated.
 - 2. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, as specified in ACI CP-1 or an equivalent certification program.
 - 3. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician – Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician – Grade II.
- I. Concrete Preinstallation Conference:
 - 1. Schedule and conduct at Project site prior to submitting mix designs.
 - 2. Required meeting attendees:
 - a. Contractor’s superintendent.
 - b. Structural Engineer in responsible charge or designee.

- c. Independent testing agency.
- d. Ready-mix producer.
- e. Concrete Subcontractor.
- f. Admixture representative.
- 3. Agenda shall include:
 - a. Concrete testing and special inspection.
 - b. Mix designs and admixtures.
 - c. Formwork and formwork removal.
 - d. Reinforcement.
 - e. Placement methods.
 - f. Concrete finishing.
 - g. Curing procedures.
 - h. Hot and cold weather placement protections.
 - i. Joints.
 - j. Placement of anchors and miscellaneous embeds.
 - k. Tolerances including floor and slab flatness and levelness.
 - l. Concrete repair procedures.

1.7 MOCKUPS

- A. Section 01 40 00 – Quality Requirements, specifies requirements for mockups.
- B. Construct mockups for architectural concrete surfaces receiving special treatment or finish as result of formwork.
- C. Size:
 - 1. Sufficient to indicate required special treatment or finish.
- D. If requested by Architect/Engineer, cast concrete against sample panel.
- E. Obtain acceptance of Architect/Engineer for resultant surface finish prior to erecting formwork.
- F. Locate where indicated on Drawings.
- G. Incorporate accepted mockup as part of Work.

1.8 AMBIENT CONDITIONS

- A. Section 01 50 00 – Temporary Facilities and Controls, specifies requirements for ambient condition control facilities for product storage and installation.
- B. Maintain concrete temperature after installation at minimum 50°F for minimum seven days.

1.9 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete:
 - 1. Cement:
 - a. Comply with ASTM C150, for cement type, see Supplement at End of Section.
 - b. Type: Portland.

2. Blended Cement:
 - a. Comply with ASTM C595.
 - b. For sulfate resistance option, see Supplement at End of Section.
 - c. Color: Gray.
 3. Normal Weight Aggregates:
 - a. Comply with ASTM C33.
 - b. Coarse Aggregate Maximum Size: 1 in. nominal.
 - c. Coarse Aggregate – NOT more than 15% by weight of thin or elongated pieces having a length of five times the average thickness.
 - d. Fine Aggregate – consisting of clean natural sand or of sand prepared from crushed stone or crushed gravel.
 4. Water:
 - a. Comply with ACI 318.
 - b. Potable, without deleterious amounts of chloride ions.
- B. Admixtures:
1. Manufacturers:
 - a. BASF Admixtures, Inc, Shakopee, MN.
 - b. Euclid Chemical Co., Cleveland, OH.
 - c. W.R. Grace & Co., Cambridge, MA.
 - d. Substitutions: As specified in Section 01 60 00 – Product Requirements.
 2. Air Entrainment: Comply with ASTM C260.
 3. Chemical:
 - a. Comply with ASTM C494.
 - b. Type A – Water-Reducing. Type B – Retarding.
 - d. Type C – Accelerating.
 - e. Type D – Water-Reducing and Retarding.
 - f. Type E – Water-Reducing and Accelerating.
 - g. Type F – Water-Reducing, High Range.
 - h. Type G – Water-Reducing, High Range, and Retarding.
 4. Fly Ash: Comply with ASTM C618, Class F.
 5. Silica Fume: Comply with ASTM C1240.
 6. Slag:
 - a. Description: Ground-granulated blast-furnace slag.
 - b. Comply with ASTM C989.
 - c. Grade 100 or 120.
 7. Plasticizing:
 - a. Comply with ASTM C1017.
 - b. Type I or Type II.
 8. Shrinkage Reducing Admixture:
 - a. BASF; Tetraguard AS20.
 - b. Euclid; Eucon SRA Series.
 - c. W.R. Grace; Eclipse Series.

2.2 CONCRETE MIX

- A. See Supplement at the End of this Section for design requirements for each concrete mix.
- B. Select proportions for concrete as specified in ACI 318.
- C. Use water-reducing admixture in concrete that is part of a Hydraulic Structure or with a water-cementitious ratio below 0.50.
- D. Where fly ash is used, it shall be limited to 25% of total cementitious materials, unless approved in writing by the Engineer.

- E. Limit water-soluble chloride-ion content in hardened concrete to 0.15% by weight of cement for nonhydraulic structures and 0.10% for hydraulic structures.
- F. Fine aggregate shall be in the range of 36 – 40 % of total aggregate weight.
- G. Concrete Shrinkage Limits:
 - 1. See Subsection 3.5.J.
- H. Target Slump:
 - 1. Without high-range water reducers – 4 in.
 - a. With high-range water reducers – 2 in. prior to the addition of the admixture, 8 in. maximum at point of delivery, unless otherwise permitted.
 - b. Target slump for drilled pier – 6 in. – 8 in.
- I. Admixtures:
 - 1. Include admixture types and quantities indicated in concrete mix designs only if approved by Architect/Engineer.
 - 2. Cold Weather:
 - a. Use accelerating admixtures in cold weather.
 - b. Use of admixtures shall NOT relax cold weather placement requirements.
 - 3. Hot Weather: Use set-retarding admixtures.
 - 4. DO NOT use calcium chloride or admixtures containing calcium chloride.
 - a. Add air entrainment admixture to concrete mix for Work exposed to freezing and thawing.
 - b. Average Compressive Strength Reduction: NOT permitted.
- J. Ready-Mixed Concrete:
 - 1. Mix and deliver concrete as specified in ASTM C94 and deliver batch ticket information.
 - 2. When air temperature is between 85°F – 90°F, reduce mixing and delivery time from 90 minutes to 75 minutes; when air temperature is above 90°F, reduce mixing and delivery time to 60 minutes.
 - a. Contractor may coordinate with the concrete producer and admixture manufacturer to demonstrate the efficacy of using a retarding admixture to extend placement times during hot weather.
- K. Site-Mixed Concrete:
 - 1. Mix concrete as specified in ACI 318.

2.3 ACCESSORIES

- A. Bonding Agent:
 - 1. Manufacturers:
 - a. BASF Building Systems Inc.
 - b. Euclid Chemical Co.
 - c. Prime Resins
 - d. Sika Chemical Corp.
 - 2. Substitutions: As specified in Section 01 60 00 – Product Requirements.
 - 3. Furnish materials as specified in ASTM C881, Type V standards. Description: Two-component moisture insensitive, 100% solids epoxy resin.
- B. Vapor Retarder:
 - 1. Manufacturers:
 - a. Fortifiber Corp.
 - b. Revan Industries, Inc.
 - c. Stego Industries, LLC

2. Substitutions: As specified in Section 01 60 00 – Product Requirements.
 3. Furnish materials as specified in E1745, Class B standards. Description: Clear polyethylene film.
 5. Thickness: 10 mils min.
 6. Type: As recommended for below-grade application.
 - a. Joint Tape: As recommended by manufacturer.
- C. Bond Breaker:
1. Manufacturers:
 - a. Dayton Superior: EDOCO Clean Lift Bond Breaker
 2. Substitutions: As specified in Section 01 60 00 – Product Requirements.
 3. Description: Nonstaining, providing positive bond prevention.
- D. Concrete Reinforcing Fibers:
1. Manufacturers:
 - a. Euclid Chemical Co.
 - b. Propex Concrete Systems Corp.
 - c. Substitutions: As specified in Section 01 60 00 – Product Requirements.
 2. Description: High-strength industrial-grade fibers specifically engineered for secondary reinforcement of concrete.
 3. Comply with ASTM C1116.
 4. Tensile Strength: 130 ksi.
 5. Toughness: 15 ksi.
 6. Fiber Length: 3/4 in.
 7. Fiber Count: 34 million/lb.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 77 00 – Closeout Procedures, specifies requirements for installation examination.
- B. Verify requirements for concrete cover over reinforcement.
- C. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and shall NOT interfere with placing concrete.

3.2 PREPARATION

- A. Section 01 77 00 – Closeout Procedures specifies requirements for installation preparation.
- B. Previously Placed Concrete:
 1. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent.
 - a. Remove laitance, coatings, and unsound materials.
 - b. Doweled Joints: Install dowel bars and support assemblies at joints as indicated on drawings.
 - c. Remove debris and ice from formwork, reinforcement, and concrete substrates.
- C. Remove water from areas receiving concrete before concrete is placed.

3.3 INSTALLATION

- A. Placing Concrete:
 1. Place concrete as specified in ACI 301.

2. Notify testing laboratory Engineer minimum 24 hrs. prior to commencement of operations.
3. Make sure reinforcement, inserts, embedded parts, formed expansion and contraction joints, and waterstop are NOT disturbed during concrete placement.
4. Install vapor retarder under interior slabs on grade as specified in ASTM E1643. Lap joints minimum 6 in. and seal watertight by taping edges and ends as specified in manufacturer's instructions.
 - a. Repairs:
 - 1) Repair vapor retarder damaged during placement of concrete reinforcement.
 - 2) Using vapor retarder material, lap over damaged areas minimum 6 in. and seal watertight.
 - 5) Joint Filler:
 - b. Separate slabs on grade from vertical surfaces with 1/2 in. thick joint filler.
 - c. Place joint filler in floor slab pattern placement sequence; set top to required elevations; secure to resist movement by wet concrete.
 - d. Extend joint filler from bottom of slab to within 1/2 in. of finished slab surface.
6. Deposit concrete at final position, preventing segregation of mix. Limit vertical free fall to 5 ft.
7. Place concrete in continuous operation for each panel or section as determined by predetermined expansion, control and construction joints.
 - a. Place in horizontal layers NOT to exceed 2.0 ft in depth, except for slabs which shall be placed full depth.
 - b. DO NOT exceed formwork design pressures.
8. DO NOT use aluminum conveying devices.
9. Retempering of concrete is NOT permitted where cement has partially hydrated.
10. Pumping of Concrete:
 - a. Provide standby pump, conveyor system or other system onsite during pumping to ensure completion of concrete placement without cold joints in case of equipment failure.
11. Consolidate concrete using mechanical vibrating equipment per ACI 301
 - a. DO NOT use vibrators to transport concrete within formwork. Insert and withdraw vibrators vertically at uniform spacing to quickly penetrate placed layer and at least 6 in. into preceding layer. DO NOT insert vibrators into lower layers that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement, waterstop and other items without causing segregation.
 - b. Slabs with horizontal waterstop: limit concrete placement to elevation of waterstop in first pass, ensure space beneath waterstop completely fills with concrete, vibrate under waterstop, then place remaining concrete to full height of slab.
 - c. Maintain at least one standby vibrator prior to placing concrete.
12. Maintain records of concrete placement, including date, location, quantity, air temperature, and test samples taken.
13. Maximum Size of Concrete Placements:
 - a. Locate expansion, control and contraction joints where shown on drawings.
 - b. Locate construction joints where shown on drawings or where approved in joint location submittal per Section 03 15 00 – Concrete Joints and Accessories.
 - c. Provide vertical construction joints in walls and slabs at maximum spacing of 40 feet, unless shown or approved otherwise.
 - d. Place joints to avoid penetrations.
14. DO NOT interrupt successive placement and DO NOT permit cold joints to occur.
15. Minimum Time Between Adjacent Placements:
 - a. Construction or Control Joints: 7 days unless otherwise specified.
 - b. Construction joint between top of footing or slab and column or wall: NOT less than 24 hrs.
 - c. Expansion or Contraction Joints: NOT less than 24 hrs.
16. Hot Weather Placement:
 - a. Comply with ACI 305.1

- b. Maintain concrete temperature below 95°F at time of placement. If chilled water or ice are used to maintain concrete temperature, that water equivalent shall be included in the total water used to calculate the water-cement ratio.
 - c. Fog-spray forms, reinforcement, and subgrade just before placing concrete, without creating standing water or dry areas.
 - 17. Cold Weather Placement:
 - a. Comply with ACI 306.1
 - b. DO NOT place concrete on frozen subgrade or subgrade containing frozen materials. Top 12 in. of subgrade shall be thawed prior to concrete placement.
 - c. DO NOT place concrete in contact with reinforcement or embedment with surfaces less than 35°F.
 - d. Provide supplemental heat when other means of thermal protection are insufficient. Vent carbon-based fuel heaters away from concrete surface to avoid concrete carbonation.
 - e. Provide temperature sensors placed on the concrete surfaces throughout the work. Record surface temperature at least once every 12 hrs.
 - f. Protect concrete from freezing until the end of the curing period.
 - 18. Saw-Cut Joints (where permitted):
 - a. Saw-cut joints within 12 hrs after placing.
 - b. Use 3/16 in. thick blade.
 - c. Cut into 1/4 depth of slab thickness.
 - 19. Screeding:
 - a. Screed floors and slabs to elevations and slopes shown on drawings.
 - b. Surface Flatness: FF 20 (conventional slab).
 - B. Concrete Finishing:
 - a. Per Section 03 35 00 – Concrete Finishing.
 - C. Curing and Protection:
 - 1. Per Section 03 39 00 – Concrete Curing.
- 3.4 BACKFILL AGAINST STRUCTURES
- A. DO NOT backfill against walls until the concrete has reached the design 28-day strength as demonstrated by concrete cylinder breaks.
 - B. For structures with top slabs or diaphragms, the top slab shall reach design strength, or the diaphragm shall be secured per the contract documents prior to backfill.
 - C. Unless otherwise permitted, backfill evenly around structure to prevent differential horizontal pressures.
- 3.5 FIELD QUALITY REQUIREMENTS
- A. Section 01 40 00 – Quality Requirements, specifies requirements for inspecting and testing.
 - B. Inspection and Testing:
 - 1. Performed by testing laboratory as specified in ACI 318.
 - C. Provide unrestricted access to Work and cooperate with appointed testing and inspection firm.
 - D. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work.
 - E. Concrete Inspections:

1. Continuous Placement Inspection: Inspect for proper installation procedures.
 2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.
 - a. Samples for testing air content in pumped concrete shall be taken at point of placement and point of delivery to establish a correlation to estimate air content at point of placement. All other samples shall be taken at point of delivery.
 - b. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hrs.
- F. Strength Test Samples:
1. Sampling Procedures: Comply with ASTM C172.
 2. Cylinder Molding and Curing Procedures: Comply with ASTM C31.
 - b. Cylinder Specimens: Standard cured.
 3. Sample concrete and make one set of four 4 in. diameter test cylinders for every 50 yd³ or less of each class of concrete placed each day, and for every 5,000 ft² of surface area for slabs and walls.
 4. If volume of concrete for a class of concrete would provide less than five sets of cylinders, take samples from five random batches, or from every batch if less than five batches are used.
 - a. Make one additional cylinder during cold weather concreting and field cure.
- G. Field Testing:
1. Slump Test Method: Comply with ASTM C143.
 2. Air Content Test Method: Comply with ASTM C173 or C231.
 3. Temperature Test Method: Comply with ASTM C1064.
 4. Frequency of Testing:
 - a. Measure slump and temperature for each sample.
 - b. Measure air content in air-entrained concrete for each sample.
- H. Cylinder Compressive Strength Testing:
1. Test Method: See ASTM C39.
 2. Test Acceptance: See ACI 318.
 3. Test one cylinder at seven days.
 4. Test two cylinders at 28 days. Retain one cylinder for 56 days for testing when requested by Engineer.
 - a. Dispose of remaining cylinders if testing is NOT required.
- I. Core Compressive Strength Testing:
1. Sampling and Testing Procedures: Comply with ASTM C42.
 2. Test Acceptance: As specified in ACI 318.
 - a. Drill three cores for each failed strength test from failed concrete.
- J. Shrinkage Testing:
1. As specified in ASTM C157 with modifications:
 - a. Prisms shall be moist cured for 7 days prior to the 28-day drying period.
 - b. Measurement at the end of the 7-day moist cure shall be considered the initial length.
 - c. The reported results shall be the average of three prisms.
 2. If the drying shrinkage measurement of a specimen varies from the average by more than 0.04%, disregard the results from that specimen.
 3. Test shrinkage characteristics every 5,000 yd³ and every 3 months during construction of hydraulic structures.
 4. Results at the end of the 28-day drying period shall NOT exceed 0.04% if 3 in. prisms are used or 0.038% if 4 in. prisms are used.
 - a. If the 7-day or 14-day field shrinkage tests exceed the limits established by testing of the mix design, furnish an additional 14 days of water cure beyond the original curing period for hydraulic structures. Modify the mix design to reduce shrinkage.

- K. Liquid Tightness Tests:
1. As specified in ACI 350.1.
 2. Purpose:
 - a. To determine the integrity and water tightness of finished concrete surfaces of liquid containment structures.
 - b. Contractor shall perform and pay for all costs associated with liquid tightness tests.
 - c. Report all test results to the Engineer.
 3. For All Water-Holding Structures:
 - a. Perform tightness tests after the concrete structure is complete and capable of resisting the hydrostatic pressure of the water test. The concrete shall have achieved its full design strength.
 - b. Perform tightness tests before backfill, brick facing, or other work that shall cover the concrete wall surfaces has begun.
 - c. Install all temporary bulkheads, cofferdams and pipe blind flanges and close all valves. Inspect each to assure that it provides a complete seal.
 - d. Fill with water to test level shown, or maximum liquid level if no test level is given. Maintain this level for 72 hrs. prior to the start of the test to allow for water absorption, structural deflection, and temperature to stabilize.
 - e. Measure evaporation and precipitation by floating a partially filled, transparent, calibrated, open top container.
 - f. Measure the water surface at two points 180 degrees apart, when possible where attachments such as ladders exist, at 24 hr. intervals. Use a sharp pointed hook gage and fixed metal measure capable of reading to 1/100 in. Continue the test for a period sufficient to produce at least 1/2 in. drop in the water surface based on the assumption that leakage would occur at the maximum allowable rate specified or for 72 hrs, whichever is the lesser time.
 4. Acceptance Criteria:
 - a. Volume loss shall NOT exceed 0.075% of contained liquid volume in a 24-hr. period, correcting for evaporation, participation, and settlement.
 - b. No damp spots or seepage visible on exterior surfaces. A damp spot is defined as sufficient moisture to be transferred to a dry hand upon touching.
 5. Repairs when test fails:
 - a. Dewater the structure; fill leaking cracks with crack repair epoxy as specified in Section 03 64 00 – Concrete Repair Crack Injection. Patch areas of damp spots previously recorded and repeat tightness test in its entirety until the structure successfully passes the test.
- L. Water-Soluble Chloride-Ion Concentration Test Method:
1. Comply with ASTM C1218.
 2. Test at 28 days.
 - a. Maximum Chloride-Ion Concentration: As permitted by applicable code.
- M. Patching:
1. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
 2. Honeycombing or Embedded Debris in Concrete:
 - a. NOT acceptable.
 - b. Notify Engineer upon discovery.
 - c. Patch imperfections per Section 03 01 00 – Maintenance of Concrete.
- N. Defective Concrete:
1. Description: See Definitions.
 2. Repair or replacement of defective concrete shall be determined by Engineer.
 3. DO NOT patch, fill, touch up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

3.6 SUPPLEMENTS

- A. Requirements of concrete mix designs after “End of Section” are a part of this section.

END OF SECTION

5000 PSI CONCRETE MIX

- A. Use for Hydraulic Structures exposed to freezing and thawing cycles, severe sulfate exposure and requiring low permeability. Typically used in wastewater treatment.
- B. Mix Design Properties:
 - 1. Maximum water / cementitious ratio of 0.40.
 - 2. Minimum compressive strength at 28 days of 5,000 psi.
 - 3. Conform to shrinkage limits.
 - 4. Air content of 4.5% to 7.0%, assuming 3/4 in. or 1 in. maximum aggregate size.
 - 5. Provide Cementitious Materials as Specified in Either:
 - a. ASTM C150 Type V – type F fly ash may be included as an option
 - 6. Minimum cementitious materials content in the mix shall be:
 - a. 560 lbs/yd³ for 3/4 in. maximum aggregate size.
 - b. 535 lbs/yd³ for 1 in. maximum aggregate size.
 - c. Limit maximum cementitious content to 100 lbs/yd³ greater than specified minimums.
 - 7. Limit water-soluble, chloride-ion content in hardened concrete to 0.10%.
 - a. Test if total chloride-ion content of individual ingredients, calculated on the basis of concrete proportions, exceeds 0.10%.
 - b. Refer to this Section for additional requirements.

4500 PSI CONCRETE MIX

- A. Use for Hydraulic Structures exposed to freezing and thawing cycles, moderate sulfate exposure and requiring low permeability. Typically used in water treatment.
- B. Mix Design Properties:
 - 1. Maximum water / cementitious ratio of 0.42.
 - 2. Minimum compressive strength at 28 days of 4,500 psi.
 - 3. Conform to shrinkage limits.
 - 4. Air content of 4.5 – 7.0%, assuming 3/4 in. or 1 in. maximum aggregate size.
 - 5. Provide Cementitious Materials Per as Specified in Either:
 - a. ASTM C150 Type II – type F fly ash may be included as an option.
 - b. ASTM C595 Type IP – complies with moderate sulfate resistance option.
 - 6. Minimum cementitious materials content in the mix shall be:
 - a. 560 lbs/yd³ for 3/4 in. maximum aggregate size
 - b. 535 lbs/yd³ for 1 in. maximum aggregate size
 - c. Limit maximum cementitious content to 100 lbs/yd³ greater than specified minimums.
 - 7. Limit water-soluble, chloride-ion content in hardened concrete to 0.10%.
 - a. Test if total chloride-ion content of individual ingredients, calculated on the basis of concrete proportions, exceeds 0.10%.
 - b. Refer to this section for additional requirements.

4500 PSI CONCRETE MIX

- A. Use for Hydraulic Structures NOT exposed to freezing and thawing cycles, moderate sulfate exposure and requiring low permeability. Typically used in water treatment in non-freeze/thaw areas.
- B. Mix Design Properties:
 - 1. Maximum water / cementitious ratio of 0.42.
 - 2. Minimum compressive strength at 28 days of 4,500 psi.
 - 3. Conform to shrinkage limits.
 - 4. Air content of 3.5% to 6.0% for 3/4 in. maximum aggregate size and 3.0% to 5.5% for 1 in. maximum aggregate size.
 - 5. Provide Cementitious Materials as Specified in Either:
 - a. ASTM C150 Type II – type F fly ash may be included as an option.
 - b. ASTM C595 Type IP – complies with moderate sulfate resistance option.
 - 6. Minimum cementitious materials content in the mix shall be:
 - a. 560 lbs/yd³ for 3/4 in. maximum aggregate size
 - b. 535 lbs/yd³ for 1 in. maximum aggregate size
 - c. Limit maximum cementitious content to 100 lbs/yd³ greater than specified minimums.
 - 7. Limit water-soluble, chloride-ion content in hardened concrete to 0.10%.
 - a. Test if total chloride-ion content of individual ingredients, calculated on the basis of concrete proportions, exceeds 0.10%.
 - b. Refer to this section for additional requirements.

4500 PSI CONCRETE MIX

- A. Use for nonhydraulic structural concrete exposed to freezing and thawing cycles, moderate sulfate exposure and requiring low permeability. Typically used for buildings.
- B. Mix Design Properties:
 - 1. Maximum water / cementitious ratio of 0.45.
 - 2. Minimum compressive strength at 28 days of 4,500 psi.
 - 3. Air content of 5.5% – 7.0% for 3/4 in. and 1 in. maximum aggregate size.
 - 4. Provide Cementitious Materials as Specified in Either:
 - a. ASTM C150 Type II – type F fly ash may be included as an option.
 - b. ASTM C595 Type IP – complies with moderate sulfate resistance option.
 - 5. Limit water-soluble, chloride-ion content in hardened concrete to 0.30%.
 - a. Test if total chloride-ion content of individual ingredients, calculated on the basis of concrete proportions, exceeds 0.30%.
 - b. Refer to this section for additional requirements.

4000 PSI CONCRETE MIX

- A. Use for secondary elements NOT exposed to freezing and thawing cycles, with moderate sulfate exposure. Typically used below grade for electrical duct banks, pipe encasements NOT cast monolithically with structural slabs, thrust blocks, and drilled piers.
- B. Mix Design Properties:
 - 1. Maximum water / cementitious ratio of 0.50.
 - 2. Minimum compressive strength at 28 days of 4,000 psi.
 - 3. Air content of 1.5% – 4.5% for 3/4 in. and 1 in. maximum aggregate size.
 - 4. Provide Cementitious Materials as Specified in Either:
 - a. ASTM C150 Type II – type F fly ash may be included as an option.
 - b. ASTM C595 Type IP – complies with moderate sulfate resistance option.
 - 5. Limit water-soluble, chloride-ion content in hardened concrete to 0.30%.
 - a. Test if total chloride-ion content of individual ingredients, calculated on the basis of concrete proportions, exceeds 0.30%.
 - b. Refer to this section for additional requirements.

SECTION 03 35 00 – CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Finishing Methods.
 - 2. Flatness Tolerances.
 - 3. Schedule of Concrete Finishes.
- B. Related Sections:
 - 1. Section 03 64 00 – Concrete Repair Crack Injection
 - 2. Section 09 90 00 – Painting and Protective Coatings

1.2 REFERENCES

- A. ACI (American Concrete Institute):
 - 1. 117 – Specification for Tolerances for Concrete Construction and Materials.
- B. ASTM International:
 - 1. E1155 – Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.

1.3 QUALITY ASSURANCE

- A. Mockup Panels for Architectural Wall Finishes:
 - 1. Construct as specified in Contract Documents to demonstrate wall finish types WF-3, WF-4, WF-5, or WF-6, if used on the project.
 - 2. Panel dimension 6 ft by 8 ft, minimum.
 - 3. Construct panel with the same materials, forming and curing methods as the final product.
- B. Flatwork Finisher:
 - 1. Unless otherwise permitted, there shall be at least one ACI-certified Flatwork Finisher on the finishing crew. An equivalent certification shall be considered.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONCRETE WALL FINISHES

- A. Type WF-1 (Rough-form Finish):
 - 1. Patch tie holes.
 - 2. Chip or rub off projections over 1/2 in.
 - 3. Leave surfaces with the texture imparted by the forms.
 - 4. Repair defective areas.
 - 5. Inject cracks per Section 03 64 00 – Concrete Repair Crack Injection.
- B. Type WF-2 (Smooth-form Finish):
 - 1. Patch tie holes.
 - 2. Grind off projections level to surface.
 - 3. Repair defective areas to provide smooth uniform appearance.
 - 4. Inject cracks per Section 03 64 00 – Concrete Repair Crack Injection.

- C. Type WF-3 (Smooth Rubbed Wall Finish):
 - 1. Water cure only for this finish type.
 - 2. Remove forms as early as permitted and patch as required.
 - 3. Produce finish with one day of removing forms.
 - 4. Wet surface and rub with carborundum brick or abrasive of equal quality until uniform color and texture are produced.
 - 5. Use no cement grout other than the paste drawn from the concrete itself.
 - 6. Float or brush produced paste uniformly over surface.
 - 7. Continue water cure for the required time as soon as water shall NOT erode the rubbed surface.
- D. Type WF-4 (Grout-cleaned Rubbed Wall Finish):
 - 1. Meet requirements of WF-3, 1 – 3.
 - 2. Mix grout consisting of one-part Portland cement and 1 1/2 parts fine sand with enough water to produce the consistency of thick paint – match color of surrounding concrete.
 - 3. Wet surface of concrete sufficiently to prevent absorption of water from grout and apply uniformly over surface.
 - 4. Scrub grout into voids and remove excess grout.
 - 5. When the grout whitens from drying, rub the surface with clean burlap.
 - 6. Continue to water cure until the curing period is complete.
- E. Type WF-5 (Architectural Fractured Fin Wall Finish):
 - 1. Form with appropriate form liner.
 - 2. Patch tie holes.
 - 3. Break off tips of ridges with light bush-hammering, or other approved process.
 - 4. For consistency of finish, use the same person or people to complete any given structure.
- F. Type WF-6 (Architectural Abrasive Blast Wall Finish):
 - 1. Repair cracks before blasting.
 - 2. Abrasives shall be clean silica sand free of foreign materials.
 - 3. Concrete shall have achieved at least 50% of specified strength before blasting.
 - 4. All surfaces to have the same blast finish shall be worked when the concrete is the same age.
 - 5. Unless otherwise specified, blasting shall expose fine aggregate with occasional exposure of coarse aggregate, NOT to exceed a reveal of 1/16 in.
 - 6. When abrasive grit contains water for dust abatement, wash debris from wall before drying occurs.

3.2 CONCRETE SLAB FINISHES

- A. Type SF-1 (Float Slab Finish):
 - 1. Screed slab with straightedges to create surface at required finish plane.
 - 2. Float once bleedwater sheen has disappeared and the surface has stiffened sufficiently to permit the operation.
 - 3. Remove laitance and clean surface.
- B. Type SF-2 (Steel Trowel Slab Finish):
 - 1. Float surface per SF-1.
 - 2. Hand trowel to produce smooth dense surface, free of trowel marks.
 - 3. For air-entrained slabs, provide light steel trowel finish, (two troweling).
 - 4. For non-air-entrained slabs, provide hard steel trowel finish (ringing sound from the trowel).
- C. Type SF-3 (Broomed Slab Finish):
 - 1. Finish per SF-2, light steel trowel finish, then draw a fine-hair broom lightly across the surface.

2. Broom in consistent direction.
3. For inclined slabs, broom perpendicular to slope.

- D. Type SF-4 (Sidewalk Slab Finish):
1. Use broomed finish per SF-3.
 2. Slope walks 1/4 in. per foot away from structures, unless shown otherwise.
 3. Broom surface at right angles to the direction of traffic.

3.3 CONCRETE SLAB TOLERANCES

- A. Thickness:
1. Maximum minus 1/4 in. or plus 1/2 in. from thickness and elevation shown.
- B. Slab Flatness and Levelness:
1. Finish floor tolerances shall be measured as specified in ASTM E1155.
 2. Levelness tolerances shall NOT apply to inclined or cambered surfaces.
 3. Levelness tolerances shall be measured within 72 hrs. of concrete placement.
 4. Flatness F_F and Levelness F_L numbers for slabs NOT designated as Flat Slabs:
 - a. Minimum Overall $F_F = 20$
Minimum Local $F_F = 15$
 - b. Minimum Overall $F_L = 15$
Minimum Local $F_L = 10$
 5. Flatness F_F and Levelness F_L numbers for slabs designated as Flat Slabs:
 - a. Minimum Overall $F_F = 30$
Minimum Local $F_F = 15$
 - b. Minimum Overall $F_L = 20$
Minimum Local $F_L = 10$

3.4 SCHEDULE OF CONCRETE FINISHES

- A. Exterior Wall Surfaces:
1. Below grade – WF-1.
 2. Above grade, exposed – WF-2.
 3. Above grade, covered – WF-1.
- B. Interior Wall Surfaces:
1. Covered water-holding structures, NOT coated – WF-1.
 2. Open top water-holding structures, NOT coated – WF-2.
 3. Water-holding structures, coated – WF-2 and Section 09 90 00 – Painting and Coating.
 4. Dry areas, NOT coated – WF-2.
 5. Dry areas, coated – WF-2 and Section 09 90 00 – Painting and Coating.
- C. Exterior Slabs:
1. Roof slab, NOT covered – SF-3.
 2. Roof slab, covered (roofing material) – SF-2.
 3. Water-holding base slabs – SF-2.
 4. Top of footing – SF-1.
 5. Stairs and landings – SF-3.
 6. Sidewalks – SF-4.
- D. Interior Slabs:
1. Dry areas – SF-2.
 2. Slabs to receive carpet or resilient flooring – SF-2.
 3. Slabs to receive mortar bed for tile – SF-1.
 4. Hydraulic channels – SF-2.

E. Beams and Columns:

1. As specified in instructions for similar areas for slabs and walls.

END OF SECTION

SECTION 03 39 00 – CONCRETE CURING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Curing Methods.
 - 2. Curing Products.

1.2 REFERENCES

- A. ASTM International:
 - 1. C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- B. American Concrete Institute:
 - 1. 308.1 – Specification for Curing Concrete.
- C. NSF International:
 - 1. 61 – Drinking Water Components – Health Effects.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Manufacturer's Product Data:
 - 1. Curing Compound.
 - 2. Evaporation Retardant.
 - 3. Penetrating Water Repellant Sealer.
- C. Curing Methods:
 - 1. For each type of element in the facility such as slabs, walls, beams, or columns.

1.4 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Curing Compound:
 - 1. Water-based, high-solids, white pigmented, nonyellowing curing compound meeting the requirements of ASTM C309, Type 2, Class A.
 - 2. Manufacturers:
 - a. Euclid Chemical; Kurez VOX White Pigmented.
 - b. WR Meadows; 1640 – White.
 - c. Vexcon; Certi-Vex Envio Cure White.
- B. Evaporation Retardant:
 - 1. Manufacturers:
 - a. BASF; MasterKure ER 50.
 - b. Euclid Chemical; Eucobar.

- C. Penetrating Water Repellant Sealer:
 - 1. Water-based, single component, silane/siloxane, penetrating, clear water repellant sealer.
 - 2. Manufacturers:
 - a. BASF; MasterProtect H 400.
 - b. Euclid Chemical; Baracade WB 244.

PART 3 - EXECUTION

3.1 CONCRETE CURING

- A. General:
 - 1. Cure all concrete per project specifications and ACI 308.1.
 - 2. Use only water curing procedures where surfaces are to receive paint or other coatings.
 - 3. Use only water curing procedures on potable water structures.
 - 4. If the result of the 7-day concrete strength test is less than 50 percent of the specified 28-day strength, extend the moist curing period for an additional 7 days.
 - 5. Protect concrete from freezing during curing period.
- B. Use one of the curing methods below as approved by the Engineer:
 - 1. Vertical Surfaces:
 - a. Method 1 – leave concrete forms in place and keep surfaces of forms and concrete wet for 7 days.
 - b. Method 2 – apply curing compound, where allowed, immediately after removal of forms.
 - 2. Horizontal Surfaces:
 - a. Method 1 – water pond surface for 7 days.
 - b. Method 2 – continuously sprinkle surface for 7 days.
 - c. Method 3 – cover surface with material that will retain moisture such as burlap or cotton mats, sand or sawdust and keep continuously wet for 7 days.
 - d. Method 4 – apply curing compound, where allowed, immediately after final finishing.
- C. All slabs for structures defined as Environmental Structures per ACI 350 – Code Requirements for Environmental Engineering Concrete Structures shall be cured per the Horizontal Surfaces Methods 1, 2 or 3.

3.2 EVAPORATION RETARDANT APPLICATION

- A. Use when environmental conditions will cause rapid drying of the concrete surface. DO NOT use on potable water structures unless NSF 61 approved.
- B. Apply and reapply as required per manufacturer's written instructions.

3.3 PENETRATING WATER REPELLENT SEALER APPLICATION

- A. Apply as specified in Drawings.
- B. Water cure concrete to receive sealer. DO NOT use membrane curing compounds. Keep surface clean and unpainted.
- C. Apply per manufacturer's recommendations for coverage and curing time.

END OF SECTION

SECTION 03 62 00 – NON–SHRINK GROUTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cementitious non-shrink grout.
 - 2. Epoxy non-shrink grout.

1.2 REFERENCES

- A. ASTM International:
 - 1. C307 – Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts and Monolithic Surfacing.
 - 2. C579 – Standard Test Methods for Compressive Grout Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes.
 - 3. C882 – Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 - 4. C939 – Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - 5. C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product data and manufacturer's written instructions.
- C. Forming method for fluid grout placements under machinery base plates.
- D. Curing methods.
- E. Qualifications of grout installers for specific grout type(s) selected.

1.4 QUALITY ASSURANCE

- A. Evaluation and Acceptance of Non-Shrink Grout:
 - 1. Inspect the concrete substrates and formwork for conformance with the manufacturer's recommendations.
 - 2. Make three 2 in³ for every 25 ft³ of grout used to perform flow cone tests per ASTM C939.
 - 3. An independent testing laboratory shall prepare, store, cure, and test cubes per ASTM C1107.
 - 4. Grout cubes shall meet specified strength requirements – grout that fails strength test shall be removed and replaced at no additional cost to the Owner.
- B. Evaluation and Acceptance of Epoxy Grout:
 - 1. Inspect the concrete substrates and formwork for conformance with the manufacturer's recommendations.
 - 2. Verify that the consistency of the epoxy grout mix is appropriate for proper field placement at the installed temperatures.
 - 3. Record that the "pot life" of the epoxy grout has NOT been exceeded.
 - 4. A set of (3) shall be made for testing at 7 days per ASTM C579.
 - 5. Grout cubes shall meet specified strength requirements – grout that fails strength test shall be removed and replaced at no additional cost to the Owner.

- C. Qualification of Grout NOT Listed Herein
 - 1. Provide independent laboratory test results conducted within the last 18 months.

1.5 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 CEMENTITIOUS NON-SHRINK GROUT

- A. Use For:
 - 1. Column baseplates
 - 2. Precast joints
 - 3. Machine bases 25 hp or less
 - 4. Tank foundations
 - 5. Form tie and through bolt patching
- B. Shall Have the Following Properties:
 - 1. Ready to use, requiring only the addition of water.
 - 2. Nonmetallic and non-gas generating.
 - 3. Test as specified in ASTM C1107.
 - 4. Fluid consistency as specified in ASTM C939.
- C. Manufacturers and Products:
 - 1. BASF Building Systems; MasterFlow 928
 - 2. Five Star Products; Five Star Fluid Grout 100
 - 3. Euclid Chemical Co.; Hi Flow Grout

2.2 EPOXY GROUT

- A. Use For:
 - 1. Machine bases over 25 hp
 - 2. Machine baseplates that are anticipated to have vibration or thermal movement.
- B. Shall Have the Following Properties:
 - 1. Premeasured, prepackaged system.
 - 2. 100 percent solids two-component epoxy resin system.
 - 3. Flowable, noncorrosive, moisture insensitive.
 - 4. Minimum compressive strength per ASTM C579 of 9,500 psi at 7 days, 11,000 psi fully cured.
 - 5. Minimum bond strength per ASTM C882 of 2,000 psi.
 - 6. Minimum tensile strength per ASTM C307 of 2,000 psi.
 - 7. Minimum working time of 1.0 hours at 70°F.
- C. Manufacturers and Products:
 - 1. Euclid Chemical Co; E³ Flowable
 - 2. BASF Building Systems; MasterFlow 648
 - 3. Five Star Products, Inc.; DP Epoxy Grout

PART 3 - EXECUTION

3.1 GENERAL

- A. All areas to be grouted shall be clean and free of oil, grease, dirt, and contaminants. All metal components in contact with grout shall be free of rust, paint, and oils.
- B. All concrete slabs shall be fully cured for a minimum of 28 days. Concrete shall be in saturated surface dry condition when placing grout.
- C. Machinery and Tank Foundations:
 - 1. Prepare concrete surface by sandblasting or chipping to remove loose material. Create surface roughness per manufacturer's instructions.
 - 2. Form with watertight forms at least 2 in. higher than the bottom of the plate. Treat any form materials that could absorb water.
 - 3. Place grout at one edge and flow to the opposite edge, if possible. Otherwise, create air vents in plate to prevent air entrapment.

3.2 MIXING AND PLACING

- A. Grout shall be mixed with a paddle-type or other mechanical mixer. DO NOT mix more grout than can be placed within the manufacturer's allotted work time.
- B. Place grout immediately after mixing at a temperature range between 45°F – 75°F. Place grout per manufacturer's written instructions.

3.3 CURING

- A. Per manufacturer's written instructions.

END OF SECTION

SECTION 03 63 00 – CONCRETE DOWELING – ADHESIVE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work required for furnishing concrete doweling – adhesive.
- B. Related Sections:
 - 1. Section 03 20 00 – Concrete Reinforcing

1.2 REFERENCES

- A. ANSI (American National Standards Institute)
- B. ASTM International:
 - 1. C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - 2. E488 – Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
- C. ICC (International Code Council):
 - 1. IBC (International Building Code).
 - 2. Evaluation Services Reports.
- D. NSF International:
 - 1. 61 – Drinking Water System Components – Health Effects.

1.3 DEFINITIONS

- A. ICC Evaluation Services Report:
 - 1. Published by ICC for products provided by concrete adhesive anchor manufacturers.
- B. Special Inspection:
 - 1. As defined in the ICC IBC and as specified in the Supplement located at the end of Section 01 40 00 – Quality Requirements.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Action Submittals:
 - 1. Product Data: Manufacturer's catalog information.
- C. Informational Submittals:
 - 1. Manufacturer's instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
 - 2. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.

1.5 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: At least three similar projects with same products within last 3 years.
 - 2. Installer: Trained and certified by manufacturer.

- B. Adhesive shall be certified as meeting NSF 61 for use in potable water structures where required.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store adhesive components as specified in manufacturer's written instructions.

1.7 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Adhesive:
 - 1. Approved by an ICC Evaluation Services Report or equal for conformance to IBC requirements for doweling of steel reinforcing bars in cracked concrete.
 - 2. Suitable for long-term loads as well as for wind and seismic loads.
 - 3. Meet requirements of ASTM C881.
 - 4. Disposable, Self-Contained Cartridge System:
 - a. Capable of dispensing both components in proper mixing ratio.
 - b. Fit into manually or pneumatically operated caulking gun.
 - 5. For Potable Water Structures:
 - a. Adhesive shall be acceptable for use by NSF 61.
 - 6. Manufacturers and Products:
 - a. Hilti, Inc.
Tulsa, OK
HIT-RE 500 V3 (ESR-3814)
or
HIT-HY 200 (ESR-3963) Adhesive
 - b. DeWalt Industrial Tool Co.
Towson, MD
PURE110+ Epoxy (ESR-3298).
 - c. Simpson Strong-Tie Co., Inc.
Pleasanton, CA
SET-3G Epoxy Adhesive (ESR-2508 for concrete)
or
(IAMPO UES ER-265 for masonry)
- B. Mixing Nozzles:
 - 1. Disposable manufactured in several sizes to accommodate size in reinforcing dowels.
- C. Reinforcing Dowels:
 - 1. As specified in Section 03 20 00 – Concrete Reinforcing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Drilling Equipment:
 - 1. Electric or pneumatic rotary type with medium or light impact. Hollow drills with flushing air systems are preferred.
 - 2. Where edge distances are less than 2 in, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

- B. Hole Diameter:
 - 1. As recommended by the manufacturer.
- C. Obstructions in Drill Path:
 - 1. When existing steel reinforcement is encountered during drilling, obtain Engineer approval for proposed fix.
- D. Doweling:
 - 1. Install per details shown on Drawings and as specified in adhesive manufacturer's instructions.
- E. Adhesive:
 - 1. Install as specified in written manufacturer's instructions.
 - 2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

3.2 FIELD QUALITY ASSURANCE AND QUALITY REQUIREMENTS

- A. Proof Loading:
 - 1. To be performed where continuous inspection of concrete dowels is required.
 - 2. Testing shall be performed by an Independent Testing Agency.
 - 3. Proof loading to be performed only after adhesive has achieved proper cure per manufacturer's requirements.
 - 4. Testing shall be conducted on a minimum of 10% of installed dowels, with a minimum of two tension tests. A minimum of two cartridges per box or packaging unit shall be tested.
 - 5. Testing shall be conducted as specified in ASTM E488.
 - 6. Failure of dowel bar or failure within base concrete shall cause dowel to be rejected. For each rejected dowel, two additional dowels shall be tested. Replace rejected dowels as approved by Engineer.
- B. Quality Assurance:
 - 1. As specified in IBC Chapter 17 requirements
 - 2. Provided in the Supplement located at end of Section 01 40 00 – Quality Requirements.

END OF SECTION

SECTION 03 64 00 – CONCRETE REPAIR CRACK INJECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete

1.2 REFERENCES

- A. ASTM International:
 - 1. D638 – Standard Test Method for Tensile Properties of Plastics.
 - 2. D648 – Standard Test Method for Deflection of Plastics Under Flexural Load.
 - 3. D695 – Standard Test Method for Compressive Properties of Rigid Plastics.
 - 4. D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- B. NSF (National Sanitation Foundation):
 - 1. Standard 61 – Standard for Drinking Water System Components – Health Effects.

1.3 DEFINITIONS

- A. Defective Area:
 - 1. Per Section 03 30 00 – Cast-In-Place Concrete.
- B. Large Cracks:
 - 1. Wider than 0.015 in.
- C. Small Cracks:
 - 1. Width equal to 0.015 in. or less.
- D. Hydraulic Structure:
 - 1. Structure designed to contain liquid and/or keep liquid from entering.
- E. Leak/Leakage:
 - 1. Crack showing presence of moisture or recent efflorescence.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Physical and chemical properties for epoxy adhesives.
 - 2. Technical data for metering, mixing, and injection equipment.
- C. Information Submittals:
 - 1. Manufacturer's recommended surface preparation procedures and application instructions for epoxy adhesives.
 - 2. Installation instructions for repairing core holes with epoxy grout.
 - 3. Manufacturer's Certificate of Compliance: Certified test results for each batch of epoxy adhesive.
 - 4. Statements of Qualification for Epoxy Adhesive:
 - a. Manufacturer's site representative.
 - b. Injection applicator.

- c. Injection pump operating technician.
- 5. Epoxy adhesive two component ratio and injection pressure test records for concrete crack repair work.
- 6. Certificate of NSF 61 compliance, if required.

1.5 QUALITY ASSURANCE

- A. Qualifications for Epoxy Injection Staff:
 - 1. Manufacturer's Site Representative:
 - a. Capable of instructing successful methods for restoring concrete structures utilizing epoxy injection process.
 - b. Understands and can explain technical aspects of correct material selection and use.
 - c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
 - 2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
 - a. Licensed and certified by epoxy Manufacturer.
 - b. Minimum 3 years of experience in successful epoxy injection for at least 10,000 LF of successful crack injection including 2,000 LF of wet crack injection to stop water leakage.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping:
 - 1. Package adhesive material in new sealed containers and label with following information:
 - a. Manufacturer's name.
 - b. Product name and lot number.
 - c. ANSI Hazard Classification (formerly SPI Classification).
 - d. ANSI recommended precautions for handling.
 - e. Mix ratio by volume.
- B. Storage and Protection:
 - 1. Store adhesive containers at ambient temperatures between 32 – 120°F.

1.7 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Epoxy Manufacturers and Products:
 - 1. Sika Corp., Lyndhurst, NJ; Sikadur 35 Hi-Mod LVPL.
 - 2. Euclid Chemical Co., Cleveland, OH; Eucopoxy injection resin.

2.2 EPOXY ADHESIVE

- A. Two-component A and B structural epoxy adhesive for injection into cracks or other voids in concrete structures for bonding or grouting.
- B. Adhesive Properties:
 - 1. When cured for 7 days at 77°F plus or minus 3°F and conditioned at test temperature 12 hrs. prior to test, unless otherwise specified.

	Test Method	Large Cracks	Small Cracks
Ultimate Tensile Strength (psi)	ASTM D638	8,000 min.	5,000 min.
Tensile Elongation @ Break (percent)	ASTM D638	3.7 max.	3.7 max.
Flexural Strength (psi)	ASTM D790	10,000 min.	10,000 min.
Flexural Modulus (psi)	ASTM D790	5.5 x10 ⁵ min.	4.5 x10 ⁵ min.
Compressive Yield Strength (psi)	ASTM D695*	15,000 min.	12,000 min.
Compressive Modulus (psi)	ASTM D695*	3.8 x10 ⁵ min.	3.8 x10 ⁵ min.
Heat Deflection Temperature	ASTM D648*	130°F min.	140°F min.
Slant Shear Strength: (5,000 psi Compressive Strength Conc.)	AASHTO T 237**		
Cured 3 days @ 40°F – Wet Concrete			3,500 psi min
Cured 1 day @ 77°F – Dry Concrete			5,000 psi min.
Cured 3 days @ 77°F plus or minus 3°F			5,000 psi min.
<i>*Cure test specimens so that peak exothermic temperature of adhesive does NOT exceed 100°F</i>			
<i>**See referenced specifications for preparation method of test specimens</i>			

2.3 SURFACE SEAL

- A. Sufficient strength and adhesion for holding injection fittings firmly in-place, and to resist pressures preventing leakage during injection.
- B. Capable of removal after injection adhesive has cured.

PART 3 - EXECUTION

3.1 GENERAL

- A. Structurally repair cracks in structures as specified in Section 03 30 00 – Cast-In-Place Concrete.
- B. Cracks:
 - 1. Repair by injection of epoxy adhesive.

3.2 PREPARATION

- A. Free cracks from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.
- B. Clean cracks as specified in epoxy adhesive manufacturer's instructions.
- C. Clean surfaces adjacent to cracks from dirt, dust, grease, oil, efflorescence, and other foreign matter detrimental to bond of surface seal system.
- D. DO NOT use acids and corrosives for cleaning, unless neutralized prior to injecting epoxy.

3.3 APPLICATION

- A. Sealing:
 - 1. Apply surface seal as specified in Manufacturer's instructions to designated crack face prior to injection. Seal surface of crack to prevent escape of injection epoxy.
- B. Entry Ports:
 - 1. Establish openings for epoxy entry in surface seal along crack.

2. Determine space between entry ports equal to thickness of concrete member to allow epoxy to penetrate to the full thickness of the wall.
3. Provide a means to prevent concrete dusts and fines from contaminating the crack or ports when drilling.
4. Space entry ports close together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:
 - a. Cracks extend entirely through wall.
 - b. Backfill of walls on one side.
 - c. Difficult to excavate behind wall to seal both crack surfaces.
5. Core drill to verify epoxy depth where only one side of wall is exposed.

C. Epoxy Injection:

1. Store epoxy at minimum of 70 °F.
2. Start injection into each crack at lowest elevation entry port.
3. Continue injection at first port until adhesive begins to flow out of port at next highest elevation.
4. Plug first port and start injection at second port until adhesive flows from next port.
5. Inject entire crack with same sequence.

D. Finishing:

1. Cure epoxy adhesive after cracks have been completely filled to allow surface seal removal without draining or runback of epoxy material from cracks.
2. Remove surface seal from cured injection adhesive.
3. Finish crack face flush with adjacent concrete.
4. Indentations or protrusions caused by placement of entry ports are NOT acceptable.
5. Remove surface seal material and injection adhesive runs and spills from concrete surfaces.

3.4 EQUIPMENT

- A. Portable, positive displacement type pumps with in-line metering to meter and mix two adhesive components and inject mixture into crack.
- B. Discharge Pressure: Automatic pressure controls capable of discharging mixed adhesive at pressures up to 200 psi, $\pm 5\%$, and able to maintain pressure.
- C. Automatic Shutoff Control: Provide sensors on both Component A and B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.
- D. Proportioning Ratio Tolerance: Maintain epoxy adhesive Manufacturer's prescribed mix ratio within a tolerance of plus or minus 5% by volume at discharge pressure (p) to 160 psi.
- E. Ratio/Pressure Check Device:
 1. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.
 2. Pressure gauge capable of sensing pressure behind each valve.

3.5 FIELD QUALITY REQUIREMENTS

A. Epoxy Adhesive Two Component Ratio Tests:

1. Disconnect mixing head and pump two adhesive components simultaneously through ratio check device.
2. Adjust discharge pressure to 160 psi for both adhesive components.
3. Simultaneously discharge both adhesive components into separate calibrated containers.

4. Compare amounts simultaneously discharged into calibrated containers during same time period to determine mix ratio.
 5. Complete test at 160 psi discharge pressure and repeat procedure for 0 psi discharge pressure.
 6. Run ratio test for each injection unit at beginning and end of each injection workday, and when injection work has stopped for more than 1 hr.
 7. Document and maintain complete accurate records of ratios and pressure checks.
- B. Injection Pressure Test:
1. Disconnect mixing head of injection equipment and connect two adhesive component delivery lines to pressure check device.
 2. Pressure Check Device:
 - a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
 - b. Pressure gauge capable of sensing pressure buildup behind each valve.
 3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
 4. Stop pumps and observe pressure; DO NOT allow pressure gauge to drop below 150 psi within 3 minutes.
 5. Run pressure test for each injection equipment unit:
 - a. Beginning and end of each injection workday.
 - b. When injection work has stopped for more than 45 minutes.
 6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.
- C. Crack Injection Tests:
1. Initial Cores:
 - a. 4 in. diameter for full crack depth taken from Engineer selected locations.
 - b. Take three cores in first 100 LF of crack repaired and one core sample for each 500 LF thereafter.
 2. Provide suitable containers for storage, curing, and transportation of test specimens.
 3. Methods of Testing Cores:
 - a. Penetration: Visual examination.
 - b. Bond Strength/Compression Test: Concrete failure prior to adhesive failure.
 4. Test Requirements:
 - a. Penetration: Minimum of 90% of crack shall be full of epoxy adhesive.
 - b. Bond Strength/Compression Test: Concrete failure before adhesive failure, or 6,500 psi with no failure of either concrete or adhesive.
 5. Evaluation and Acceptance of Tests:
 - a. If initial cores pass tests as specified, epoxy adhesive injection Work at area represented by cores will be accepted.
 - b. If initial cores fail either by lack of penetration or bond strength, crack repair Work shall NOT proceed further until areas represented by cores are reinjected or repaired and retested for acceptance.
 - c. Obtain verifying core samples, number and location as selected by Engineer, after rework of areas represented by failed initial core is complete.
 6. Core Hole Repair:
 - a. Correct Work as result of testing upon notification from Engineer.
 - b. Refill initial and verifying core holes with an epoxy grout tamped and rodded in-place to form a dense fill.
 - c. Finish surface to blend with adjacent concrete.

END OF SECTION

DIVISION 9
FINISHES

SECTION 09 96 00 – HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. High-performance coatings and special preparation for surfaces of piping and process equipment, and other surfaces in contact with process water and wastewater.
- B. Related Sections:
 - 1. Section 09 90 00 – Painting and Coating.

1.2 REFERENCES

- A. Federal Specification Unit:
 - 1. FS A-A-3054 – Paint, Heat Resisting (204°C).
 - 2. FS AA-3120A – Paint: For Swimming Pools.
 - 3. FS TT-C-555B – Coating, Textured (for Interior and Exterior Masonry Surfaces).
 - 4. FS TT-P-28H – Paint, Aluminum, Heat Resisting.
- B. Master Painters Institute:
 - 1. MPI – Approved Products List.
 - 2. MPI – Architectural Painting Manual.
- C. SSPC (The Society for Protective Coatings):
 - 1. SSPC – Painting Manual, Volume 2: Systems and Specifications.
 - 2. SSPC-Paint 16 – Coal Tar Epoxy-Polyamide Black (or Dark Red).
 - 3. SSPC-SP 2 – Hand Tool Cleaning.
 - 4. SSPC-SP 3 – Power Tool Cleaning.
 - 5. SSPC-SP 5 – White Metal Blast Cleaning.
 - 6. SSPC-SP 6 – Commercial Blast Cleaning.
 - 7. SSPC-SP 7 – Brush-Off Blast Cleaning.
 - 8. SSPC-SP 10 – Near-White Metal Blast Cleaning.
 - 9. SSPC-SP 11 – Power Tool Cleaning to Bare Metal.
 - 10. SSPC-SP 13 – Concrete Surface Preparation.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Schedule of proposed coating materials.
 - 2. Schedule of surfaces to be coated with each coating material.
- C. Product Data:
 - 1. Submit manufacturer information indicating coating materials, performance ratings and description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips:
 - 2. Data Sheets:
 - a. For each paint system, furnish a Paint System Data Sheet (PSDS), the Manufacturer's Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system. The PSDS form is appended to the end of this section.

- b. Submit required information on a system-by-system basis.
 - c. Furnish copies of paint system submittals to the coating applicator.
 - d. Indiscriminate submittal of Manufacturer's literature only is not acceptable.
 - e. Regulatory requirements – Submit data concerning:
 - 1) Volatile organic compound limitations.
 - 2) Coatings containing lead compounds and PCBs.
 - 3) Abrasives and abrasive blast cleaning techniques, and disposal.
 - 4) NSF certification of coatings for use in potable water supply systems.
 - 3. Include MPI – Approved Products Lists with proposed products highlighted.
- D. Samples:
- 1. Submit two square drawdowns or brushouts of topcoat finish samples 8 in. by 8 in. in size, illustrating colors for selection. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.
- E. Manufacturer's Certificate:
- 1. Certify that products meet or exceed specified requirements.
- F. Manufacturer Instructions:
- 1. Submit special procedures, perimeter conditions requiring special attention.
 - 2. Include:
 - a. Special requirements for transportation and storage.
 - b. Mixing instructions.
 - c. Shelf life.
 - d. Pot life of material.
 - e. Precautions for applications free of defects.
 - f. Surface preparation.
 - g. Method of application.
 - h. Recommended number of coats.
 - i. Recommended dry film thickness (DFT) of each coat.
 - j. Recommended total dry film thickness (DFT).
 - k. Drying time of each coat, including prime coat.
 - l. Required prime coat.
 - m. Compatible and noncompatible prime coats.
 - n. Recommended thinners, when recommended.
 - o. Limits of ambient conditions during and after application.
 - p. Time allowed between coats (minimum and maximum).
 - q. Required protection from sun, wind, and other conditions.
 - r. Touchup requirements and limitations.
 - s. Minimum adhesion of each system submitted as specified in ASTM D 4541.
- G. Qualifications Statements:
- 1. Submit qualifications for manufacturer and applicator.
 - 2. Submit manufacturer's approval of applicator.
- 1.4 CLOSEOUT SUBMITTALS
- A. Section 01 77 00 – Closeout Procedures: Requirements for submittals.
- B. Operation and Maintenance Data:
- 1. Submit maintenance and cleaning requirements for coatings, repair, and patching techniques.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Section 01 77 00 – Closeout Procedures: Requirements for maintenance materials.
- B. Extra Stock Materials:
 - 1. Furnish 5 gal. of each color of each type of coating specified, for Owner's maintenance use.
 - 2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

1.6 QUALITY ASSURANCE

- A. MPI Standards:
 - 1. Comply with indicated MPI standards.
 - 2. Products: Listed in MPI – Approved Products List.
- B. Quality Assurance Submittals:
 - 1. Quality Assurance plan.
 - 2. Qualifications of coating applicator including List of Similar Projects and List of References substantiating experience.
 - 3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
 - 4. If the Manufacturer of finish coating differs from that of shop primer, provide both Manufacturers' written confirmation that materials are compatible.
 - 5. Manufacturer's written instructions and special details for applying each type of paint.
 - 6. Manufacturers' Certification of Proper Installation.
- C. Certifications:
 - 1. All paints and coatings to be used on this project comply with current federal, state, and local VOC regulations.
- D. Compatibility of coatings:
 - 1. Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.
- E. Services of coating manufacturer's representative:
 - 1. Arrange for coating manufacturer's representative to attend preinstallation conferences. Make periodic visits to the project site to provide consultation and inspection services during surface preparation and application of coatings, and to make visits to coating plants to observe and approve surface preparation procedures and coating application of items to be "shop primed and coated".

1.7 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this Section with minimum five years' experience.
- B. Applicator Qualifications:
 - 1. Company specializing in performing Work of this Section with minimum five years of experience applying specified type or types of coatings under conditions similar to those of the Work and approved by manufacturer.
 - 2. Provide qualifications of applicator and references listing 5 similar projects completed in the past 2 years.
 - 3. Manufacturer approved applicator when manufacturer has approved applicator program.

4. Approved and licensed by polymorphic polyester resin manufacturer to apply polymorphic polyester resin coating system.
5. Approved and licensed by elastomeric polyurethane (100% solids) manufacturer to apply 100% solids elastomeric polyurethane system.
6. Applicator of offsite application of coal tar epoxy shall have successfully applied coal tar epoxy on similar surfaces in material, size, and complexity as on the Project.

C. Regulatory requirements:

1. Comply with governing agencies regulations by using coatings that do not exceed permissible volatile organic compound limits and do not contain lead:
 - a. Do not use coal tar epoxy in contact with drinking water or exposed to ultraviolet radiation.
 - b. Perform surface preparation and painting as specified in recommendations of:
 - 1) Paint Manufacturer's instructions.
 - 2) SSPC-PA Guide No. 3, Guide to Safety in Paint Applications.
 - 3) Federal, state, and local agencies having jurisdiction.

1.8 MOCKUPS

- A. Prior to start of surface preparation, furnish a 4 in. by 4 in. steel panel for each grade of sandblast specified in this section, prepared to specified requirements.
- B. Provide panel representative of the steel used; prevent deterioration of surface quality.
- C. Upon approval of Engineer, panel to be reference source for inspection.
- D. Unless otherwise specified, before painting work is started, prepare minimum 8 in. by 10 in. samples with type of paint and application specified on similar substrate to which paint is to be applied.
- E. Furnish additional samples as required until colors, finishes, and textures are approved.
- F. Approved samples to be the quality standard for final finishes.
- G. Field samples:
 1. Prepare and coat a minimum 100 ft² area between corners or limits such as control or construction joints of each system.
 2. Approved field sample may be part of Work.
 3. Obtain approval before painting other surfaces.
- H. Section 01 40 00 – Quality Requirements: Requirements for mockup.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver new unopened containers.
- B. Do not deliver materials aged more than 12 months from manufacturing date.
- C. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- D. Container Labeling:
 1. Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

- E. Inspection:
 - 1. Accept materials on Site in manufacturer's sealed and labeled containers.
 - 2. Inspect for damage and to verify acceptability.
- F. Store materials in ventilated area and as specified in manufacturer instructions.
- G. Remove unspecified and unapproved paints from Project site immediately.
- H. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection as specified in manufacturer instructions.
 - 3. Take precautions to prevent fire and spontaneous combustion.
- I. Shipping:
 - 1. Where precoated items are to be shipped to the site, protect coating from damage. Batten coated items to prevent abrasion.
 - 2. Use nonmetallic or padded slings and straps in handling.

1.10 AMBIENT CONDITIONS

- A. Section 01 50 00 – Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Minimum Conditions:
 - 1. Do not install materials when temperature is below 55°F or above 90°F.
- C. Subsequent Conditions:
 - 1. Maintain above temperature range, 24 hours before, during, and 72 hours after installation of coating.
- D. Provide lighting level of 80 fc, measured mid-height at substrate surface.
- E. Restrict traffic from area where coating is being applied or is curing.

1.11 WARRANTY

- A. Section 01 77 00 – Closeout Procedures: Requirements for warranties.
- B. Furnish Manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of work specified in this Specification section found defective during a period of 1 year after the date of Substantial Completion.
- C. Contractor and paint Manufacturer shall jointly and severally furnish guarantee.
- D. Include coverage for bond to substrate, and degradation of chemical resistance.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

- A. Coating materials shall be especially adapted for use in water and wastewater treatment plants.

- B. Coating materials used in contact with potable water supply systems shall be certified to NSF 61.

2.2 HIGH-PERFORMANCE COATINGS

A. Manufacturers:

1. High Performance Coatings Manufacturers (Choose ONE):
 - a. Carboline: Carboline, St. Louis, MO.
 - b. Ceilcote: International Protective Coatings, Berea, OH.
 - c. Dampney: The Dampney Company, Everett, MA.
 - d. Devoe: International Protective Coatings, Louisville, KY.
 - e. Dudick: Dudick, Inc., Streetsboro, OH.
 - f. GET: Global Eco Technologies, Pittsburg, CA.
 - g. Henkel: Henkel North America, Madison Heights MI.
 - h. IET: Integrated Environmental Technologies, Santa Barbara, CA.
 - i. Induron Protective Coatings, Birmingham, AL.
 - j. PPG Amercoat: PPG Protective & Marine Coatings, Brea, CA.
 - k. Raven Lining Systems, Broken Arrow, OK.
 - l. Rustoluem : Rustoleum Corp., Sommerset, NJ.
 - m. Sanchem: Sanchem, Chicago, IL.
 - n. Sauereisen: Sauereisen, Pittsburgh, PA
 - o. Superior: Superior Environmental Products, Inc., Addison, TX.
 - p. S-W: Sherwin-Williams Co., Cleveland, OH.
 - q. Tnemec: Tnemec Co., Kansas City, MO.
 - r. Wasser: Wasser High Tech Coatings, Kent, WA.
 - s. ZRC: ZRC Worldwide Innovative Zinc Technologies, Marshfield, MA.
 - t. Or Approved Equal.
2. Preparation And Pretreatment Materials:
 - a. Metal pretreatment (Choose ONE):
 - 1) Henkel: Galvaprep 5.
 - 2) International: AWLGrip Alumiprep 33.
 - 3) Or Approved Equal.
 - b. Surface cleaner and degreaser (Choose ONE):
 - 1) Carboline Surface Cleaner No.3.
 - 2) Devoe: Devprep 88.
 - 3) S-W: Clean and Etch.
 - 4) Or Approved Equal.
3. Coating Materials:
 - a. Alkali resistant bitumastic (Choose ONE):
 - 1) Carboline: Bitumastic No. 50.
 - 2) Sherwin Williams: Targuard.
 - 3) Wasser: MC-Tar.
 - 4) Or Approved Equal.
 - b. Wax coating:
 - 1) Sanchem: No-Ox-Id A special.
 - 2) Or Approved Equal.
 - c. High solids epoxy (self-priming) not less than 72% solids by volume (Choose ONE):
 - 1) Carboline: Carboguard 891.
 - 2) Devoe: Bar Rust 233H.
 - 3) Induron: PE-70.
 - 4) PPG Amercoat: Amerlock 2.
 - 5) S-W: Macropoxy 646.
 - 6) Tnemec: HS Epoxy Series N140.
 - 7) Or Approved Equal.

- d. Aliphatic or aliphatic-acrylic polyurethane (Choose ONE):
 - 1) Carboline: Carbothane 134 VOC.
 - 2) Devoe: Devthane 379.
 - 3) PPG Amercoat: Amershield VOC.
 - 4) S-W: High Solids Polyurethane [CA].
 - 5) Tnemec: Endura-Shield II Series 1075 (U).
 - 6) Or Approved Equal.
- e. Epoxy Novolac: Multi-component aggregate-filled epoxy system specifically designed for exposure to municipal wastewater. (Choose ONE):
 - 1) Sauereisen: Sewergard No. 210, 210S, or 210GL.
 - 2) Carboline: Plasite 4550 S.
 - 3) Devoe: Devmat 100.
 - 4) Raven 410.
 - 5) Or Approved Equal.
- f. High temperature coating 150–350°F (Choose ONE):
 - 1) Carboline: Thermaline 4900.
 - 2) Dampney: Thermalox 245 Silicone – Zinc Dust.
 - 3) PPG Amercoat: Amerlock 2/400 GFK.
 - 4) Or Approved Equal.
- g. High temperature coating 400–1,000°F (dry) (Choose ONE):
 - 1) Carboline: Thermaline 4700.
 - 2) Dampney: Thermolox 230C Series Silicone.
 - 3) Devoe: HT-12, High Heat Silicone.
 - 4) Or Approved Equal.
- h. High temperature coating up to 1,400°F:
 - 1) Dampney: Thermalox 240 Silicone Ceramix.
 - 2) Or Approved Equal.
- i. Asphalt varnish: AWWA C 500.
- j. Protective coal tar:
 - 1) Not Acceptable.
- k. Coal tar epoxy:
 - 1) Not Acceptable.
- l. Coal tar:
 - 1) Where coal tar, coal tar epoxy, or coal tar mastic are specified or indicated on the Drawings, use coal tar epoxy substitute in their place. Coal tar shall not be allowed.
- m. Coal Tar Epoxy Substitute Manufacturer:
 - 1) Tnemec: Series 431.
 - 2) Or Approved Equal.
- n. Vinyl ester: Glass mat reinforced, total system 125 mils DFT. (Choose ONE):
 - 1) Carboline: Semstone 870.
 - 2) Ceilcote: 6640 Ceilcrete.
 - 3) Dudick: Protecto-Flex 800.
 - 4) Tnemec: Chembloc Series 239SC.
 - 5) Or Approved Equal.
- o. Elastomeric polyurethane, 100% solids, ASTM D16, Type V, (Urethane P):
 - 1) GET: Endura-Flex EF-1988.
 - 2) Or Approved Equal.
- p. Anti-slip floor coatings:
 - 1) PPG: SFT675.
- q. Concrete floor coatings (Choose ONE):
 - 1) Carboline: Semstone 140SL.
 - 2) Devoe: Devran 124.
 - 3) Dudick: Polymer Alloy 1000.
 - 4) Tnemec: Tnem-Glaze Series 282.
 - 5) Or Approved Equal.

- r. Waterborne acrylic emulsion (Choose ONE):
 - 1) S-W: DTM Acrylic B66W1.
 - 2) Tnemec: Tneme-Cryl Series 6.
 - 3) Or Approved Equal.
- s. Galvanizing Zinc Compound:
 - 1) ZRC: Cold Galvanizing Compound.
 - 2) Other Approved Equal.

2.3 COATING SYSTEMS

- A. Coatings:
 - 1. Description:
 - a. Complete multicoat systems formulated and recommended by manufacturer for intended applications and in indicated thicknesses.
 - b. Specified number of coats does not include primer or filler coat.
 - 2. Lead content: None.
 - 3. Chromium Content as Zinc Chromate or Strontium Chromate: None.
 - 4. Maximum VOC Content: As required by applicable regulations.
 - 5. Colors: As selected from manufacturer's standard colors or indicated on Drawings.
- B. System 1 Submerged Metals – Potable Water – High-Solids Epoxy Coating:
 - 1. Description: High-solids, two-component epoxy.
 - 2. Exposure: Moderate.
 - 3. Surface Prep: Abrasive Blast, or Centrifugal Wheel Blast (SP 5).
 - 4. Number of Coats: One.
 - 5. Finish: Low gloss.
 - 6. Minimum Solids Content: 78% by volume.
 - 7. Minimum Dry Film Thickness Per Coat: 6 mils.
 - 8. Primer: High Solids Epoxy (Self Priming).
- C. System 2 Submerged Metals – Domestic Sewage – High-Solids Epoxy Coating:
 - 1. Description: High-solids, two-component.
 - 2. Exposure: Severe.
 - 3. Surface Prep: Abrasive Blast, or Centrifugal Wheel Blast (SP 5).
 - 4. Number of Coats: Two.
 - 5. Finish: Low gloss.
 - 6. Minimum Solids Content: 100% by volume.
 - 7. Minimum Dry Film Thickness Per Coat: 30 mils.
 - 8. Primer: High Solids Epoxy – As recommended by painting system manufacturer.
- D. System 3: Exposed Metal – Highly Corrosive – Epoxy/Polyurethane Coating or Novolac Epoxy:
 - 1. Description: High-solids, two-component epoxy intermediate coat and solvent-based, two-component, pigmented polyurethane top coat.
 - 2. Exposure: Severe.
 - 3. Surface Prep: Abrasive Blast (SP 10).
 - 4. Number of Coats: Two.
 - 5. Finish: Semi-Gloss.
 - 6. Minimum Epoxy Solids Content: 78% by volume.
 - 7. Minimum Polyurethane Solids Content: 69% by volume.
 - 8. Minimum Dry Film Thickness Per Coat: 4 mils.
 - 9. Primer: As recommended by painting system manufacturer.
- E. System 4: Exposed Metal – Mildly Corrosive – Polyurethane Coating:
 - 1. Description: Solvent-based, two-component, pigmented polyurethane.
 - 2. Exposure: Moderate.
 - 3. Surface Prep: Abrasive Blast (SP 10).

4. Number of Coats: One.
5. Finish: Semi-Gloss.
6. Minimum Solids Content: 69% by volume.
7. Minimum Dry Film Thickness Per Coat: 3 mils.
8. Primer: As recommended by painting system manufacturer.

F. System 5: Buried Metal – General:

1. Standard Conditions
 - a. Description:
 - 1) Standard Hot Coal-Tar Enamel, or
 - 2) Coal-Tar Epoxy Substitute, or
 - 3) Tape Coat System.
 - b. Exposure: Moderate.
 - c. Surface Prep: Abrasive Blast (SP 10).
 - d. Number of Coats and Minimum Dry Film Thickness Per Coat:
 - 1) Standard Hot Coal-Tar Enamel: Conform to AWWA C203
 - 2) Coal-Tar Epoxy Substitute: Conform to AWWA C210
 - 3) Tape Coat System: Conform to AWWA C214
 - e. Primer: As recommended by painting system manufacturer.
2. For Acidic Soil, Brackish Water, High Bacteria
 - a. Description:
 - 1) Coal-Tar Epoxy Substitute, Double Felt
 - b. Exposure: Moderate.
 - c. Surface Prep: Abrasive Blast (SP 10).
 - d. Number of Coats and Minimum Dry Film Thickness Per Coat:
 - 1) AWWA C203, App. A, Sec. A1.5
 - e. Primer: As recommended by painting system manufacturer.
3. For Highly Abrasive Soil, Brackish Water
 - a. Description:
 - 1) Coal-Tar Epoxy Substitute, Fibrous Glass, or
 - 2) Tape Coat System.
 - b. Exposure: Moderate.
 - c. Surface Prep: Abrasive Blast (SP 10).
 - d. Number of Coats and Minimum Dry Film Thickness Per Coat:
 - 1) Coal-Tar Epoxy Substitute, Fibrous Glass: AWWA C203, App. A, Sec. A1.5
 - 2) Tape Coat System: AWWA C214 with Double Outer Wrap
 - e. Primer: As recommended by painting system manufacturer.

G. System 6: Moderate-Heat-Resistant Coating for Ferrous Metal (150°–400°F):

1. Description: Solvent-based, pigmented enamel, formulated for service up to 400°F.
2. Exposure: Moderate.
3. Surface Prep: Abrasive Blast (SP 10).
4. Number of Coats: One.
5. Minimum Dry Film Thickness Per Coat: 2 mils.
6. Primer: As recommended by painting system manufacturer.

H. System 7: High-Heat-Resistant Coating for Ferrous Metal (400°–1,000°F):

1. Description: Solvent-based, silicone type, aluminum coating, formulated for service up to 1,000°F.
2. Exposure: Severe.
3. Surface Prep: Abrasive Blast (SP 10).
4. Number of Coats: Two.
5. Minimum Solids Content: 46% by volume.
6. Minimum Dry Film Thickness Per Coat: 2 mils.
7. Primer: As recommended by painting system manufacturer.

- I. System 8: High-Heat-Resistant Coating for Ferrous Metal (1,000°–1,400°F):
 - 1. Description: Silicon ceramic matrix and thermally stable pigments., formulated for service up to 1,400°F.
 - 2. Exposure: Severe.
 - 3. Surface Prep: Abrasive Blast (SP 10).
 - 4. Number of Coats: Two.
 - 5. Minimum Dry Film Thickness Per Coat: 1.5 mils.
 - 6. Primer: As recommended by painting system manufacturer.
- J. System 10: Galvanized Metal Conditioning – Wash Primer:
 - 1. Description: Wash Primer or Coating Manufacturer's Recommendation.
 - 2. Exposure: Severe.
 - 3. Surface Prep: Solvent Clean (SP 1), followed by Hand Tool (SP 2), or Power Tool (SP 3).
 - 4. Number of Coats: One minimum, additional coats as required by exposure.
 - 5. Minimum Dry Film Thickness Per Coat: 0.4 mils.
- K. System 11: Galvanized Metal Conditioning – Zinc Primer:
 - 1. Description: Organic Zinc Rich or Coating Manufacturer's Recommendation.
 - 2. Exposure: Severe.
 - 3. Surface Prep: Solvent Clean (SP 1), followed by Hand Tool (SP 2), Power Tool (SP 3), or Brushoff Blast (SP 7).
 - 4. Number of Coats: One minimum, additional coats as required by exposure.
 - 5. Minimum Dry Film Thickness Per Coat: 3 mils.
- L. System 12: Skid-Resistant Walkway Surface Coatings:
 - 1. Description: Aggregated High Solids Epoxy for use on steel, wood, aluminum, brick, block, fiberglass, or concrete.
 - 2. Exposure: Moderate.
 - 3. Surface Prep: Brushoff Blast (SP 7) or Plastic Surface Preparation.
 - 4. Number of Coats: One.
 - 5. Minimum Solids Content: 100% by volume.
 - 6. Minimum Dry Film Thickness Per Coat: 30 mils.
 - 7. Primer: High Solids Epoxy – As recommended by painting system manufacturer.
 - 8. Aggregate Size: GL-400, grit size 20.
- M. System 13: Sliding Metal:
 - 1. Description: Wax coating.
 - 2. Surface Prep: Solvent Clean (SP 1), followed by Hand Tool (SP 2), Power Tool (SP 3), or Brushoff Blast (SP 7).
 - 3. Number of Coats: One.
 - 4. Minimum Dry Film Thickness Per Coat: 30 mils.
- N. System 14: Exposed PVC – Epoxy/Polyurethane Coating:
 - 1. Description: High-solids, two-component epoxy primer and solvent-based, two-component, pigmented polyurethane top coat.
 - 2. Exposure: Severe.
 - 3. Surface Prep: Brushoff Blast (SP 7) or Plastic Surface Preparation.
 - 4. Number of Coats: Two.
 - 5. Finish: Semi-Gloss.
 - 6. Minimum Epoxy Solids Content: 78% by volume.
 - 7. Minimum Polyurethane Solids Content: 69% by volume.
 - 8. Minimum Dry Film Thickness Per Coat: 2 mils.
- O. System 15: Aluminum and Dissimilar Metal Insulation:
 - 1. Description: Alkali Resistant Bitumastic or Coal-Tar Epoxy Substitute.
 - 2. Surface Prep: Solvent Clean (SP 1).

3. Number of Coats: One.
 4. Minimum Dry Film Thickness Per Coat: 18 mils.
- P. System 16: Existing Concrete/CMU Repair:
1. Description: High-solids, two-component epoxy, with filler.
 2. Exposure: Moderate.
 3. Surface Prep: SP 13.
 4. Filler: Per Manufacturer's Recommendations, 10 MDFT.
 5. Primer: High Solids Epoxy – As recommended by painting system manufacturer, 5 MDFT, min.
 6. Number of Coats: One.
 7. Finish: Low gloss.
 8. Minimum Solids Content: 78% by volume.
 9. Minimum Dry Film Thickness Per Coat: 6 mils.
- Q. System 17: New Concrete/CMU Exterior-Epoxy/Polyurethane (as required by application schedule):
1. Description: High-solids, two-component epoxy intermediated coat and, Aliphatic Polyurethane, with filler.
 2. Exposure: Moderate.
 3. Surface Prep: SP 13.
 4. Filler: Per Manufacturer's Recommendations, 10 MDFT.
 5. Primer: As recommended by painting system manufacturer.
 6. Number of Coats: One.
 7. Minimum Epoxy Solids Content: 78% by volume.
 8. Minimum Polyurethane Solids Content: 69% by volume.
 9. Minimum Dry Film Thickness Per Coat: 4 mils.
- R. System 18: Concrete/CMU Interior or Immersion Mildly Corrosive – Epoxy/Epoxy (as required by application schedule):
1. Description: High-solids, two-component epoxy intermediated coat and, -solids, two-component epoxy top coat.
 2. Exposure: Moderate.
 3. Surface Prep: SP 13.
 4. Filler: Per Manufacturer's Recommendations, 10 MDFT.
 5. Primer: As recommended by painting system manufacturer.
 6. Number of Coats: Two.
 7. Minimum Epoxy Solids Content: 78% by volume.
 8. Minimum Dry Film Thickness Per Coat: 6 mils.
- S. System 19: Concrete/CMU – Immersion Highly Corrosive – Novolac Epoxy:
1. Description: Epoxy Novolac.
 2. Exposure: Severe.
 3. Surface Prep: SP 13.
 4. Filler: Per Manufacturer's Recommendations.
 5. Primer: As recommended by painting system manufacturer.
 6. Number of Coats: Two.
 7. Minimum Dry Film Thickness Per Coat: 40 mils minimum or as noted otherwise.
- T. System 20: Epoxy Concrete Floor Coating – Moderate Corrosive Areas:
1. Description: A highly chemical-resistant and solvent-resistant colored novolac glaze.
 2. Exposure: Moderate.
 3. Number of Coats: Two.
 4. Finish: Gloss.
 5. Minimum Solids Content: 100% by volume.
 6. Minimum Dry Film Thickness Per Coat: 6 mils.

7. Primer: As recommended by painting system manufacturer.
- U. System 21: Epoxy Concrete Floor and Secondary Containment Coating – Highly Corrosive Areas:
1. Description: Epoxy Mortar and Fiberglass intermediate coat with a highly chemical-resistant and solvent-resistant colored novolac glaze top coat.
 2. Exposure: Severe.
 3. Primer: High Solids Epoxy, 6 mils.
 4. Intermediate Coat: Novolac Epoxy Mortar, 70 mils.
 5. Top Coat: Novolac Epoxy, 6 mils.
 6. Finish: Gloss.
 7. Minimum Solids Content: 100% by volume.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 77 00 – Closeout Procedures: Requirements for application examination.
- B. Substrates:
1. Verify that substrate surfaces are ready to receive Work of this Section as indicated by coating manufacturer.
 2. Obtain and follow manufacturer instructions for examination and testing of substrates.
 3. Cementitious Substrates: Do not begin application until substrate has cured minimum 28 days and measured moisture content is not greater than 16%.
- C. Masonry:
1. Verify that masonry joints are struck flush.
- D. Wood:
1. Do not begin application if substrate has moisture content greater than 12%.

3.2 GENERAL PROTECTION

- A. Protect adjacent surfaces from coatings and damage. Repair damage resulting from inadequate or unsuitable protection:
- B. Protect adjacent surfaces not to be coated from spatter and droppings with drop cloths and other coverings:
- C. Mask off surfaces of items not to be coated or remove items from area.
- D. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being coated and in particular, surfaces within storage and preparation area.
- E. Place cotton waste, cloths, and material which may constitute fire hazard in closed metal containers and remove daily from site.
- F. Remove electrical plates, surface hardware, fittings, and fastenings, prior to application of coating operations. Carefully store, clean, and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

3.3 PREPARATION

- A. Section 01 70 00 – Execution Requirements: Requirements for application preparation.
- B. Clean surfaces of loose foreign matter.
- C. Remove substances that would bleed through finished coatings; if removal is not possible, seal surface with shellac.
- D. Remove finish hardware, fixture covers, and accessories and store.
- E. Prepare surfaces as specified in coating manufacturer's instructions, unless more stringent requirements are specified in this Section.
- F. Protect surfaces listed from abrasive blasting by masking, or other means:
 - 1. Threaded portions of valve and gate stems, grease fittings, and identification plates.
 - 2. Machined surfaces for sliding contact.
 - 3. Surfaces to be assembled against gaskets.
 - 4. Surfaces of shafting on which sprockets are to fit.
 - 5. Surfaces of shafting on which bearings are to fit.
 - 6. Machined surfaces of bronze trim, including those slide gates.
 - 7. Cadmium-plated items, except cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment requiring abrasive blasting.
 - 8. Galvanized items, unless scheduled to be coated.
- G. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.
- H. Existing Painted and Sealed Surfaces:
 - 1. Remove loose, flaking, and peeling paint, and feather edge and sand smooth edges of chipped paint.
 - 2. Cleaning of previously coated surfaces:
 - a. Utilize cleaning agent to remove soluble salts such as chlorides and sulfates from concrete and metal surfaces:
 - 1) Cleaning agent: Biodegradable nonflammable and containing no volatile organic compounds.
 - 2) Manufacturer:
 - a) Chlor-Rid International, Inc.
 - b) Or Approved Equal.
 - b. Or Steam clean and degrease surfaces to be coated to remove oils and grease.
 - c. Cleaning of surfaces utilizing the decontamination cleaning agent may be accomplished in conjunction with abrasive blast cleaning, steam cleaning, high-pressure washing, or hand washing as approved by the coating manufacturer's representative and the Engineer.
 - d. Test cleaned surfaces as specified in the cleaning agent manufacturer's instructions to ensure all soluble salts have been removed. Additional cleaning shall be carried out as necessary.
 - e. Final surface preparation prior to application of new coating system shall be made as specified in coating manufacturer's printed instructions.
- I. Concrete:
 - 1. Allow new concrete to cure for minimum of 28 days before coating.
 - 2. Clean concrete surfaces of dust, mortar, fins, loose concrete particles, form release materials, oil, and grease. Fill voids so that surface is smooth. Etch or brush off-blast clean as specified in SSPC SP-7 to provide surface profile equal to 40-grit – 60-grit

sandpaper, or as recommended by coating manufacturer. All concrete surfaces shall be vacuumed clean prior to coating application.

- J. Galvanized Surfaces:
 - 1. Degrease or solvent clean (SSPC SP-1) to remove oily residue.
 - 2. Power tool or hand tool clean or whip abrasive blast.
 - 3. Test surface for contaminants using copper sulfate solution.
 - 4. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded physically, such as bolts, nuts, or preformed channels.
- K. Ferrous Metal:
 - 1. Solvent clean.
 - 2. Remove loose rust, loose mill scale, and other foreign substances.
 - 3. Hand Tools: Comply with SSPC-SP 2.
 - 4. Power Tools: Comply with SSPC-SP 3.
 - 5. Blasting: Comply with SSPC-SP 7.
 - 6. Surfaces to Be Finished as Indicated in Coating Schedules
 - a. Remove tight rust to bare metal.
 - b. Hand Tools: Comply with SSPC-SP 2.
 - c. Power Tools: Comply with SSPC-SP 3.
 - d. Blasting: Comply with SSPC-SP 10.
 - e. Protect from corrosion until coated.
- L. Ductile iron pipe and fittings to be lined or coated:
 - 1. Abrasive blast clean as specified in NAPF 500-03.
- M. Sherardized, aluminum, copper, and bronze surfaces:
 - 1. Prepare as specified in coating manufacturer's instructions.
- N. Shop primed metal:
 - 1. Certify that primers applied to metal surfaces in the shop are compatible with coatings to be applied over such primers in the field.
 - 2. Remove shop primer from metal to be submerged by abrasive blasting as specified in SSPC SP-10, unless greater degree of surface preparation is required by coating manufacturer's representative.
 - 3. Correct abraded, scratched, or otherwise damaged areas of prime coat by sanding or abrasive blasting to bare metal as specified in SSPC SP-2, SP-3, or SP-6, as directed by the Engineer.
 - 4. When entire shop priming fails or has weathered excessively (more than 25% of the item), or when recommended by coating manufacturer's representative, abrasive blast shop prime coat to remove entire coat and prepare surface as specified in SSPC SP-10.
 - 5. When incorrect prime coat is applied, remove incorrect prime coat by abrasive blasting as specified in SSPC SP-10.
 - 6. When prime coat not authorized by Engineer is applied, remove unauthorized prime coat by abrasive blasting as specified in SSPC SP-10.
 - 7. Shop applied bituminous paint or asphalt varnish: Abrasive blast clean shop applied bituminous paint or asphalt varnish from surfaces scheduled to receive non-bituminous coatings.
- O. Cadmium-plated, zinc-plated, or sherardized fasteners:
 - 1. Abrasive blast in same manner as unprotected metal when used in assembly of equipment designated for abrasive blasting.
 - 2. Abrasive blast components to be attached to surfaces which cannot be abrasive blasted before components are attached.
 - 3. Grind sharp edges to approximately 1/16 in. radius before abrasive blast cleaning.

4. Remove and grind smooth all excessive weld material and weld spatter before blast cleaning as specified in NACE SP0178.

P. PVC and FRP Surfaces:

1. Prepare surfaces to be coated by light sanding (de-gloss) and wipe-down with clean cloths, or by solvent cleaning.

Q. Mechanical And Electrical Equipment Preparation:

1. Identify equipment, ducting, piping, and conduit as specified in:
 - a. Section 22 05 53 – Mechanical Identification
 - b. Section 26 05 53 – Identification for Electrical Systems
2. Remove grilles, covers, and access panels for mechanical and electrical system from location and coat separately.
3. Prepare and finish coat-primed equipment with color selected by the Engineer.
4. Prepare and prime and coat insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are covered with prefinished coating.
5. Replace identification markings on mechanical or electrical equipment when coated over or spattered.
6. Prepare and coat interior surfaces of air ducts, convactor and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line.
7. Prepare and coat dampers exposed immediately behind louvers, grilles, convactor, and baseboard cabinets to match face panels.
8. Prepare and coat exposed conduit and electrical equipment occurring in finished areas with color and texture to match adjacent surfaces.
9. Prepare and coat both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.
10. Color code equipment, piping, conduit, and exposed ductwork and apply color banding and identification, such as flow arrows, naming and numbering, as specified in Contract Documents.

3.4 APPLICATION

A. General

1. Apply primer to each surface, unless specifically not required by coating manufacturer.
2. Apply coatings as specified in manufacturer's instructions.
3. Coat metal unless specified otherwise:
4. Aboveground piping to be coated shall be empty of contents during application of coatings.
5. Verify metal surface preparation immediately before applying coating as specified in SSPC SP COM.
6. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.
7. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.
8. Prime shop primed metal surfaces. Spot prime exposed metal of shop primed surfaces before applying primer over entire surface.
9. Multiple coats:
10. Apply minimum number of specified coats.
11. Apply additional coats when necessary to achieve specified thicknesses.
12. Apply coats to thicknesses specified, especially at edges and corners.
13. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.
14. Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.

15. Dust coatings between coats.
16. Coat surfaces without drops, overspray, dry spray, runs, ridges, waves, holidays, laps, or brush marks.
17. Remove spatter and droppings after completion of coating.
18. Apply coating by brush, roller, trowel, or spray, unless method of application is required by coating manufacturer's instructions or these Specifications.
19. Plural component application: Drums shall be premixed each day. All gauges shall be working order prior to the start of application. Ratio checks shall be completed prior to each application. A spray sample shall be sprayed on plastic sheeting to ensure set time is complete prior to each application. Hardness testing shall be performed after each application.
20. Spray application:
 - a. Stripe coat edges, welds, nuts, bolts, difficult to reach areas by brush before beginning spray application, as necessary, to ensure specified coating thickness along edges.
 - b. When using spray application, apply coating to thickness not greater than that recommended in coating manufacturer's instructions for spray application.
 - c. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
 - d. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist, fumes, or overspray.
21. Drying and recoating:
 - a. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
 - b. For submerged service the Contractor shall provide a letter to the Engineer that the lining system is fully cured and ready to be placed into service.
 - c. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
 - d. Do not allow excessive drying time or exposure which may impair bond between coats.
 - e. Recoat epoxies within time limits recommended by coating manufacturer.
 - f. When time limits are exceeded, abrasive blast clean and de-gloss clean prior to applying another coat.
 - g. When limitation on time between abrasive blasting and coating cannot be met before attachment of components to surfaces which cannot be abrasive blasted, coat components before attachment.
 - h. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
 - i. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
 - j. Leave no holidays.
 - k. Sand and feather into a smooth transition and recoat and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to naked eye.
22. Concrete:
 - a. Apply first coat (primer) only when surface temperature of concrete is decreasing in order to eliminate effects of off-gassing on coating.
 - b. Prior to priming, patch with masonry filler to produce smooth surface.
23. Wood:
 - a. Prior to priming patch with filler to produce smooth, even surface. Wood Items to Receive Transparent Finish:
 - 1) Remove dust and grit, sealing residue, seal knots, pitch streaks, and sappy sections as indicated by coating manufacturer.
 - 2) Fill nail holes and cracks with matching tinted filler.

B. ALKALI RESISTANT BITUMASTIC

1. Preparation:
 - a. Prepare surfaces as specified in general preparation requirements.
2. Application:
 - a. Apply as specified in general application requirements.
 - b. Apply at least 2 coats, 8 mils–14 mils dry film thickness each.

C. WAX COATING

1. Preparation:
 - a. Prepare surfaces as specified in general preparation requirements.
2. Application:
 - a. Apply as specified in general application requirements.
 - b. Apply at least 1/32 in. thick coat with 2 in. or shorter bristle brush.
 - c. Thoroughly rub coating into metal surface with canvas covered wood block or canvas glove.

D. HIGH SOLIDS EPOXY SYSTEM

1. Preparation:
 - a. Prepare surfaces as specified in general preparation requirements.
 - b. Abrasive blast ferrous metal surfaces to be submerged at jobsite as specified in SSPC SP-5 prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces as specified in SSPC SP-10.
 - c. Abrasive blast non-submerged ferrous metal surfaces at jobsite as specified in SSPC SP-10, prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces as specified in SSPC SP 6.
 - d. Abrasive blast clean ductile iron surfaces at jobsite as specified in SSPC SP-7.
2. Application:
 - a. Apply coatings as specified in general application requirements.
 - b. Apply minimum 2-coat system with minimum total dry film thickness (DFT) of 12 mils.
 - c. Recoat or apply succeeding epoxy coats within time limits recommended by manufacturer. Prepare surfaces for recoating as specified in manufacturer's instructions.
 - d. Coat metal to be submerged before installation when necessary, to obtain acceptable finish, and to prevent damage to other surfaces.
 - e. Coat entire surface of support brackets, stem guides, pipe clips, fasteners, and other metal devices bolted to concrete.
 - f. Coat surface of items to be exposed and adjacent 1 in. to be concealed when embedded in concrete or masonry.

E. HIGH SOLIDS EPOXY AND POLYURETHANE COATING SYSTEM

1. Preparation:
 - a. Prepare surfaces as specified in general preparation requirements.
 - b. Prepare concrete surfaces as specified in general preparation requirements.
 - c. Touch up shop primed steel and miscellaneous iron.
 - d. Abrasive blast ferrous metal surfaces at jobsite prior to coating. Abrasive blast clean rust and discoloration from surfaces.
 - e. Degrease or solvent clean, whip abrasive blast, power tool, or hand tool clean galvanized metal surfaces.
 - f. Lightly sand (de-gloss) fiberglass and poly vinyl chloride (PVC) pipe to be coated and wipe clean with dry cloths, or solvent clean as specified in coating manufacturer's instructions.
 - g. Abrasive blast clean ductile iron surfaces.
2. Application:
 - a. Apply coatings as specified in general application requirements.
 - b. Apply 3 coat system consisting of:

- 1) Primer: 4 mils–5 mils dry film thickness high solids epoxy.
 - 2) Intermediate coat: 4 mils–5 mils dry film thickness high solids epoxy.
 - 3) Topcoat: 2.5 mils–3.5 mils dry film thickness aliphatic or aliphatic-acrylic polyurethane topcoat.
- c. Recoat or apply succeeding epoxy coats within 30 days or within time limits recommended by manufacturer, whichever is shorter. Prepare surfaces for recoating as specified in manufacturer's instructions.

F. EPOXY NOVOLAC SYSTEM

1. Preparation:
 - a. Prepare surfaces as specified in general preparation requirements.
 - b. Prepare concrete to obtain clean, open pore with exposed aggregate as specified in manufacturer's instructions.
 - c. Prepare ferrous metal surfaces as specified in SSPC SP-5, with coating manufacturer's recommended anchor pattern.
 - d. Complete application of prime coat within 6 hours of abrasive blast cleaning. When cleaned surfaces rust or discolor, abrasive blast surfaces as specified in SSPC SP-5.
 - e. When handling steel, wear gloves to prevent hand printing.
 - f. Adjust pH of concrete to within 7 pH–11 pH before applying prime coat.
2. Application:
 - a. Apply coatings as specified in general application requirements and as specified in manufacturer's instructions.
 - b. Continue to monitor dew point. Dew point shall remain 5 degrees above ambient temperature for a minimum of 8 hours after application of coating.

G. HIGH TEMPERATURE COATING

1. Preparation:
 - a. Prepare surfaces as specified in general preparation requirements.
 - b. Abrasive blast surface as specified in SSPC SP-10.
2. Application:
 - a. Apply coatings as specified in general application requirements.
 - b. Apply number of coats as specified in manufacturer's instructions.

H. ASPHALT VARNISH

1. Preparation:
 - a. Prepare surfaces as specified in general preparation requirements.
2. Application:
 - a. Apply coatings as specified in general application requirements.
 - b. Apply minimum 2 coats.

I. VINYL ESTER

1. Preparation:
 - a. Prepare surfaces as specified in coating manufacturer's recommendations and as directed and approved by coating manufacturer's representative.
2. Application:
 - a. Apply prime coat, as required by coating manufacturer, base coat, glass mat, and topcoat to total dry film thickness of 125 mils minimum:
 - 1) Final topcoat on floors shall include nonskid surface, applied as specified in manufacturer's instructions.
 - b. Perform high voltage holiday detection test as specified in SP0188-06, over 100% of coated surface areas to ensure pinhole free finished coating system.
 - c. All work shall be accomplished as specified in coating manufacturer's instructions and under direction of coating manufacturer's representative.

J. ELASTOMERIC POLYURETHANE (100% SOLIDS)

1. Preparation:
 - a. Prepare surfaces as specified in coating manufacturer's instructions and as directed and approved by coating manufacturer's representative.
2. Application:
 - a. Apply epoxy primer at DFT of 1 mils–2 mils, as specified in manufacturer's instructions.
 - b. Apply polyurethane coating at minimum total DFT:
 - 1) Steel: 60 mils DFT.
 - 2) Ductile iron and ductile iron pipe coating and lining: 30 mils DFT.
 - 3) Concrete: 120 mils DFT.
 - 4) Or as recommended by the coating manufacturer and accepted by Engineer.
3. For concrete application, provide saw cutting for coating terminations as specified in manufacturer's instructions:
4. For application to damaged concrete, refer to Division 03 concrete specifications.
5. Perform high voltage holiday detection test as specified in SP0188-06, over 100% of coated surface areas to ensure pinhole free finished coating system.

K. CONCRETE FLOOR COATINGS

1. Preparation:
 - a. Prepare surfaces as specified in general application requirements and as specified in coating manufacturer's instructions.
2. Application:
 - a. Apply primer if required by coating manufacturer.
 - b. Apply 1 or more coats as recommended by coating manufacturer to receive a minimum total dry film thickness of 25 mils, color as selected by Owner.
3. Final topcoat shall include nonskid surface, applied as specified in coating manufacturer's instructions.

L. WATERBORNE ACRYLIC EMULSION

1. Preparation:
 - a. Remove all oil, grease, dirt, and other foreign material by Solvent Cleaning as specified in SSPC SP-1.
 - b. Lightly sand all surfaces and wipe thoroughly with clean cotton cloths before applying coating.
2. Application:
 - a. Apply 2 or more coats to obtain a minimum dry film thickness (DFT) of 5.0 mils.

3.5 FIELD QUALITY CONTROL

- A. Section 01 75 00 – Startup Testing and Training: Requirements for testing, adjusting, and balancing.
- B. Each coat will be inspected. Strip and remove defective coats, prepare surfaces and recoat. When approved, apply next coat.
- C. Control and check dry film thicknesses and integrity of coatings.
- D. Measure dry film thickness with calibrated thickness gauge.
- E. Dry film thicknesses on ferrous-based substrates may be checked with Elcometer Type 1 Magnetic Pull-Off Gage or Positector 6000.
- F. Verify coat integrity with low-voltage sponge or high-voltage spark holiday detector, as specified in SP0188 06. Allow Engineer to use detector for additional checking.

- G. Check wet film thickness before coal tar epoxy coating cures on concrete or nonferrous metal substrates.
- H. Arrange for services of coating manufacturer's field representative to provide periodic field consultation and inspection services to ensure proper surface preparation of facilities and items to be coated, and to ensure proper application and curing:
 - 1. Notify Engineer 24 hours in advance of each visit by coating manufacturer's representative.
 - 2. Provide Engineer with a written report by coating manufacturer's representative within 48 hours following each visit.

3.6 CLEANING

- A. Section 01 77 00 – Closeout Procedures: Requirements for cleaning.
- B. Collect waste material that may constitute fire hazard, place in closed metal containers, and remove daily from Site.
- C. Clean surfaces immediately of overspray, splatter, and excess material.
- D. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.7 PROTECTION

- A. Section 01 77 00 – Closeout Procedures: Requirements for protecting finished Work.
- B. Protect adjacent surfaces and materials not receiving coating from overspray.
- C. Mask when necessary to provide adequate protection and repair damage.

3.8 SCHEDULE OF ITEMS NOT REQUIRING COATING

- A. General: Unless specified otherwise, the items do not require coating:
 - 1. Items that have received final coat at factory and not listed to receive coating in field.
 - 2. Aluminum, brass, bronze, copper, plastic (except PVC pipe), rubber, stainless steel, chrome, Everdur, or lead.
 - 3. Buried or encased piping or conduit.
 - 4. Exterior concrete.
 - 5. Galvanized steel wall framing, galvanized roof decking, galvanized electrical conduits, galvanized pipe trays, galvanized cable trays, and other galvanized items:
 - a. Areas on galvanized items or parts where galvanizing has been damaged during handling or construction shall be repaired:
 - 1) Clean damaged areas by SSPC SP-1, SP-2, SP-3, or SP-7 as required.
 - 2) Apply 2 coats of a Galvanizing Zinc Compound as specified in manufacturer's instructions.
 - 6. Grease fittings.
 - 7. Fiberglass ducting or tanks in concealed locations.
 - 8. Steel to be encased in concrete or masonry.

3.9 SCHEDULE OF SURFACES TO BE COATED

- A. See attached schedule for a list of items to be coated. Schedule may not list all items that require a coating – coat unlisted surfaces with same coating system as similar listed surfaces. Color coat all piping as specified in Section 40 23 39 – Process Piping.

END OF SECTION

SECTION 09 96 00.1 – HIGH PERFORMANCE COATING SYSTEMS SCHEDULE

SURFACES TO BE COATED	COATING SYSTEM	Field/Factory	NOTES
Concrete			
Chemical Pipe Trench	20	Field Coated	Sodium Hydroxide Pipe Trench

DIVISION 22
PLUMBING

SECTION 22 05 53 – MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work required for Mechanical Identification.
 - 2. Identification devices, including:
 - a. Painted Identification Materials.
 - b. Equipment Labels.
 - c. Plastic Pipe Markers.
 - d. Plastic Tape.
 - e. Underground-Type Plastic Line Marker.
 - f. Valve Tags.
 - g. Valve Schedule Frames.
 - h. Engraved Plastic-Laminate Signs.

1.2 REFERENCES

- A. ANSI Standards:
 - 1. See ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit Manufacturer's technical product data and installation instructions for each identification material and device required.
- C. Schedules:
 - 1. Submit valve schedule for each piping system, typewritten and reproduced on 8 1/2 in. by 11 in. bond paper. Tabulate the valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shutoff and similar special uses, by special "flags", in margin of schedule.
 - 2. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 01.
- D. Maintenance Data:
 - 1. Include product data and schedules in maintenance manuals; as specified in Division 01 – General Requirements.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for NOT less than 5 years.

1.5 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: (Subject to Requirements):
 - 1. Allen Systems, Inc.
 - 2. Brady (W.H.) Co.
Signmark Div.
 - 3. Industrial Safety Supply Co., Inc.
 - 4. Seton Name Plate Corp.
 - 5. Other Approved Equal.

2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General:
 - 1. Provide Manufacturer's standard products of categories and types required for each application as referenced in other sections. Selection is Installer's option where more than a single type is specified for applications but provide single selection for each product category.

2.3 PAINTED IDENTIFICATION MATERIALS

- A. Stencils:
 - 1. Standard fiberboard stencils, prepared for required applications with letter sizes as specified in ANSI A13.1 for piping and similar applications, but NOT less than 1 1/4 in. high letters for ductwork and NOT less than 3/4 in. high letters for access door signs and similar operational instructions.
- B. Stencil Paint:
 - 1. Standard exterior type stenciling enamel; black, except as otherwise specified; either brushing grade or pressurized spray can form and grade.
- C. Identification Paint:
 - 1. Standard identification enamel of colors specified or, if NOT otherwise specified for piping systems, as specified in ANSI A13.1 and/or Owner Selection for colors.
- D. See Section 09 90 00 – Painting and Protective Coatings.

2.4 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness:
 - a. Stainless steel, 0.025 in. (0.64 mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size:
 - a. Length and width vary for required label content, but NOT less than 2 1/2 in. by 3/4 in. (64 mm by 19 mm).
 - 3. Minimum Letter Size:
 - a. 1/4 in. (6.4 mm) for name of units if viewing distance is less than 24 in. (600 mm).
 - b. 1/2 in. (13 mm) for viewing distances up to 72 in. (1830 mm).
 - c. Proportionately larger lettering for greater viewing distances.
 - d. Include secondary lettering 2/3 – 3/4 the size of principal lettering.
 - 4. Fasteners:
 - a. Stainless-steel rivets or self-tapping screws
 - 5. Adhesive:

- a. Contact-type permanent adhesive, compatible with label and with substrate.

2.5 PLASTIC PIPE MARKERS

- A. Snap-On Type:
 - 1. Provide Manufacturer's standard preprinted, semi-rigid snap-on, color-coded pipe markers, as specified in ANSI A13.1.
- B. Pressure-Sensitive Type:
 - 1. Provide Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, as specified in ANSI A13.1.
- C. Insulation:
 - 1. Furnish 1 in. thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2 in. beyond each end of plastic pipe marker.
 - 2. Small Pipes:
 - a. For external diameters less than 6 in. (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the methods below:
 - 1) Snap-on application of pretensioned semi-rigid plastic pipe marker.
 - 2) Adhesive lap joint in pipe marker overlap.
 - 3) Laminated or bonded application of pipe marker to pipe (or insulation).
 - 4) Taped to pipe (or insulation) with color-coded plastic adhesive tape, NOT less than 3/4 in. wide; full circle at both ends of pipe marker, tape lapped 1 1/2 in.
 - 3. Large Pipes:
 - a. For external diameters of 6 in. and larger (including insulation if any), provide either full-band or strip-type pipe markers, but NOT narrower than 3 times letter height (and of required length), fastened by one of the methods below:
 - 1) Laminated or bonded application of pipe marker to pipe (or insulation).
 - 2) Taped to pipe (or insulation) with color-coded plastic adhesive tape, NOT less than 1 1/2 in. wide; full circle at both ends of pipe marker, tape lapped 3 in.
 - 3) Trapped-to-pipe (or insulation) application of semi-rigid type, with Manufacturer's standard stainless-steel bands.
- D. Lettering:
 - 1. Manufacturer's standard preprinted nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with name as specified.
 - 2. Arrows: Print each pipe marker with arrows specifying direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.6 PLASTIC TAPE

- A. General:
 - 1. Provide Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, NOT less than 3 mils thick.
- B. Width:
 - 1. Provide 1 1/2 in. wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6 in, 2 1/2 in. wide tape for larger pipes.

- C. Color:
 - 1. See ANSI A13.1, except where another color selection is specified.

2.7 UNDERGROUND–TYPE PLASTIC LINE MARKERS

- A. General:
 - 1. Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; NOT less than 6 in. wide by 4 mils thick.
 - 2. Provide tape with printing most accurately specifying type of service of buried pipe.
- B. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.8 VALVE TAGS

- A. Brass Valve Tags:
 - 1. Provide 19 GA polished brass valve tags, with a stamp-engraved piping system abbreviation in 1/4 in. high letters and sequenced valve numbers 1/2 in. high, and with 5/32 in. hole for fastener.
 - 2. Provide 1 1/2 in. diameter tags, except as otherwise specified.
 - 3. Provide size and shape as specified or scheduled for each piping system.
 - 4. Fill tag engraving with black enamel.
- B. Plastic Laminate Valve Tags:
 - 1. Provide Manufacturer's standard 3/32 in. thick engraved plastic laminate valve tags, with piping system abbreviation in 1/4 in. high letters and sequenced valve numbers 1/2 in. high, and with 5/32 in. hole for fastener.
 - 2. Provide 1 1/2 in² black tags with white lettering, except as otherwise specified.
 - 3. Provide size, shape and color combination as specified or scheduled for each piping system.
- C. Valve Tag Fasteners:
 - 1. Provide Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- D. Access Panel Markers:
 - 1. Provide Manufacturer's standard 1/16 in. thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.9 VALVE SCHEDULE FRAMES

- A. General:
 - 1. For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.10 ENGRAVED PLASTIC–LAMINATE SIGNS

- A. General:
 - 1. Provide engraving stock melamine plastic laminate, as specified in FS L-P-387, in the sizes and thicknesses specified, engraved with engraver's standard letter style of the sizes and wording specified, black with white core (letter color) except as otherwise specified, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

- B. Thickness:
 - 1. 1/16 in. for units up to 20in² or 8 in. length; 1/8 in. for larger units.
- C. Fasteners:
 - 1. Self-tapping stainless-steel screws, except contact-type permanent adhesive where screws CANNOT or should NOT penetrate the substrate.

2.11 LETTERING AND GRAPHICS

- A. General:
 - 1. Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified, or scheduled. Provide numbers, lettering and wording as specified, or, if NOT otherwise, as specified by manufacturers, or as required for proper identification and operation/maintenance of mechanical systems and equipment.
- B. Multiple Systems:
 - 1. Where multiple systems of same generic name are shown and specified, provide identification which specifies individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination:
 - 1. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate Equipment Labels Where Accessible and Visible.

3.4 PIPING SYSTEM IDENTIFICATION

- A. Install pipe markers of ONE of the types on each system specified to receive identification, and include arrows to show normal direction of flow:
 - 1. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2 in. beyond ends of lettering.
 - 2. Stenciled markers, with lettering color as specified in ANSI A13.1.
 - 3. Plastic pipe markers, with application system as specified under "Materials" in this section. Install on pipe insulation segment where required for hot uninsulated pipes.
 - 4. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

5. Locate pipe markers and color bands wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior unconcealed locations.
 - a. Near each valve and control device.
 - b. Near each branch, excluding short takeoffs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where pipes pass through walls or floors/ceilings, or enter inaccessible enclosures.
 - d. At access doors, manholes and similar access points which permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced intermediately at maximum spacing of 50 ft along each piping run, except reduce spacing to 25 ft in congested areas of piping and equipment.
 - g. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.5 UNDERGROUND PIPING IDENTIFICATION

- A. General:
 1. During back-filling/top-soiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6 in. to 8 in. below finished grade. Where multiple small lines are buried in common trench and DO NOT exceed overall width of 16 in, install single line marker. For tile fields and similar installations, mark only edge pipelines of field.

3.6 VALVE IDENTIFICATION

- A. Provide valve tag on every valve, cock, and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shutoff valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
- B. Mount valve schedule frames and schedules in machine rooms where specified, or if NOT otherwise, where specified by Contracting Officer.
- C. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.7 ADJUSTING AND CLEANING

- A. Adjusting:
 1. Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning:
 1. Clean face of identification devices, and glass frames of valve charts.

3.8 EXTRA STOCK

- A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (NOT less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

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

END OF SECTION

DIVISION 26
ELECTRICAL

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The basic requirements for electrical installations and includes requirements common to Division 26 –Electrical.
2. Expansion and supplementation of requirements specified in the General and Supplementary Conditions.
3. Construction of the new building structures, associated facilities, and all related electrical systems as defined in the plans and in these specifications.
4. The installation, connection, and testing of new electrical equipment, including power distribution equipment, lighting equipment, underground electrical work, grounding systems, control systems, conduit and wiring, temporary power systems, special electrical systems, and all appurtenances to construct and demonstrate proper operation of the completed electrical systems.
5. The Contractor shall be responsible for the coordination of power, communication, and controls for the project.
6. The electrical plans do not give exact locations, etc., and do not show all the offsets, control lines, pilot lines, and other installation details. Each contractor shall carefully lay out the work at the sites to conform to the job conditions, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide complete operating systems.
7. The electrical plans show diagrammatically the locations of the various electrical outlets and apparatus and the general method of circuiting and controlling. Exact locations of these outlets and apparatus shall be determined by reference to the general plans and to all detail drawings, etc., by measurements at the buildings, and in cooperation with other crafts, and in all cases shall be subject to the approval of the Owner and Engineer. The Engineer reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.
8. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structure of the buildings, which will fit into the several available spaces, and which will ensure complete and satisfactory systems. Each bidder shall be responsible for the proper fitting of the material and apparatus into the buildings.
9. Should the particular equipment which any bidder proposes to install require other space conditions than those indicated on the Drawings, the Bidder shall arrange for such space with the Engineer before submitting the bid. Should changes become necessary on account of failure to comply with this clause, the Contractor shall make such changes at the Contractor's expense.
10. Where wire sizes, conduit and other items of construction are shown or required for a complete installation but are not adequately identified as to size or material requirements, the materials furnished shall be as specified in "Code" requirements as though specified in Drawings.
11. All equipment shall be leveled and made plumb. Metal junction boxes, equipment enclosures and metal raceways mounted on water or earth-bearing walls shall be separated from walls not less than 1/4 in. by corrosion-resistant spacers. All electrical conduits and items of equipment shall be run or set parallel to walls, floors, and other items of construction.

1.2 REFERENCES

A. NFPA (National Fire Protection Association):

1. 70 – National Electrical Code.
2. 70E – Standard for Electrical Safety in the Workplace.

3. 72 – National Fire Alarm Code.
 4. 101 – Life Safety Code.
 5. Internet Website: <http://www.nfpa.org>
- B. CFR (Code of Federal Regulations):
1. 29 CFR 1910 – Occupational Safety and Health Standards (OSHA).
 2. 29 CFR 1926 – Safety and Health Regulations for Construction.
 3. Internet Website: <http://www.gpo.gov/fdsys>
- C. ANSI/IEEE C2 – National Electrical Safety Code.
- D. Applicable Federal, State and Local:
1. Fire codes.
 2. Energy Codes.
 3. Building Codes.
 4. Environmental, Health, and Safety Laws and Regulations.
- E. Applicable City
1. Electrical Code.
 2. Ordinances pertaining to electrical work.
- F. Contractor shall utilize the most current editions of standards, which are current at time of bid and as recognized by the Authority Having Jurisdiction for the respective standard.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Submittals shall be furnished by the Contractor for the work involved in sufficient time so that no delay or changes will be caused.
- C. Submittals shall consist of manufacturing information, schematics, wiring diagrams, ladder logic diagrams, instrument loop diagrams, outline drawings, clearances, and related information. Shop Drawings shall be so marked as to indicate the EXACT items offered.
- D. Submittals shall bear Contractor's certification that the item complies in all respects with the item originally specified. It is the Contractor's responsibility to procure the proper sizes, quantities, rearrangements, structural modifications, or other modifications for the substituted item to comply with the established requirements.
- E. The Contractor shall combine each submittal set into one electronic file (pdf format). Group materials submitted by their Specification numbers, but do not submit the entire electrical within one submittal. Provide electronic bookmarks in the pdf to indicate the included equipment types and a title sheet to separate each section.
- F. The Contractor shall submit complete descriptions, illustrations, specification data, etc., of all materials, fittings, devices, fixtures, special systems, etc., as required by the individual sections of Division 26 – Electrical.
- G. Submittal of shop drawings, product data and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Engineer will not be processed.
- H. All submittals shall provide information of:
1. General Contractor.

2. Subcontractor.
3. Distributor and/or Supplier.
4. Sales Agency.
5. Submittals not supplying this information will be rejected.

I. Shop Drawings:

1. In addition to the above, submit shop drawings for major materials where called for and when requested by the Engineer.
2. Lockout/Tagout Program.
3. Switchboard, motor control centers, panelboards, surge arresters, and safety switches.
4. Motor starters and contactors including custom wiring diagrams for all motors.
5. Lighting fixtures and lamps including light pole foundation requirements.
6. Wire, cable, and conduit.
7. Dry type transformers including weight and dimensions.
8. Wiring devices and plates.
9. Dimensioned layout of electrical room drawn to scale, with equipment location specified. Clearances shall be as specified in NEC and local codes.
10. Dimensioned layout of all below grade conduit installations.
11. Grounding system and layout.
12. Lightning protection system layout.
13. Traffic control system layout and schematics.
14. Seismic protection materials and methods for all electrical equipment.
15. Mounting brackets, supports and assembly for walkway mounted equipment including instruments, lighting and control panels.

1.4 QUALITY ASSURANCE

- A. Any electrical equipment provided under Division 26 – Electrical shall be turned over to the Owner in operating condition. Instruction on further operation and maintenance shall be included in the operating and maintenance instructions.

1.5 PRODUCT LISTING

- A. Prepare listing of major electrical equipment and materials for the project.
- B. Provide all information requested.
- C. Submit this listing as a part of the submittal requirements.
- D. When two or more items of same material or equipment are required they shall be of the same manufacturer when available. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment kits, and similar items used in Work, except as otherwise indicated.
- E. Provide products that are compatible within systems and other connected items.

1.6 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.7 WORK SUPERVISION

- A. The Contractor shall designate in writing the qualified electrical supervisor who shall provide supervision to all electrical work on this project. The minimum qualifications for the electrical supervisor shall be a master electrician as defined by the statutes of the State of the work being performed. The supervisor or his appointed alternate possessing at least a master electrician license shall be on site whenever electrical work is being performed. The qualifications of the electrical supervisor shall be subject to approval of the Owner and the Engineer.
- B. All master and journeyman electricians shall be licensed as specified in the statutes of the State of the work being performed. No unlicensed electrical workers shall perform work on this project. Apprentice electricians in a ratio of not more than one apprentice per journeyman electrician will be allowed if the apprentices are licensed and actively participating in an apprenticeship program recognized and approved by the statutes of the State of the work being performed.

1.8 UTILITY TELECOM WORK

- A. The Contractor shall be responsible for coordinating all telecommunications services, including internet and telephone work, with the servicing utility, Owner, and Engineer. Provide all required equipment, connectors, and accessories to make all final communication system connections.

1.9 LOCKOUT / TAGOUT PROGRAM

- A. The Contractor shall provide a complete copy of and electrical energy source Lockout/Tagout Program to the Owner, with copy to the Engineer. The document shall clearly identify the onsite master electricians and their contact information, including office and mobile telephone numbers.
- B. As specified in Part 1910 – Occupational Safety and Health Standards (OSHA) Subpart S – Electrical, and meet the requirements of 29 CFR 1910.147, The Control of Hazardous Energy (Lockout/Tagout), including requirements listed in 1910.331 – 1910.335.
- C. Implementation of the Lockout/Tagout Program and all other related safety requirements are the sole responsibility of the Contractor.

1.10 SAFETY PROGRAM

- A. The Contractor shall implement an electrical safety program that complies with NFPA 70E and 29 CFR 1926.
- B. Implementation of the Electrical Safety Program, determining and providing proper Personal Protective Equipment (PPE), training and enforcing personnel to wear the prescribed PPE, conducting work area safety inspections (including correcting deficiencies), and all other related safety requirements are the sole responsibility of the Contractor.

1.11 EQUIPMENT CONNECTIONS

- A. General:
 - 1. Provide connections for all equipment installed or modified by this contract, regardless of who furnished the equipment.
- B. Provide all disconnect switches required by Code whether or not shown on the plans.
- C. Contractor shall connect Owner-furnished equipment when specified.

1.12 GENERAL CONDITIONS

- A. The work under this paragraph is subject to the General and Supplementary Conditions, special conditions for mechanical and electrical work, and the Contractor or subcontractor will be responsible for and be governed by all requirements thereunder as though specifically repeated in this paragraph.

1.13 COORDINATION

- A. The Contractor shall coordinate arrangement, mounting and support of all electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at a required slope.
 - 4. So connecting raceways, cables and wireways will be clear of obstructions and of the working and access space of other equipment.
- B. The Contractor shall coordinate electrical equipment to be mounted on vendor supplied walkways with supplier.

1.14 SPECIAL NOTE

- A. The mechanical, structural and process plans and specifications, including the general conditions and all supplements issued thereto, information to bidders, and other pertinent documents issued by the Engineer, are a part of these specifications and the accompanying electrical plans, and shall be complied with in every respect. All the above is included herewith, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of mechanical, process and structural details from the electrical drawings.

1.15 CONTINUATION OF SERVICES

- A. The Contractor shall install any temporary lines and connections required to maintain electric services and safely remove and dispose of them when complete. The Contractor shall supply emergency power whenever any existing electrical service is without power. In general, the existing facility shall remain operational during construction.
- B. Planned outages shall be coordinated two weeks in advance with duration and time of start approved by the Owner. Changeover work which may be required after normal hours or weekends shall not constitute the basis for additional cost to the Owner. When an outage begins, the Contractor shall proceed directly to completion of the work without unscheduled interruptions or delays due to lack of manpower, equipment, or tools.
- C. The Contractor shall refer to the sequence of construction and shall provide temporary connections as may be required to complete each phase of construction as may be required. The Contractor shall submit proposed electrical service plans for each phase of construction to the Owner and Engineer for consideration.

1.16 LAYOUT

- A. The Contractor shall coordinate and establish all benchmarks and control lines. The Contractor shall lay out all work. The layout shall be reviewed by the Engineer and Owner prior to starting any work.

1.17 RELATED WORK SPECIFIED ELSEWHERE

- A. Mechanical Equipment:
 - 1. The Contractor shall rough-in for and make final electrical connections to all motor, panels, fixtures, and equipment furnished under other sections of the specifications, providing all material and equipment required for such final connections, except what was previously described. This includes, but is not limited to, control panels and other miscellaneous equipment.
- B. The Contractor shall refer to other sections of these specifications for all information relating to the requirements of all electrical connections to the equipment and shall furnish and install electrical items required for a complete installation, ready for operation.
- C. Roughing-in shall be accomplished from approved shop drawings.
- D. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- E. Refer to equipment specifications in other Divisions for rough-in requirements.

1.18 LOCAL CONDITIONS

- A. Inspection of Sites:
 - 1. The bidder shall inspect the site, thoroughly acquaint himself with conditions to be met and work to be accomplished. Failure to comply with this shall not constitute grounds for any additional payments.

1.19 RECORD DOCUMENTS

- A. Refer to the General and Supplementary Conditions for requirements.
- B. Supplement Requirements of the General and Supplementary Conditions:
 - 1. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned for column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices.
 - 2. The Contractor shall locate all underground and concealed work, identifying all equipment, conduit, circuit numbers, motors, feeders, breakers, switches, and starters. The Contractor will certify accuracy by endorsement. Record drawings shall be correct in every detail, such that the Owner can properly operate, maintain, and repair exposed and concealed work.
 - 3. The Contractor shall store the Record drawings on the site. Drawings shall not be rolled. Make corrections, additions, etc., with pencil, with date and authorization of change.
 - 4. Mark specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

1.20 OPERATION AND MAINTENANCE DATA

- A. Installation manual:
 - 1. Description of function, installation and calibration manuals, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
- B. Operations manual:

1. Manufacturer's printed operating instructions and procedures to include startup, break-in, routine, and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; summer and winter operating instructions; and all programming and equipment settings.
 - C. Maintenance manual:
 1. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - D. Service manual:
 1. Servicing instructions and lubrication charts and schedules, including the names and telephone numbers of personnel to contact for both routine periodic and warranty service for equipment and materials provided under Division 26 – Electrical.
 - E. Final approved equipment shop drawings, clearly labeled.
 - F. Final test reports, clearly labeled, including motor certification tests.
 - G. Final certified calibration sheets for all equipment and instruments.
 - H. After approval of the O&M Manuals, the Contractor shall provide to the Owner and Engineer as specified in 01 77 00 – Closeout Procedures.
- 1.21 GUARANTEE
- A. Refer to the General and Supplementary Conditions for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
 - B. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.
 - C. Upon completion of the installation, the Contractor shall adjust the systems to the satisfaction of the Engineer.
 - D. This guarantee shall include the capacity and integrated performance of the component parts of the various systems as specified in the intent of the specifications. The Contractor shall conduct complete tests required by the Engineer to demonstrate the ability of the various systems.
- 1.22 CLEANING
- A. Electrical systems and components shall be thoroughly cleaned inside and outside. Remove debris, dust, concrete splatter, plaster paint and lint from all enclosures.
- 1.23 WARRANTY
- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. All materials and equipment used in carrying out these specifications shall be new and have UL listing, or listing by other recognized testing laboratory when such listings are available.

Specifications and drawings indicate name, type, or catalog numbers of materials and equipment to be used as standards.

2.2 HEAT TRACING

- A. Heat trace and insulate all exposed piping, water lines, and valves where subject to freezing and not protected by other means. Where exact sizes, panels, boxes, conduit, circuitry and other items of construction are shown or required for a complete installation, but are not adequately identified as to size or material requirements, the materials furnished shall be as needed to provide freeze protection requirements as though shown in detail on the Drawings. The Contractor shall be responsible for supplying all items as required for complete heat tracing systems.
- B. Contractor shall meet all National Electrical code requirements for heat tracing and particularly to Resistance Heating Elements Article 427-21, 22 and 23.

PART 3 - EXECUTION

3.1 SALVAGE

- A. All salvage and equipment removed by the work shall remain the property of the Owner unless directed otherwise by the Owner. Material removed from the project shall be stored on the project site where and as directed. Debris shall be removed from the job site and disposed of by the Contractor.

3.2 DEMOLITION AND DISPOSAL

- A. All conduit, wire, and other electrical appurtenances associated with equipment removed in this project, and no longer in use, shall be removed and stored or disposed of as directed by the Owner. The Contractor shall patch and apply finish to walls, floors, and other structures from which such items are removed to match surrounding colors, textures, or other visual characteristics.

3.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site unless offsite storage is authorized in writing. Protect stored equipment and materials from damage.
- C. Equipment and materials shall be stored as specified in the manufacturer's recommendations and instructions.
- D. All equipment, including but not limited to equipment containing coils and/or electronics, shall be stored in a clean, dry, ventilated, and heated building. The storage area shall be free from condensation or other injurious environmental conditions. Freedom from condensation shall be essential and shall be accomplished using auxiliary heaters as required to raise the temperature to 5°C above the ambient temperature. The equipment shall be protected from excessive dust.
- E. In addition, certain electronic equipment that requires cooling based upon its specific storage temperature range shall be stored in an airconditioned building.

- F. All motors shall be stored in a clean, dry, ventilated, and heated building. The storage area shall be free from condensation or other injurious environmental conditions. Freedom from condensation shall be essential and shall be accomplished using auxiliary heaters as required to raise the temperature to 5°C above the ambient temperature. The motors shall be protected from excessive dust.
- G. Cables and wiring shall be kept in a dry location out of the sun.
- H. Outdoor storage, even when protected by a tarpaulin, is unacceptable.
- I. Equipment may be rejected if the storage criteria are not followed.

3.4 INSTALLATION

- A. Coordinate electrical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.
- D. The Contractor shall keep ends of conduits, including those extending through roofs, equipment and fixtures covered or closed with caps or plugs to prevent foreign material from entering during construction.
- E. Coordinate the installation of required supporting devices and sleeves to be set in concrete and other structural components as they are constructed.
- F. Sequence, coordinate, and integrate installations of electrical materials and equipment for maintaining the required operation of the facility. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- G. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
- H. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.
- I. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- J. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
- K. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- L. Coordinate installation of electrical equipment on vendor supplied walkways with supplier.

3.5 MATERIALS AND WORKMANSHIP

- A. All materials shall be new and shall be of the latest standard design of a manufacturer regularly engaged in the manufacture of that type of equipment. Materials shall be in good condition and shall be free from dents, scratches or other damage incurred in shipment or installation.
- B. All equipment shall comply with the National Electrical Code, Underwriters Laboratories, or other appropriate agency.
- C. Installation shall be made in a neat and workmanlike manner, and all materials shall be installed as specified in the recommendations of the various manufacturers. The installation shall be subject to the approval of the Owner and Engineer.
- D. Incidental materials required to complete the installation as intended by these Specifications shall be of the type and quality in keeping with specified equipment.

3.6 COORDINATION

- A. Carefully examine specification and drawings to be thoroughly familiar with items which require electrical connections and coordination. (Electrical drawings are diagrammatic and shall not be scaled for exact sizes.)
- B. Notify other tradesmen of any deviations or special conditions necessary for the installation of work. Interference between work of various contractors shall be resolved prior to installation. Work installed not in compliance with specifications and drawings and without properly checking and coordinating as specified above shall, if necessary, be removed and properly reinstalled without additional cost to the Owner. Engineer to be mediating authority in all disputes arising on project.
- C. Equipment shall be installed as specified in manufacturer's recommendation. Where conflicts occur between contract documents and these recommendations, a ruling shall be requested of the Engineer for decision before proceeding with such work.

3.7 CUTTING AND PATCHING

- A. Repair or replace routine damage caused by cutting in performance of work under Division 26 – Electrical.
- B. Correct unnecessary damage caused due to installation of electrical work, brought about through carelessness or lack of coordination.
- C. Holes cut through floor slabs to be sleeved or core drilled with drill designed for this purpose. All openings, sleeves, and holes in slabs to be properly sealed, fireproofed, and waterproofed.
- D. Repairs to be performed with materials which match existing materials and to be installed as specified in appropriate sections.
- E. All cutting and patching work shall be coordinated in advance with the Engineer and Owner prior to any work.

3.8 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

- A. Provide trenching, excavation, and backfilling necessary for performance of work under Division 26 – Electrical.

3.9 FOUNDATIONS AND PADS

- A. Foundations and pads required for equipment shall be provided as indicated. Proper size and location of foundations, pads and anchor bolts shall be determined under Division 26 – Electrical.
- B. Provide anchors and bases for electrical equipment to withstand lateral forces and accommodate displacements.

3.10 NOISE AND VIBRATION CONTROL

- A. The electrical system as installed shall be free of objectionable noise or vibration. The Contractor shall isolate motors, starters, transformers, equipment, ballasts, etc., as directed or required as to make sure of acceptable noise level free from objectionable vibration in all systems.

3.11 TESTS

- A. On completion of work, installation shall be completely operational and entirely free from ground, short circuits, and open circuits. Perform a thorough operational test in presence of the Owner and Engineer. Furnish all labor, materials, and instruments for above tests.
- B. Furnish the Engineer, as part of closing file, a copy of such tests including identification of each circuit and readings recorded. Test information to be furnished to the Engineer includes ampere readings of all panels and major circuit breakers, isolation resistance reading of motors and transformers.
- C. Prior to final observation and acceptance test, all electrical systems and equipment shall be in satisfactory operating condition. Including, but not limited to:
 - 1. Electrical power and distribution system.
 - 2. Lighting systems.
 - 3. Transformers.
 - 4. Electric motors for all equipment.
 - 5. Telecommunication system.
 - 6. Emergency power system.
 - 7. Special electrical control systems.
- D. After installation of the electrical system and before operating equipment, functional checking shall be conducted as specified in:
 - 1. The manufacturer's recommendations
 - 2. The contract drawings
 - 3. Functional checking shall include inspection, testing and repair, replacement or adjustments as necessary to ensure compliance with the requirements of the specifications. Tests and inspections shall be recorded on standard test forms and checklists to indicate that wiring and controls are in place as specified in requirements and to form the basis of record drawings.
 - 4. The functional test procedures shall be signed and dated by the Contractor and presented to the Owner's construction observation personnel prior to operating any equipment.
 - a. Visual Inspection – The electrical system shall be examined as outlined below:
 - 1) Parts of components missing.
 - 2) Improper assembly.
 - 3) Parts or components not functioning properly.
 - 4) Finish not as specified.
 - 5) Materials not as specified.

- 6) Connections not tight.
- 7) Mounting and supports loose or unsatisfactory.
- 8) Nameplates missing or inaccurate.
- b. Grounding System Tests
 - 1) Measure the resistance of the counterpoise grounding system by the rate-of-fall of potential method. Record all measurements on an approved standard test form made specifically for the purpose. The resistance of the grounding system to ground shall not exceed NFPA 70 requirements.
- c. Continuity Tests
 - 1) Each wire and each wire in each cable rated 300 V and below shall be tested for continuity. Record wire number and pass or fail on checklist for each wire.
- d. Dielectric Tests:
 - 1) Each power conductor rated 600 V and above shall be tested (meggered) for dielectric strength to ground.
 - 2) Prior to testing, all components that could be damaged should be disconnected. After testing, the circuit shall still register a resistance value of not less than 1 megohm at 600 V DC. This test shall apply between all insulated circuits and external metal parts. Record equipment name, phase or wire number and all observed values for each wire.
 - 3) Subsequent to wire and cable hookups, energize circuits and demonstrate proper functioning of all circuits. Record equipment or circuit number and pass or fail on function test checklist for each circuit.
 - 4) The Contractor shall develop nonconforming material reports for each failure. Repair and report failures all failures to Owner and Engineer.
 - 5) The Contractor shall replace defective parts, correct malfunctioning units, make all repairs and retest to demonstrate compliance. The Contractor shall document all actions taken on appropriate nonconforming material report.

3.12 INSPECTION FEES AND PERMITS

- A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.

3.13 IDENTIFICATION OF EQUIPMENT

- A. Properly identify all electrical equipment, including but not limited to:
 - 1. Switchgear, switchboards, motor control centers, and control panels.
 - 2. Main distribution panel and individual devices within it.
 - 3. Panelboards and individual devices within it.
 - 4. Safety switches and disconnects.
 - 5. Contactors and lighting control center, including all branch circuits.
 - 6. Individually mounted circuit breakers.
 - 7. Relays.
 - 8. Transformers.
 - 9. Generators and automatic transfer switches.
 - 10. Any other type of enclosure that includes electrical equipment.

3.14 TEMPORARY LIGHTS AND POWER

- A. Provide a temporary electrical lighting and power distribution system of adequate size to properly serve construction activities, including adequate feeder sizes to prevent excessive voltage drop. Temporary work to be installed in a neat and safe manner as specified in the NEC, Article 590, and as required by OSHA or applicable local safety codes.
- B. The Contractor will pay for power consumption related to construction activity.

END OF SECTION

SECTION 26 05 19 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Wire and cable for low-voltage power applications, 600V and less.
- B. Related Sections:
 - 1. Section 26 05 53 – Identification for Electrical Systems

1.2 REFERENCES

- A. NETA (International Electrical Testing Association):
 - 1. ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- B. NFPA (National Fire Protection Association):
 - 1. 70 – National Electrical Code.
 - 2. 262 – Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
- C. UL (Underwriters Laboratories, Inc.):
 - 1. 1277 – Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit for building wire.
- C. Test Reports:
 - 1. Specify procedures and values obtained.
- D. Closeout Submittals
 - 1. Project Record Documents: Record actual locations of components and circuits.

1.4 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 FIELD MEASUREMENTS

- A. Verify field measurements are as specified in Drawings.

1.6 COORDINATION

- A. Where wire and cable destination is specified and routing is not, determine routing and lengths required.

- B. Wire and cable routing specified is approximate unless dimensioned.

1.7 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLE

- A. Available Manufacturers (Subject to compliance with requirements):
 - 1. Rio Tinto Alcan; Alcan Cable Division.
 - 2. Southwire Company/ American Insulated Wire Corp.
 - 3. Prysmian/General Cable Corporation.
 - 4. Other Approved Equal.
- B. Product Description:
 - 1. Single conductor insulated wire.
- C. Conductor:
 - 1. Copper.
- D. Insulation Voltage Rating:
 - 1. 600 V.
- E. Insulation Temperature Rating:
 - 1. 90°C

2.2 WIRING CONNECTORS

- A. Available Manufacturers (Subject to compliance with requirements):
 - 1. Atkore/AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; Appleton Electrical Co.
 - 4. 3M; Electrical Products Division.
 - 5. TE Connectivity.
 - 6. ABB Group
 - 7. ECM Industries/ILSCO
 - 8. Ideal Industries Inc.
 - 9. Leviton
 - 10. Other Approved Equal.

2.3 TERMINATIONS

- A. Terminal Lugs for Wires 6 AWG and Smaller:
 - 1. Solderless, compression type copper.
- B. Lugs for Wires 4 AWG and Larger:
 - 1. Color keyed, compression type copper, with insulating sealing collars.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Service Entrance and Feeders:

1. Copper, stranded.
- B. Branch Circuits:
 1. Copper. Stranded for No. 8 AWG and larger.
- C. Motor branch circuits and other vibration applications:
 1. Copper, stranded.
- D. Control circuits:
 1. Copper, stranded.

3.2 CONDUCTOR INSULATION APPLICATIONS

- A. Service Entrance:
 1. Type USE-2, RHW-2, or XHHW-2, single conductors in raceway.
- B. Feeders:
 1. Type XHHW-2 single conductors in raceway.
- C. Feeders in Cable Tray:
 1. Type XHHW-2, single conductors in raceway for larger than 4/0 AWG; otherwise type TC tray cable.
- D. Branch Circuits:
 1. Type XHHW-2 or THWN-2, single conductors in raceway.
- E. Variable Frequency Drive Circuits:
 1. Shielded three conductor cable with symmetrical ground conductors, identified for use in VFD applications up to 2000V.
- F. Cord Drops and Portable Appliance Connection:
 1. Type SO, hard service cord with stainless steel, wire mesh, strain relief device at terminations to suit application.
- G. Control Circuits:
 1. Type THWN-2 or XHHW-2, in raceway.

3.3 CONDUCTOR SIZING

- A. Not smaller than 12 AWG for power and lighting circuits.
- B. Not smaller than 14 AWG for control circuits.
- C. Increase wire size in branch circuits to limit voltage drop to a maximum of 3%.

3.4 EXAMINATION

- A. Verify interior of building has been protected from weather.
- B. Verify mechanical work likely to damage wire and cable has been completed.
- C. Verify raceway installation is complete and supported.

3.5 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.6 EXISTING WORK

- A. Remove exposed abandoned wire and cable. Patch surfaces where removed cables pass through building finishes.
- B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.
- C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.
- D. Extend existing circuits using materials and methods as specified.
- E. Clean and repair existing wiring and cable remaining, or wire and cable to be reinstalled.

3.7 INSTALLATION

- A. All wiring shall be installed in a raceway.
- B. Route wire and cable to meet Project conditions.
- C. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- D. Conceal cables in finished walls, ceilings, and floors, unless otherwise specified.
- E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- H. Support cables according to Section 26 05 29 – Hangers and Supports for Electrical Systems.
- I. Identify and color code wire and cable under provisions of Section 26 05 53 – Identification for Electrical Systems. Identify each conductor with its circuit number or other designation specified.
- J. Special Techniques:
 - 1. Building Wire in Raceway:
 - a. Pull conductors into raceway at same time.
 - b. Install building wire 4 AWG and larger with pulling equipment.
 - 2. Wiring Connections:
 - a. Clean conductor surfaces before installing lugs and connectors.
 - b. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

- c. Tape uninsulated conductors and connectors with electrical tape to 150% of insulation rating of conductor.
 - d. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
 - e. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
 - f. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- K. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not specified, use those specified in UL 486A and UL 486B.
- L. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
- M. Wiring at Outlets:
 - 1. Install conductor at each outlet, with at least 6 in. of slack.
- N. Cable splicing, in general, will not be allowed without prior approval from Engineer or Owner. Where applicable, all wiring connections to be made using terminal block type connections. Wire nut use is only permitted in outlet boxes for receptacle or switch wiring.
- O. Install crimp on fork terminals for device terminations with stranded wire. Do not place bare stranded conductors directly under screws.
- P. Install terminal lugs on ends of 600 V wires unless lugs are furnished on connected device, such as circuit breakers.
- Q. Size lugs in accordance with manufacturer's recommendations for terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.
- R. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2 1/2 times normal potential of circuit.

3.8 WIRE COLOR

- A. General:
 - 1. For wire sizes 10 AWG and smaller, install wire colors as specified:
 - a. Black and red for single phase circuits at 120/240 V.
 - b. Black, red, and blue for circuits at 120/208 V single or three phase.
 - c. Orange, brown, and yellow for circuits at 277/480 V single or three phase.
 - 2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices, and boxes. Colors are:
 - a. Black and red for single phase circuits at 120/240 V.
 - b. Black, red, and blue for circuits at 120/208 V single or three phase.
 - c. Orange, brown, and yellow for circuits at 277/480 V single or three phase.
- B. Neutral Conductors:
 - 1. White. When two or more neutrals are in one conduit, individually identify each with proper circuit number.
- C. Branch Circuit Conductors:
 - 1. Install three or four wire home runs with each phase uniquely color coded.

- D. Feeder Circuit Conductors:
 - 1. Uniquely color code each phase.
- E. Ground Conductors:
 - 1. For 6 AWG and smaller: Green.
 - 2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.9 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS.
- B. Perform tests and inspections and prepare test reports.
 - 1. Megger Test of individual conductors to ground after installation. Prepare megger test reports and submit to Engineer.
 - 2. Visual observation of conductor at accessible locations.
- C. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance:
 - a. All panel feeders.
 - b. All motor feeders.
 - c. All control wires for continuity.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Test Reports:
 - 1. Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Electrical grounding and bonding as specified in Drawings and as specified. Grounding and bonding are defined as encompassing systems, circuits, and equipment.
 - 2. Applications of electrical grounding and bonding include:
 - a. Metal underground water pipe.
 - b. Metal building frame.
 - c. Underground structures.
 - d. Concrete-encased electrode.
 - e. Structural Steel.
 - f. Electrical power systems.
 - g. Counterpoise grounding loops.
 - h. Separately derived systems.
 - i. Raceways.
 - j. Service equipment.
 - k. Equipment.

1.2 REFERENCES

- A. IEEE (Institute of Electrical and Electronics Engineers):
 - 1. 81 – Guide for Measuring Ground Resistance, and Potential Gradient in the Earth.
 - 2. 42 – Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 3. 1100 – Recommended Practice for Powering and Grounding Electronic Equipment.
- B. NETA (International Electrical Testing Association):
 - 1. ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. NECA (National Electrical Contractors Association) Installation Standards.
- D. NFPA (National Fire Protection Association):
 - 1. 70 – National Electrical Code.
 - 2. 780 – Lighting Protection Code.
- E. UL LCC:
 - 1. 467 – Electrical Grounding and Bonding Equipment.

1.3 SYSTEM DESCRIPTION

- A. Grounding systems use the following elements as grounding electrodes:
 - 1. Metal underground water pipe.
 - 2. Metal building frame.
 - 3. Concrete-encased electrode.
 - 4. Rod electrode.

1.4 PERFORMANCE REQUIREMENTS

- A. Grounding System Maximum Resistance:
 - 1. 10 ohms maximum.

- B. Excessive Ground Resistance:
 - 1. If resistance to ground exceeds specified value, notify Engineer promptly and include recommendations to reduce ground resistance.

1.5 SUBMITTALS

- A. Subject to requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit data on grounding electrodes and connections.
- C. Test Reports:
 - 1. Specify overall resistance to ground.
- D. Manufacturer's Installation Instructions:
- E. Project Record Documents:
 - 1. Record actual locations of components and grounding electrodes.

1.6 QUALITY ASSURANCE

- A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

1.7 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer:
 - 1. Company specializing in performing work of this section with minimum 3 years documented experience approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.9 COORDINATION

- A. Complete grounding and bonding of building reinforcing steel prior to concrete placement.

1.10 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide grounding and bonding products from ONE for each type of product.
- B. Acceptable Manufacturers:
 - 1. Grounding Products:
 - a. Advanced Lightning Technology.
 - b. Anderson/Square D.
 - c. Burndy LLC.
 - d. Cadweld Div.; Erico Products Inc.
 - e. Crouse-Hinds Div.; Cooper Industries.
 - f. Erico-International Corporation.
 - g. Fushi-Copperweld Inc.
 - h. Harger Lighting and Grounding.
 - i. Ideal Industries, Inc.
 - j. Joslyn Corporation.
 - k. Myers Electric Products, Inc.
 - l. O.Z. Gedney Div.; General Signal Corp.
 - m. Thomas & Betts Corp.
 - n. Or equal.

2.2 ROD ELECTRODES

- A. Product Description:
 - 1. Material: Copper-clad steel or copper-alloy, sectional type or pointed rods.
 - 2. Diameter: 3/4 in.
 - 3. Length: 10 ft.

2.3 WIRE

- A. Insulated Conductors:
 - 1. Stranded copper wire insulated for 600V.
- B. Direct Buried Bare Conductors:
 - 1. Stranded tinned copper.
- C. Above Grade Bare Conductors:
 - 1. Stranded copper.
- D. Foundation Electrodes:
 - 1. Size per NEC or as specified in Drawings, minimum #4AWG.
- E. Grounding Electrode Conductor:
 - 1. Size per NEC or as specified in Drawings, minimum #4AWG.

2.4 GROUNDING BUS BARS

- A. Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 in. by 4 in. in cross section, length as required for the application. The bus bar shall be mounted using steel brackets and UL-listed standoff insulators rated for a minimum of 2500V.

2.5 BONDING PLATES, CONNECTORS, TERMINALS, AND CLAMPS:

A. Description:

1. Provide electrical bonding plates, connectors, terminals, lugs, and clamps as recommended by bonding plate, connector, terminal, and clamp manufacturers for specified applications.
2. Bolted Connectors for Conductors and Pipes: Copper or copper-alloy, pressure type with at least two silicon bronze or stainless-steel bolts and lock washers.
3. Irreversible Compression Fittings: Pure wrought copper extrusion clamps and connectors, made to be held in the dies of an installation tool. Connectors must be factory filled with an oxide inhibitor.
4. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
5. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals and long-barrel, two-bolt connection to ground bus bar.

2.6 EXOTHERMIC CONNECTIONS

A. Product Description:

1. Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.7 GROUND CLIPS:

- ### A.
- A 2 in. by 6 in. by 1/4 in. galvanized steel plate with hole for 1/2 in. hardware. Clip shall be welded to structural steel to facilitate bonding.

PART 3 - EXECUTION

3.1 EXAMINATION

- ### A.
- Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

- ### A.
- Remove paint, rust, mill oils, surface contaminants at connection points.

3.3 GROUNDING APPLICATIONS

- ### A.
- Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise specified.
- ### B. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 2. Underground Connections: Welded connectors except at test wells and as otherwise specified.
 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 4. Connections to Structural Steel: Bolted connectors.

3.4 GROUNDING INSTALLATION

- ### A.
- Install as specified in IEEE 142 1100.
- ### B.
- Install grounding and bonding conductors concealed from view.

- C. Test Wells: Install grounding test well box with cover at rod locations as specified in Drawings, or a minimum of one per service. Install well cover flush with finished grade.
- D. Bond together metal siding not attached to grounded structure; bond to ground.
- E. Bond together each metallic raceway, pipe, duct, and other metal object entering a structure. Install 2 AWG bare copper bonding conductor.
- F. Permanently ground entire light and power system as specified in NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed noncurrent carrying metal parts of electrical equipment.
- G. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.
- H. Equipment Grounding Conductor:
 - 1. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors as specified in NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on conduit box fittings.
- I. Grounding Conductors:
 - 1. Route along shortest and straightest paths possible, unless otherwise specified by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- J. Common Ground Bonding with Lightning Protection System:
 - 1. See NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.
- K. Ground rods:
 - 1. Drive rods until tops are 2 in. below finished floor or final grade, unless otherwise specified.
 - 2. Install rod electrodes at locations as specified in Drawings. Install additional rod electrodes to achieve specified resistance to ground.
 - 3. Interconnect ground rods with grounding electrode conductor below grade and as otherwise specified. Make connections without exposing steel or damaging coating, if any.
- L. Bonding Straps and Jumpers:
 - 1. Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 2. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 3. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 4. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

M. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit from building's main service equipment, or grounding bus, to main metal water service entrance to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

N. Bonding Interior Metal Ducts:

1. Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

O. Grounding for Steel Building Structure:

1. Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft apart.

P. Ground Ring:

1. Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column and specified item, extending around the perimeter of building.
2. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
3. Bury ground ring not less than 24 in from building foundation at a depth not less than 30 in. below finished grade.

Q. Ufer Ground (Concrete-Encased Grounding Electrode):

1. Fabricate as specified in NFPA 70, using a minimum of 20 ft of bare copper conductor not smaller than No. 4 AWG.
2. If concrete foundation is less than 20 ft long, coil excess conductor within base of foundation.

R. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

S. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.5 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. See ANSI/IEEE C2 grounding requirements.

B. Grounding Manholes:

1. Install a driven ground rod through manhole floor, close to wall, and set rod depth so 4 in. will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 in. above to 6 in. below concrete. Seal floor opening with waterproof, non-shrink grout.

- C. Grounding Connections to Manhole Components:
 - 1. Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Equipment:
 - 1. Install four ground rods and ground ring around the pad for outdoor transformers, generators, or switchgear. Ground pad-mounted equipment and noncurrent-carrying metal items associated with equipment by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 in. from the foundation.

3.6 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
- B. Air-Duct Equipment Circuits:
 - 1. Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing and Antifrost Heating Cables:
 - 1. Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment and components.
- D. Metal Poles Supporting Outdoor Lighting fixtures:
 - 1. Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.7 FIELD QUALITY CONTROL

- A. Inspect and test as specified in NETA ATS.
- B. Perform ground resistance testing as specified in IEEE 142.
- C. Perform continuity testing as specified in IEEE 142.
- D. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Test completed grounding system at service disconnect enclosure grounding terminal at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method as specified in IEEE 81.
 - 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

END OF SECTION

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Conduit supports.
 - 2. Formed slotted support channel.
 - 3. Spring steel clips.
 - 4. Equipment bases and supports.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete.

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Specify system layout with location and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
- D. Design Data:
 - 1. Specify load carrying capacity of trapeze hangers and hangers and supports.
- E. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
- F. Manufacturer's Certificate:
 - 1. Certify products meet or exceed specified requirements.

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing Products specified in this section with minimum five years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.6 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
 - 1. Atkore/Allied Tube & Conduit.
 - 2. Cooper B-Line, Inc, a division of Eaton Corp.
 - 3. ERICO International Corporation, a nVent brand.
 - 4. GS Metals Corp.
 - 5. Thomas & Betts Corporation, a division of ABB.
 - 6. Atkore/Unistrut.
 - 7. Wesanco, a Zsi-Foster brand.
 - 8. Other Approved Equal.
- B. Hanger Rods:
 - 1. Threaded high tensile strength with free running threads.
- C. Beam Clamps:
 - 1. With tapered hole in base and back to accept either bolt or hanger rod.
- D. Conduit clamps:
 - 1. For Trapeze Hangers:
 - a. Notched to fit trapeze with single bolt to tighten.
 - 2. General Purpose:
 - a. One hole for surface mounted conduits.

2.2 FORMED SLOTTED SUPPORT CHANNEL

- A. Manufacturers:
 - 1. Atkore/Allied Tube & Conduit.
 - 2. Cooper B-Line, Inc.; a division of Eaton Corp.
 - 3. ERICO International Corporation, a nVent brand.
 - 4. GS Metals Corp.
 - 5. Thomas & Betts Corporation, a division of ABB.
 - 6. Atkore/Unistrut.
 - 7. Wesanco, a Zsi-Foster brand
 - 8. Or equal.
- B. Product Description:
 - 1. Factory fabricated slotted support channels with holes 1 1/2 in. on center, as specified in MFMA-4.

2.3 SPRING CLIPS

- A. Manufacturers:
 - 1. Atkore/Allied Tube & Conduit.
 - 2. Cooper B-Line, Inc.; a division of Eaton Corp.
 - 3. ERICO International Corporation, a nVent brand.
 - 4. GS Metals Corp.
 - 5. Thomas & Betts Corporation, a division of ABB.
 - 6. Atkore/Unistrut.

7. Wesanco, a Zsi-Foster brand
8. Or equal.

- B. Product Description:
1. Mounting hole and screw closure.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS APPLICATION

- A. Outdoor Locations
1. Slotted support channels shall be PVC-Coated steel or stainless steel.
 2. Clips, clamps, threaded rods, and fastening hardware shall be stainless steel.
- B. Dry Indoor Locations:
1. Slotted support channels shall be galvanized steel.
 2. Clips, clamps, threaded rods, and fastening hardware shall be galvanized steel.
- C. Damp or Wet Indoor Locations:
1. Slotted support channels shall be galvanized steel.
 2. Clips, clamps, threaded rods, and fastening hardware shall be galvanized steel.
- D. Chemical Rooms:
1. Slotted support channels shall be FRP where PVC conduit is installed.

3.2 HANGERS AND SUPPORTS INSTALLATION

- A. See NECA 1 and NECA 101 for application of hangers and supports for electrical system except if requirements in this Section are stricter.
- B. Anchors and Fasteners:
1. Concrete Structural Elements: Provide precast inserts, expansion anchors, powder actuated anchors and preset inserts.
 2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
 3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners. Do not mount electrical panels directly to hollow walls – provide slotted support channels attached to wall studs for panel mounting.
 5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
 6. Sheet Metal: Provide sheet metal screws.
 7. Wood Elements: Provide wood screws.
- C. Inserts:
1. Install inserts for placement in concrete forms.
 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 in.
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- D. Install conduit and raceway support and spacing as specified in NEC.
- E. DO NOT fasten supports to pipes, ducts, mechanical equipment, or conduit.

- F. Install multiple conduit runs on common hangers, sized for 25% spare capacity for future raceways.
- G. Slotted support channels supported from threaded hanger rods shall be secured with double nuts.
- H. Supports:
 - 1. Fabricate supports from structural steel or formed metal channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
 - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 - 3. Install channel supports to stand cabinets and panelboards 1 in. off wall.
 - 4. Support vertical conduit at every floor.
- I. Strength of Support Assemblies:
 - 1. Where not specified, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs.

3.3 EQUIPMENT BASES AND SUPPORTS INSTALLATION

- A. Provide housekeeping pads of concrete, minimum 4 in. thick and extending 6 in. beyond supported equipment. See Section 03 30 00 – Cast in Place Concrete.
- B. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts as specified in anchor-bolt manufacturer's written instructions.

END OF SECTION

SECTION 26 05 33 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Surface raceways, fittings, outlet boxes, pull and junction boxes, and conduit sleeves for electrical systems.

1.2 REFERENCES

- A. ANSI (American National Standards Institute):
 - 1. C80.1 – Rigid Steel Conduit, Zinc Coated.
 - 2. C80.3 – Specification for Electrical Metallic Tubing, Zinc Coated.
 - 3. C80.5 – Aluminum Rigid Conduit – (ARC).
- B. NEMA (National Electrical Manufacturers Association):
 - 1. 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. OS 1 – Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. OS 2 – Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 5. RN 1 – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 6. TC 2 – Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 7. TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Liquidtight flexible metal conduit.
 - 2. Nonmetallic conduit.
 - 3. Flexible nonmetallic conduit.
 - 4. Nonmetallic tubing.
 - 5. Raceway fittings.
 - 6. Conduit bodies.
 - 7. Surface raceway.
 - 8. Pull and junction boxes.
- C. Manufacturer's Installation Instructions:
 - 1. Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- D. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual routing of all conduits.
 - b. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.4 SYSTEM DESCRIPTION

- A. Raceway and boxes located as specified in Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are specified in approximate locations unless dimensioned. Provide raceway to complete wiring system.

1.5 DESIGN REQUIREMENTS

- A. Minimum Raceway Size:
 - 1. 3/4 in. unless otherwise specified.
- B. Flexible Conduit Connections:
 - 1. Use maximum of 36 in. of flexible conduit for equipment subject to vibration, noise transmission, or movement.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- B. Protect PVC conduit from sunlight.

1.7 COORDINATION

- A. Coordinate mounting heights, orientation, and locations of outlets mounted above counters, benches, and backsplashes.

1.8 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Manufacturers:
 - 1. Atkore/AFC Cable Systems, Inc.
 - 2. Southwire Co./Alflex Inc.
 - 3. Atkore/Allied Tube & Conduit.
 - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 5. Electri-Flex Co.
 - 6. Manhattan/CDT/Cole-Flex, a brand for Alpha Wire.
 - 7. Tenaris.
 - 8. O-Z Gedney; a unit of General Signal.
 - 9. Wheatland Tube Company.
 - 10. EGS/Appleton Electric.
 - 11. Republic Conduit.
 - 12. Thomas & Betts Corporation; A Member of the ABB Group.
 - 13. Western Tube & Conduit Corporation.
 - 14. Other Approved Equal.
- B. Rigid Steel Conduit:
 - 1. ANSI C80.1 and UL 6.

- C. Rigid Aluminum Conduit:
 - 1. ANSI C80.5.
- D. Fittings and Conduit Bodies:
 - 1. NEMA FB 1; material to match conduit.
- E. Threaded Joint Compound:
 - 1. UL listed for use in conduit assemblies, to lubricate and protect threaded conduit joints from corrosion and to enhance conductivity.
 - 2. Eaton STL8 or equal.

2.2 PVC COATED METAL CONDUIT

- A. See Section 26 05 33.13 – PVC Coated Conduit for requirements.
- B. Available Manufacturers (Subject to compliance with requirements):
 - 1. Atkore/AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Dura-Line/Arnco Corp.
 - 4. Cantex Inc.
 - 5. CertainTeed Corp.; Pipe & Plastics Group
 - 6. Condux International, Inc.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT/Cole-Flex, a brand for Alpha Wire.
 - 11. RACO; a Hubbell Company
 - 12. Thomas & Betts Corporation, a division of ABB.
 - 13. Other Approved Equal.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Available Manufacturers (Subject to compliance with requirements):
 - 1. Cooper Crouse-Hinds, a division of Cooper Electric.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company
 - 4. Hoffman, a division of nVent.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division
 - 6. O-Z/Gedney; a unit of General Signal.
 - 7. RACO; a Hubbell company.
 - 8. Scott Fetzer Co./Adalet.
 - 9. Spring City Electrical Manufacturing Company.
 - 10. Stahlin Nonmetallic Enclosures.
 - 11. Carlon, a brand of Thomas & Betts Corporation.
 - 12. Thomas & Betts Corporation, a division of ABB.
 - 13. Legrand/Wiremold Co. (The)
 - 14. Daniel Woodhead Co, a subsidiary of Woodhead Industries, Inc.
 - 15. AFC Cable Systems: a part of Atkore International.
 - 16. Adamet Electrical, Inc.
 - 17. Southwire Company.
 - 18. Other Approved Equal.
- B. Product Description:
 - 1. Interlocked galvanized steel construction with moisture, oil, and sunlight resistant PVC jacket.

- C. Fittings:
 - 1. NEMA FB 1.

2.4 NONMETALLIC CONDUIT

- A. Manufacturers:
 - 1. Carlon, a brand of Thomas & Betts Corporation.
 - 2. EGS/Appleton Electric.
 - 3. Or equal.
- B. Product Description:
 - 1. NEMA TC 2; Schedule 40 or 80 PVC.
- C. Fittings and Conduit Bodies:
 - 1. NEMA TC 3.

2.5 OUTLET AND DEVICE BOXES

- A. Manufacturers:
 - 1. ABB
 - 2. Allied
 - 3. Emerson
 - 4. Eaton
 - 5. Hubbell
 - 6. Or equal.
- B. Sheet Metal Outlet and Device boxes:
 - 1. NEMA OS 1.
- C. Nonmetallic Outlet and Device Boxes:
 - 1. NEMA OS2.
- D. Cast Outlet and Device Boxes:
 - 1. FEMA FB1, Type FD, material to match conduit type. Furnish gasketed cover.
- E. Wall Plates for Finished Areas:
 - 1. As specified in Section 26 27 26 – Wiring Devices.
- F. Wall Plates for Unfinished Areas:
 - 1. Furnish gasketed cover.

2.6 PULL AND JUNCTION BOXES

- A. Manufacturers:
 - 1. nVent Hoffman.
 - 2. Rittal.
 - 3. Eaton.
 - 4. Hubbell
 - 5. Or equal.
- B. Hinged-Cover Enclosures:
 - 1. Continuous-hinge cover with flush latch, unless otherwise specified. NEMA 250 rating as specified in Part 3.

2.7 HAZARDOUS LOCATION CONDUIT SEAL FITTINGS

- A. Manufacturers:
 - 1. Eaton.
 - 2. Emerson.
 - 3. Or equal.
- B. UL listed seal fitting designed to restrict the passage of gasses, vapors, or flames from one portion of the conduit system to another. Listed for installation in Class I, Division 1 & 2 locations.
- C. Material type to match installed conduit material type. Designed for installation in vertical or horizontal positions.

2.8 RACEWAY SLEEVES

- A. Provide round galvanized steel or cast-iron conduit raceway sleeves when penetrating conduit through masonry or concrete walls.
 - 1. Steel Wall Sleeves: ASTM A53, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral water-stop.
 - 2. Cast-Iron Wall Sleeves: Cast or fabricated wall pipe, equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop.

2.9 SLEEVE SEALING SYSTEM

- A. Available Manufacturers (Subject to compliance with requirements):
 - 1. Advance Products & systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Other Approved Equal.
- B. Description:
 - 1. Modular elastomer sealing system, designed for field assembly, to provide weatherproof seal of annular space between sleeve and conduit.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoor Locations:
 - 1. Exposed: PVC-Coated Rigid Steel
 - 2. Connection to Vibrating Equipment (Transformers, Motors, etc.): Liquid-tight Flexible Metal Conduit (LFMC)
- B. Indoor Locations:
 - 1. Exposed Clean and Dry Locations: Galvanized Rigid Steel
 - 2. Exposed Damp or Wet Locations: PVC-Coated Rigid Steel
 - 3. Concealed above ceilings or in walls: Electric Metallic Tubing (EMT) with compression fittings.

4. Chemical Rooms: PVC-Coated Rigid Steel through concrete slabs to a minimum height of 18 in. above grade, then transition to PVC schedule 80.
5. Connection to Vibrating Equipment (Transformers, Motors, etc.): Liquid-tight Flexible Metal Conduit (LFMC)

C. Underground Locations:

1. See Section 26 05 43 – Underground Ducts and Boxes for Electrical Systems for underground raceway applications.

3.2 BOX APPLICATION

A. Outdoor Locations:

1. Pull or Junction Boxes: NEMA 4X stainless steel
2. Device or Outlet Boxes: NEMA FB1 Type FD PVC-coated cast metal with gasketed covers.

B. Indoor Locations:

1. Dedicated Locations (Electrical Rooms):
 - a. Pull or Junction Boxes: NEMA 1
 - b. Surface Mount Device or Outlet Boxes: NEMA FB1 Type FD cast metal.
 - c. Recessed or Concealed Device or Outlet Boxes: NEMA OS1 sheet metal
2. Dry Nondedicated Locations (subject to Dust, Dirt only):
 - a. Pull or Junction Boxes: NEMA 12
 - b. Surface Mount Device or Outlet Boxes: NEMA FB1 Type FD cast metal with gasketed covers
3. Damp or Wet Locations:
 - a. Pull or Junction Boxes: NEMA 4X stainless steel
 - b. Surface Mount Device or Outlet Boxes: NEMA FB1 Type FD **PVC-coated** cast metal with gasketed covers.
4. Chemical Rooms:
 - a. Pull or Junction Boxes: NEMA 4 PVC
 - b. Surface Mount Device or Outlet Boxes: NEMA OS2 PVC

C. Underground Locations

1. See Section 26 05 43 – Underground Ducts and Boxes for Electrical Systems for underground box applications.

3.3 EXAMINATION

- A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.4 GENERAL INSTALLATION

- A. Ground and bond raceway and boxes as specified in Section 26 05 26 – Grounding and Bonding.
- B. Fasten raceway and box supports to structure and finishes as specified in Section 26 05 29 – Hangers and Supports.
- C. Identify raceway and boxes as specified Section 26 05 53 – Identification for Electrical Systems.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance. Route raceway parallel and perpendicular to walls.

3.5 RACEWAY INSTALLATION

- A. Raceway routing is specified in approximate locations unless dimensioned. Route to complete wiring system.
- B. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- C. Arrange raceway supports to prevent misalignment during wiring installation.
- D. Support raceway using coated straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- E. Group related raceway; support using conduit rack. Construct rack using channel supports specified in Section 26 05 29 – Hangers and Supports; provide material type to match provided conduit material type. Provide space on each for 25% additional raceways.
- F. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary support. Do not attach raceway to ceiling support wires or other piping systems.
- G. Maintain clearance between raceway and piping for maintenance purposes. Maintain 12 in. clearance between raceway and surfaces with temperatures exceeding 104°F.
- H. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- I. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions:
 - 1. Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Aluminum raceway shall not be installed in contact with concrete or earth.
- L. Install weatherproof conduit hubs with grounding bushing and insulated throat, to fasten rigid metal conduit to boxes. Hub material type shall match conduit material type and shall provide a NEMA rating equal to or greater than the NEMA rating of the box.
- M. Install insulating bushings and inserts at raceway connections to boxes, corner fittings, or locations subject to vibration.
- N. Install no more than equivalent of three 90-degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 in. size.
- O. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- P. Install suitable pull string or cord in each empty raceway except sleeves and nipples. Leave at least 12 in. of slack at each end of pull wire.
- Q. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- R. Cord Fittings:

1. Where exposed cords or cables emerge from a raceway system, install gasketed weatherproof cord fittings to seal raceways and protect cords from damage. Cord fittings shall include an elastomeric grommet seal designed to be tightened around the cable for a weathertight seal.
 2. Where cord fitting is installed within a hazardous location, provide fitting that is UL listed for the defined hazardous classification.
 3. Cord fitting material shall match the conduit material type.
- S. Expansion and Deflection Couplings:
1. Install an expansion coupling in each run of exterior aboveground conduit that has straight-run length that exceeds 100 ft for rigid metal conduit, or 25 ft for PVC conduit, to account for thermal expansion. Provide type and quantity of fittings for each run to accommodate a 125°F temperature change.
 2. Provide an expansion and/or deflection coupling where conduit crosses a structural joint intended for expansion, contraction, or deflection.
 3. Install each coupling with position, mounting and piston setting selected as specified in manufacturer's written instructions for conditions at specific location at the time of installation.
- T. Raceways Embedded in Slabs:
1. Run conduit parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 2. Do not embed conduits larger than 1 1/2 in. in slabs. Conduits larger than 1 1/2 in. shall be routed below concrete slabs.
 3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 4. Do not install conduits in such a manner as to compromise the structural integrity of walls, roofs, ceilings, or floor. Where necessary, provide additional supporting members to support conduit runs.
 5. Comply with Chapter 6 of ACI 318.
 6. Change from nonmetallic conduit to Galvanized Rigid Steel or PVC-Coated Rigid Steel Conduit before rising above the floor.
- U. Raceway Seals:
1. Install raceway sealant compound within the interior of raceways at suitable, approved, and accessible locations. Sealants shall be identified for use with the cable insulation, shield, or other components. Install raceway seals at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or boundaries from exterior to interior locations.
 - b. Service raceway building entrances.
 - c. All spare or unused raceways.
 - d. Where otherwise required by NFPA 70.
- V. Hazardous Locations:
1. Boundary Seals: Provide hazardous location conduit seal fittings at boundaries to hazardous locations following the requirements of NEC Article 500 and Article 501.
 2. When conduit is installed within hazardous locations, provide material that is UL listed for the defined hazardous classification, and install per requirements of NEC Article 500 and Article 501.
- W. Conduit Wall or Floor Penetrations:
1. Seal all conduit penetrations through non-fire-rated walls and slabs with a weatherproof sealant, non-shrink grout, or sleeve seal system meeting the requirements of this section.
 2. Firestopping: Install conduit in a manner to preserve fire resistance rating of walls.
 3. Do not penetrate conduits through wet well walls below the high-level water mark.
 4. Coordinate installation of conduit wall sleeves prior to concrete placement.

3.6 BOXES INSTALLATION

- A. Install wall mounted boxes at elevations to accommodate mounting heights as specified in Drawings.
- B. Recessed Boxes in Masonry Walls:
 - 1. Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Coordinate masonry cutting to achieve neat opening.
- C. Adjust box location prior to rough-in to accommodate intended purpose.
- D. Orient boxes to accommodate wiring devices.
- E. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- F. In Accessible Ceiling Areas:
 - 1. Install outlet and junction boxes no more than 6 in. from ceiling access panel or from removable recessed luminaire.
- G. DO NOT install flush mounting box back-to-back in walls; install with minimum 6 in. separation.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. DO NOT fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.
- N. Install gang box where more than one device is mounted together. DO NOT use sectional box.
- O. Install gang box with plaster ring for single device outlets.
- P. Hazardous Locations:
 - 1. When boxes are installed within hazardous locations, provide material that is UL listed for the defined hazardous classification, and install per requirements of NEC Article 500 and Article 501.

3.7 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused openings in boxes.

3.8 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 05 33.13 – PVC COATED CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. PVC coated raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections:
 - 1. Section 26 05 33 – Raceway and Boxes for Electrical Systems

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.
- C. Custom enclosures and cabinets.
- D. Source quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories:
 - 1. Listed and labeled as specified in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. See NFPA 70.
- C. All the conduit, fittings, and supporting products shall be provided by the same manufacturer to make sure that a five-year product warrantee is achieved.

1.4 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers (Subject to requirements):
 - 1. Robroy (Perma-Cote/Plasti-Bond)
 - 2. Atkore/Calbond

2.2 MATERIALS

- A. PVC coated, Galvanized Rigid Conduit and fittings shall meet all the performance standards specified and such performance standards shall require verification by a nationally recognized testing agency including ASTM (American Society for Testing and Materials) and UL (Underwriter Laboratories).
- B. The PVC coated galvanized rigid conduit shall be UL Listed.

1. The PVC coating shall have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit.
 2. Ferrous fittings for general service locations shall be UL Listed with PVC as the primary corrosion protection.
 3. Hazardous location fittings, prior to plastic coating shall be UL listed.
 4. All conduits and fittings shall be new, unused material.
 5. Applicable UL standards shall include:
 - a. UL 6 Standard for Safety, Rigid Metal Conduit.
 - b. UL 514B Standard for Safety, Fittings for Conduit and Outlet Boxes.
- C. The PVC coated galvanized rigid conduit shall be Electrical Testing Laboratory (ETL) Verified to the Intertek ETL SEMKO High Temperature H2O PVC Coating Adhesion Test Procedure for 200 hours. The PVC coated galvanized rigid conduit shall bear the ETL Verified PVC-001 label to signify compliance to the adhesion performance standard.
- D. The conduit shall be hot dip galvanized inside and out with hot galvanized threads.
- E. A PVC sleeve extending one pipe diameter or two in, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.
- F. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs 40 mils in thickness to protect the coating from tool damage during installation.
- G. Form 8 Condulets, 1/2 in. – 2 in. diameters, shall have a V-seal tongue-in-groove gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hrs. shall be available. Form 8 Condulets shall be supplied with plastic encapsulated stainless steel cover screws.
- H. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable.
- I. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1°C).
- J. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.
- K. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.
- L. Independent certified test results shall be available to confirm coating adhesion:
 1. Conduit and conduit exposure to 150°F (65°C) and 95% relative humidity with a minimum mean time to failure of 30 days (ASTM D1151).
 2. The interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
 3. No trace of the internal coating shall be visible on a white cloth following six wipes over the coating which has been wetted with acetone (ASTM D1308).
 4. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.

- M. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit. All U bolts shall be supplied with plastic encapsulated nuts that cover the exposed portions of the threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All clamping, cutting, threading, bending, and assembly instructions listed in the manufacturer's installation guide should be vigorously followed.
- B. Installation of the PVC Coated Conduit System shall be performed as specified in the Manufacturer's Installation Manual. To make sure of correct installation, the installer shall be certified by Manufacturer to install coated conduit.
- C. Installer certification, before installation, is required.
- D. Clamps, bolts, angles, pipe straps, struts, rods, nuts, and other supporting products for PVC coated conduits shall be PVC coated or stainless steel.
- E. The Contractor shall use equipment specifically designed for PVC coated conduit when cutting, clamping, reaming, threading, bending, assembling, or performing other installation procedures. PVC coating shall be protected.
- F. Where PVC-coated conduit transitions to liquid-tight flexible metal conduit, utilize PVC-coated couplings on both ends of the liquid-tight flexible metal conduit connection.
- G. Touchup compound for PVC coated conduit shall NOT be allowed. All conduits with damaged coatings shall be removed and replaced at no cost to Owner.

END OF SECTION

SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Labels.
 - 3. Wire markers.
 - 4. Underground Warning Tape.
 - 5. Lockout Devices.

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit manufacturer's catalog literature for each product required.
 - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
- C. Samples:
 - 1. Submit two samples of each type of identification products applicable to project.
 - 2. Submit two nameplates, 4 in. by 4 in. in size illustrating materials and engraving quality.
- D. Manufacturer's Installation Instructions:
 - 1. Specify installation instructions, special procedures, and installation.

1.3 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer:
 - 1. Company specializing in performing Work of this section with minimum three years documented experience.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Accept identification products on site in original containers. Inspect for damage.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Install labels nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

1.6 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Available Manufacturers:
 - 1. Craftmark Pipe Markers
 - 2. Kolbi Pipe Marker Co.
 - 3. Pipemarket.com; Brimar Industries, Inc.
 - 4. Seton Identification Products: Brady corporation Co.
 - 5. Approved equal.
- B. Product Description:
 - 1. Laminated three-layer plastic with engraved white letters on black contrasting background color.
- C. Letter Size:
 - 1. As specified in Drawings.
- D. Engraved, laminated acrylic or melamine plastic, minimum 1/16 in. thick for signs up to 20 in² and 1/8 in. thick for larger sized.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.2 LABELS

- A. Available Manufacturers:
 - 1. Brady Identification Inc.
 - 2. Seton Identification Products: Brady corporation Co.
 - 3. Approved equal.
- B. Comply with NFPA 70 and 29 CFR 1910.145 and NFPA 70E.
- C. Self-Adhesive Warning Labels:
 - 1. Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door or other access to equipment unless otherwise specified.
- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 in. galvanized-steel backing; and with colors, legend and size required for application. 1/4 in. grommets in corners for mounting. Nominal size, 10 in. by 14 in.
- E. Sample warning label and sign shall include, but are not limited to the following legends:
 - 1. Multiple Power source Warning:
 - a. "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning:
 - a. "WARNING – OSHA REGULATION – AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR"
 - 3. WARNING – ARC FLASH AND SHOCK HAZARD –APPROPRIATE PPE REQUIRED.

2.3 WIRE MARKERS

- A. Available Manufacturers:
 - 1. Brady ID.
 - 2. Grafoplast Wire Markers.
 - 3. Ideal Industries, Inc.
 - 4. Approved equal.
- B. Description:
 - 1. Cloth tape, split sleeve, or tubing type wire markers.
- C. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number as specified in Drawings.
 - 2. Control Circuits: Control wire number as specified in Drawings.

2.4 UNDERGROUND WARNING TAPE

- A. Available Manufacturers:
 - 1. Brady ID.
 - 2. Kolbi Pipe Marker Co.
 - 3. Seton Identification Products: Brady corporation Co.
 - 4. Approved equal.
- B. Description:
 - 1. 3 in. wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

2.5 LOCKOUT DEVICES

- A. Lockout Hasps:
 - 1. Available Manufacturers:
 - a. Brady Identification Inc.
 - b. Seton Identification Products: Brady corporation Co.
 - c. Approved equal.
 - 2. Anodized aluminum with reinforced nylon hasp with erasable label surface; size minimum 7 1/4 in. by 3 in.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 APPLICATION

- A. Outlet Boxes for Receptacles:
 - 1. Identify branch circuit by panel name and circuit number.
- B. Power-Circuit Conductor Identification:
 - 1. Of secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- C. Branch-Circuit Conductor Identification:

1. Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor as specified in source and circuit number.
- D. Auxiliary Electrical Systems Conductor Identification:
1. Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 2. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 3. Use system of marker type designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 4. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting:
1. Comply with 29 CFR 1910.145 and apply metal-backed, butyrate warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 2. Equipment with Multiple Power or Control Sources:
 - a. Apply to door or cover of equipment including, but not limited to the following:
 - b. Power transfer switches
 - c. Controls with external control power connections.
 3. Equipment Requiring Workspace Clearance as specified in NFPA 70:
 - a. Unless otherwise specified, apply to door or cover of equipment, but not on flush panelboards and similar equipment in finished spaces.
- F. Instruction Signs:
1. Operating Instructions:
 - a. Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 2. Emergency Operating Instructions:
 - a. Install instruction signs with white legend on a red background with minimum 3/8 in. high letters for emergency instructions at equipment used for power transfer.
- G. Equipment Identification Labels:
1. On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Transformers.
 - e. Motor-control centers.
 - f. Disconnect switches.
 - g. Enclosed circuit breakers.
 - h. Motor starters.
 - i. Push-bottom stations.
 - j. Power transfer equipment.
 - k. Contactors.
 - l. Remote-controlled switches and control devices.
 - m. Power-generating units.

- n. Voice and data cable terminal equipment.
- o. Terminals, racks and patch panels for voice and data communications and for signal and control functions.

3.3 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location:
 - 1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products:
 - 1. Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less:
 - 1. Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 2. Color shall be factory applied or, for sizes larger than No. 6 AWG if authorities having jurisdiction permit, field applied.
 - 3. Colors for 480/277 V, 3 phase Circuits:
 - a. Phase A: Brown
 - b. Phase B: Orange
 - c. Phase C: Yellow
 - d. Neutral: Gray
 - e. Ground: Green
 - 4. Colors for 240/208/120 V, 3 phase Circuits:
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Phase C: Blue
 - d. Neutral: White
 - e. Ground: Green
 - 5. Colors for 240/120 V, 1 phase Circuits:
 - a. L1: Black
 - b. L2: Black
 - c. N: White
 - d. Ground: Green
 - 6. Cables for systems with a "high-leg" shall be provided with orange color-coding tape on the high leg conductor.
 - 7. Field-Applied, Color-Coding Conductor Tape:
 - a. Apply in half-lapped turns for a minimum distance of 6 in. from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- G. Underground Warning Tape Installation:
 - 1. Install underground warning tape along length of each underground conduit, raceway, or cable 12 in. below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION

SECTION 26 05 93 – ELECTRIC MOTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Materials, installation and testing of induction motors and applies to motors which are generally provided as part of equipment specified in other sections. The Supplier/Manufacturer shall provide motors, accessories, and appurtenances complete and operable as specified in the individual driven equipment sections.

1.2 DEFINITIONS

- A. ODP: Open Drip Proof.
- B. TEFC: Totally Enclosed Fan Cooled.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. For each type of product specified.
 - 2. Complete motor data shall be submitted by Supplier, including:
 - a. Machine name and specification number of driven machine.
 - b. Motor manufacturer.
 - c. Motor type or model and dimensional drawing, including weight.
 - d. Horsepower nominal.
 - e. Guaranteed minimum full load efficiency.
 - 1) Also, nominal efficiencies at 1/2 and 3/4 load.
 - f. Full load speed.
 - g. Full load current at rated horsepower for application voltage.
 - h. Service factor, minimum 1.15.
 - i. Voltage, phase, and frequency rating.
 - j. Winding insulation class.
 - k. Temperature rise class.
 - l. Frame size.
 - m. Enclosure.
 - n. NEMA design.
 - o. Thermal protection or over temperature protection.
 - p. Wiring diagram for devices such as temperature switches, space heaters and motor leak detection as applicable.
 - q. Bearing data, including recommendation of lubricants.
 - r. Inverter duty motor. Include minimum speed at which motors may be operated.
 - s. Power factor at 1/2, 3/4, and full load.
 - t. Complete nameplate data, rating, and characteristics.
 - u. Mounting arrangement, size, and location of conduit entries, including lugs.
 - v. Factory test results for each motor.

1.4 QUALITY ASSURANCE

- A. Provide routine (short commercial) test data complying with NEMA MG 1-12.51 and MG 1-23.46.

- B. Test thermally protected motors as specified in NEMA MG 1 winding temperature and trip current tests.
- C. See NEMA MG 1.

1.5 COORDINATION

- A. Furnish reviewed shop drawings from motor controller manufacturer for coordination and sizing of the controller.
- B. Coordinate supplied motor connection box with conduits sizes specified in Drawings.
- C. Coordinate motor leads and lugs with wire sizes specified in Drawings.

1.6 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

- A. All motors shall be squirrel cage, AC induction type motors. Motor driven by variable frequency drives shall be inverter duty rated. In no case shall starting torque or breakdown torque be less than the value specified in ANSI/NEMA MG 1. In all cases, motor shall be suitable for the specified starting method.
- B. Where motors are controlled by variable frequency drives, the critical vibration speed of the motor/load combination shall either not fall within the operating range of the drive or such frequencies shall be blocked with the drive critical speed avoidance circuit.
- C. Stator winding shall be copper.
- D. The maximum motor loading shall not exceed its nameplate horsepower rating (exclusive of service factor) under any operating condition.
- E. Motors shall be sized to start and accelerate the design loading and operate the full range of driven equipment without exceeding any of the specified design requirements. Motors that fail to meet these requirements shall be replaced at no additional cost to the Owner.
- F. Three phase motors shall be provided with Class F insulation, rated to operate at a maximum ambient temperature of 40°C and at the altitudes where the motors will be installed and operated without exceeding Class B temperature rise limits stated in ANSI/NEMA MG1-12, 42. Motor shall be provided with insulation systems to withstand 1600 V spikes, with dV/dt as specified in NEMA MG 1-31.
- G. Motors shall have a minimum service factor of 1.15.
- H. Motors shall have enclosures suitable for the installed location. Such motors shall be UL listed and stamped.
 - 1. Interior Dry and Clean Locations: TEFC.
 - 2. Interior Damp or Wet Locations: TEFC.
 - 3. Outdoor Locations: TEFC.
 - 4. Hazardous Locations: Motors shall be listed for operation in the installed hazardous location as defined by the NEC and NFPA.

- I. Motors located outdoors or in nonconditioned spaces shall have 120 VAC space heaters. Space heater size and quantity shall be suitable to maintain minimum recommended temperatures for the installed location.
- J. Motors shall be provided with vibration switches where specified on the equipment data sheets or contract drawings. Manufacturer shall be responsible for providing recommended trip settings based on the application.
- K. Where driven by a variable frequency drive and larger than 10 HP, provide a shaft grounding ring meeting the following requirements. Grounding ring shall be factory installed.
 - 1. Aluminum frame and internal components.
 - 2. Conductive microfiber brushes.
 - 3. Maintenance free design.
 - 4. Aegis Bearing Protection Ring or equal.
- L. Unless otherwise specified, motor shall have no-load sound power levels not to exceed the values specified in NEMA MG 1-12.53.3.
- M. Premium Efficiency Motors:
 - 1. Motors with a nameplate rating of 1 hp and larger shall be premium efficiency type motors as determined by the testing set forth in ANSI/IEEE 112 – Standard Test Procedure for Polyphase Induction Motors and Generators, Method B. Motor shall be stamped with the efficiency on the nameplate with the caption “NEMA Nominal Efficiency.”
 - 2. Efficiency index, nominal efficiency and minimum efficiency shall be defined as specified in ANSI/NEMA MG1-12.59 – Efficiency Levels of Energy Efficient Polyphase Squirrel-Cage Induction Motors. All three values are required to be specified in the submittal.

2.2 MOTOR BEARINGS

- A. All motors shall have bearings designed for 17,500 hrs. (belted) or 100,000 hrs. (coupled) L-10 life.
- B. Horizontal motors shall be shielded open-type bearing installed with labyrinth sealed end bells with pipe plugs. Bearings shall be regreasable and have provisions for purging old grease.

2.3 MOTOR THERMAL PROTECTION

- A. Motors shall be provided with winding thermostats where specified on the equipment data sheets or contract drawings, as specified in NEMA MG-1. Thermostats shall be snap action, bimetallic, temperature actuated type switches and shall be provided with a normally closed contact. Thermostats shall be calibrated by the manufacturer and shall be series connected.
- B. All single phase motors shall have integral thermal overload protection or shall be current limited. The motor nameplate shall be stamped specifying integral thermal protection is provided.
- C. Motors shall be provided with winding and bearing RTDs where specified in the equipment data sheets or contract drawings. RTDs shall be PT100 platinum type specified in IEC 60751.

2.4 ACCESSORIES

- A. Motors 1 hp and larger shall have split-type conduit boxes with a gasketed moisture seal between the conduit box and motor frame. Provide quantity and size of conduit knockouts to match the installation requirements.

- B. Motors weighing 250 lbs. or greater shall have suitable lifting eyes for installation and removal.
- C. Motor grounding lugs shall be provided and shall be suitable for terminating ground wires.
- D. Motors shall be fitted with permanent stainless-steel nameplates indelibly stamped or engraved with NEMA Standard motor data.
- E. Provide 120 VAC space heaters, winding thermostats, or RTDs as identified in the equipment data sheets or when specified in Contract Drawings.

PART 3 - EXECUTION

3.1 STORAGE

- A. The Supplier shall coordinate the storage location and delivery to the storage location with the Owner.
- B. Protect motors from exposure to elements for which they are not designed. Install and energize temporary electrical service to motors with electrical heaters.
- C. Store motors in an airconditioned, ventilated, or protected environment like or better than the destination environment.

3.2 INSTALLATION

- A. Contractor shall perform motor installation as specified in the motor manufacturer's written recommendations and the written requirements of the manufacturer of the driven equipment.
- B. Connections, switches, controls, disconnects and other items shall be provided by the Supplier as specified in the plans and specifications for each motor.
- C. The Supplier shall coordinate conduit sizes indicated in the drawings with the supplied motor connection box. The Supplier shall be responsible for providing larger connection boxes as may be required.

3.3 FIELD TESTING

- A. The Contractor shall perform all field testing as facilitated in conjunction with oversight by the Supplier and as specified in both the Manufacturer's recommendations and the requirements specified herein.
- B. Perform insulation resistance tests as specified in NEMA MG-1. Test voltage shall be 1000 VAC plus twice the rated voltage of motor.
- C. Inspect the physical and mechanical conditions of each motor installation including any deviations from the nameplate, drawings, specifications, and manufacturer's written guidelines. Verify expected rated voltage, phase, and frequency for each motor installation. Confirm the presence of and correct application of lubrications for each motor along with proper securing and torque settings for bolted installations of each motor.
- D. Check for proper phase and ground connections for each motor are connected. For multi-voltage motors, verify that motors are connected properly for the supplied voltage.
- E. Verify that space heaters, where provided, are functional.

- F. Test the motor for proper rotation prior to connection to the driven equipment. Measure and record running current and evaluate the current relative to the load conditions and nameplate full-load amps.
- G. Simulate operating conditions for each motor to demonstrate proper operation of interlocks and control features.
- H. Record operating current in each phase for each motor ½ horsepower and larger. Motors exceeding motor nameplates values shall be repaired or replaced.
- I. For motors 50 horsepower and larger or when a discernible abnormal vibration is detectible, a vibration test shall be completed. Vibration shall not exceed 0.25 in/sec. For horizontal motors, the N-S and E-W vibrations shall be measured at the top and bottom of the front and rear bearing housing. For vertical motors, the N-S and E-W vibrations shall be measured at the upper and lower bearing housing.
- J. All testing shall be witnessed by the Engineer and Owner.
 - 1. Motor and Motor Protection Tests for motors – In addition to other testing start and stop each motor a minimum of 3 times and perform a run test for vibration, heat, and to document motor protection. The Contractor shall document the settings of the motor overcurrent protection, overload relay and similar data on the provided form – MOTOR TEST REPORT.
 - 2. The Contractor shall develop nonconforming material reports for each failure and repair or report failures.
 - 3. The Contractor shall replace defective parts, correct malfunctioning units, make all repairs and retest to demonstrate compliance. The Contractor shall document action taken on appropriate nonconforming material report.

3.4 MOTOR TEST REPORT

- A. The following form is provided for the motor certification specified herein. Master blank forms are available on request.

END OF SECTION

MOTOR TEST REPORT

Each electric motor shall be tested for proper operation. Follow manufacturer's testing recommendations and procedures.

1. Name and Horsepower of Motor Tested: _____

2. Overcurrent Protection: _____

3. Overload Protection: _____

4. Visual Inspection Checklist:

- ☐ Momentarily Bump Motor Shaft for Proper Rotation
- ☐ Motor Frame Bolts
- ☐ Shaft Coupling
- ☐ Lubricants
- ☐ Other Comments:

5. Megger motor from wire in motor control center or control panel and record results. Do not perform megger testing with wiring connected to variable frequency drive, soft start, or other electronic controller.

$\phi A-\phi B$ _____ $\phi B-\phi C$ _____ $\phi C-\phi A$ _____

$\phi A-G$ _____ $\phi B-G$ _____ $\phi C-G$ _____

6. Record full load voltage and current:

V_{ab} _____ V_{an} _____ I_a _____

V_{bc} _____ V_{bn} _____ I_b _____

V_{ca} _____ V_{cn} _____ I_c _____

7. Motor Nameplate FLA: _____

Running Amps: _____

P.F. _____

8. Comments:

Signature Required: _____

Company: _____

Date: _____

SECTION 26 24 16 – PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Distribution and lighting and appliance panelboards.

1.2 REFERENCES

- A. IEEE (Institute of Electrical and Electronics Engineers):
 - 1. C62.41 – Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. NEMA (National Electrical Manufacturers Association):
 - 1. PB 1 – Panelboards.
 - 2. NEMA PB 1.1 – General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
- C. NETA (International Electrical Testing Association):
 - 1. ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- D. NFPA (National Fire Protection Association):
 - 1. 70 – National Electrical Code.
- E. UL:
 - 1. 50 – Cabinets and Boxes
 - 2. 67 – Safety for Panelboards.
 - 3. 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - 4. 1449 – Transient Voltage Surge Suppressors.

1.3 SUBMITTALS

- A. Subject to the requirements from Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component specified. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- C. Shop Drawings:
 - 1. Specify outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker, and fusible switch arrangement and sizes.
 - 2. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 3. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 6. Include evidence of NRTL listing for series rating of installed devices.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 8. Include wiring diagrams for power, signal, and control wiring.

9. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
- D. Source Quality control submittals:
 1. Specify results of tests and inspections.
 - E. Field Quality Control Submittals:
 1. Specify results of Contractor furnished tests and inspections.
 - F. Panelboard Schedules:
 1. For installation in panelboards. Submit final versions after load balancing.
 - G. Operation and Maintenance Data:
 1. For panelboards and components to include in emergency, operation, and maintenance manuals.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
 - H. Closeout Submittals:
 1. Project Record Documents:
 - a. Record actual locations of panelboards and record actual circuiting arrangements.
 2. Operation and Maintenance Data:
 - a. Submit spare parts listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.
 - I. Maintenance Material Submittals:
 1. Extra Stock Materials:
 - a. Furnish two of each panelboard key.
 - b. Panelboards keyed alike to Owner's current keying system.
- 1.4 QUALITY ASSURANCE
- A. Qualifications:
 1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.
 - B. Source Limitations:
 1. Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
 - C. Product Selection for Restricted Space:
 1. Drawings specify maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. See specified maximum dimensions.
 - D. Electrical Components, Devices, and Accessories:
 1. Listed and labeled as specified in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - E. Comply with NEMA PB 1.
 - F. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating to prevent condensation.
- B. Handle and prepare panelboards for installation as specified in NEMA PB 1.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under conditions below unless otherwise specified:
 - a. Ambient Temperature: 0°F – 122°F.

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 – Concrete.

1.8 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 PANELBOARDS

- A. Description:
 - 1. NEMA PB 1, panelboards with bolt-on type circuit breakers.
- B. Available Manufacturers:
 - 1. Eaton
 - 2. Schneider Electric – Square D
 - 3. ABB
 - 4. Siemens
 - 5. Or Approved Equal.
- C. Enclosures:
 - 1. Surface mounted unless shown as recessed in Contract Drawings.
 - 2. Rated for the environmental conditions at the installed location:
 - a. Interior Wet Locations (Wash-Down or Corrosive): Type 4X
 - 3. Finish: Manufacturer's standard gray enamel
- D. Panelboard Bus:

1. Copper, ratings as specified in Drawings.
 2. Furnish copper ground bus in each panelboard.
 3. Full-size neutral bus shall be included for panelboards shown with neutral.
- E. Interrupting Ratings:
1. Panelboards shall be fully rated – series rated panelboards are not acceptable.
 2. For Lighting and Appliance Panelboards rated 240 VAC and less, provide interrupting rating as specified in Contract Drawings, but not less than 10 kAIC.
 3. For Distribution Panelboards rated 480 VAC, provide interrupting rating as specified in Contract Drawings, but not less than 14 kAIC.
- F. Mechanical style lugs, suitable for quantity, size, and material of specified conductors.
- G. Service Equipment Label:
1. NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- H. Future Devices:
1. For 480 VAC distribution panels, provide a minimum of 6 unused circuit spaces for future use, in addition to any breakers specified in Contract Drawings as spares.
 2. Provide mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- I. For lighting and appliance panelboards rated 240 VAC and less, fill unused circuit spaces with spare 20A single pole breakers.
- J. Doors:
1. Secured with latch with tumbler lock; keyed alike.
- K. Directory Card:
1. Inside panelboard door, mounted in metal frame with transparent protective cover.
- ## 2.2 MOLDED CASE CIRCUIT BREAKERS
- A. Description:
1. UL 489, molded-case circuit breaker: Standard frame sizes, trip ratings and number of poles.
 2. Lugs: Mechanical Compression style, suitable for number, size, trip ratings and material of conductors.
 3. Application Listing: Appropriate for application: Type SWD for switching fluorescent lighting loads; type HACR for heating, air-conditioning, and refrigerating equipment.
 4. Interrupting capacity to match the rating of the panelboard assembly.
- B. Thermal Magnetic Trip Circuit Breaker:
1. Circuit breakers specified in Drawings as “TM”, or 250 amps and smaller not designated with adjustable electronic trip features, shall be thermal magnetic type with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Thermal magnetic breakers larger than 150-amp frame size shall have changeable trip units with adjustable magnetic trip settings.
- C. Solid State Electronic Trip Circuit Breaker:
1. Circuit breakers specified in Drawings with long-time (L), short-time (S), instantaneous (I), or ground fault (G) trip features, or any circuit breaker larger than 250-amp frame size, shall be electronic trip type with the features identified on drawings. If no trip features are

identified on the drawings, provide LSI as standard for electronic trip breakers less than 800-amp frame size, and provide LSIG for breakers 800 amps and larger.

- D. Arc Reduction Maintenance Mode:
 - 1. Provide arc reduction maintenance mode (ARMS) feature for all circuit breakers rated 1200 amps and larger, or where specified in Drawings.
- E. GFCI Circuit Breakers:
 - 1. Class A ground-fault protection (6 mA trip).
- F. Ground-Fault Equipment Protection (GFEP) Circuit Breakers:
 - 1. Class B ground-fault protection (30 mA trip).

2.3 SURGE PROTECTION DEVICES

- A. Include surge protective devices factory-installed integral to each panelboard, whether specified or not in Contract Drawings:
 - 1. As specified in UL 1449, Type 2.
 - 2. Connect through a panelboard circuit breaker for disconnection.
 - 3. Peak Surge Current Rating:
 - a. The minimum single-pulse surge current withstand rating per phase shall not be less than 160 kA.
 - b. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
 - 4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed:
 - a. Line to Neutral: 1200 V.
 - b. Line to Ground: 1200 V.
 - c. Line to Line: 2000 V.
 - 5. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed:
 - a. Line to Neutral: 700 V.
 - b. Line to Ground: 700 V.
 - c. Line to Line: 1200 V.
 - 6. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed:
 - a. Line to Neutral: 700 V.
 - b. Line to Ground: 700 V.
 - c. Line to Line: 1200 V.
 - 7. SCCR: Equal or exceed the short circuit current rating of the panelboard.
 - 8. Nominal Rating: 20kA.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards as specified in NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards as specified in NEMA PB 1.1.
- B. Install panelboards plumb.
- C. Install recessed panelboards flush with wall finishes.
- D. Height:
 - 1. 6 ft to top of panelboard; install panelboards taller than 6 ft with bottom no more than 4 in. above floor.
- E. Install filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads. Identify each circuit as to its clear, evident and specific purpose of use.
- G. Install engraved plastic nameplates as specified in Section 26 05 53 – Identification for Electrical Systems.
- H. For recessed panelboards, Install spare conduits to accessible location above ceiling or below floor, as applicable. Minimum spare conduits: five empty 1 in. Identify each as spare.
- I. Ground and bond panelboard enclosure as specified in Section 26 05 26 – Grounding and Bonding for Electrical Systems. Connect equipment ground bars of panels as specified in NFPA 70.

3.3 FIELD QUALITY CONTROL

- A. Inspect and test as specified in NETA ATS.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Perform infrared scan tests and inspections and prepare reports:
 - 1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - 2. Instruments and Equipment:
 - a. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they DO NOT pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 ADJUSTING

- A. Load Balancing:

1. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20% of each other. Maintain proper phasing for multiwire branch circuits.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 – Power System Study, or by manufacturer.

END OF SECTION

SECTION 26 24 19 – MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Motor control centers.

1.2 EXISTING EQUIPMENT

- A. Where drawings indicate adding to or otherwise modifying existing motor control centers, the following information may be used for reference to obtain compatible equipment.
 - 1. MCC-7MA; Cutler-Hammer Freedom 2100; 1200A; 65kA interrupt; 3ph 3W.
 - 2. MCC-7MB; Cutler-Hammer Freedom 2100; 1200A; 65kA interrupt; 3ph 3W.

1.3 REFERENCES

- A. IEEE (Institute of Electrical and Electronics Engineers):
 - 1. C62.41 – Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. NEMA (National Electrical Manufacturers Association):
 - 1. FU 1 – Low Voltage Cartridge Fuses.
 - 2. ICS 2 – Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 VAC or 750 VDC.
 - 3. ICS 2.3 – Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers.
 - 4. ICS 3 – Industrial Control and Systems: Factory Built Assemblies.
 - 5. ICS 5 – Industrial Control and Systems: Control Circuit and Pilot Devices.
 - 6. ICS 7 – Industrial Control and Systems: Adjustable Speed Drives.
 - 7. ICS 7.1 – Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems.
 - 8. KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum).
- C. NETA (International Electrical Testing Association):
 - 1. ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- D. UL (Underwriters Laboratories Inc.):
 - 1. 198E – Class R Fuses.
 - 2. 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - 3. 508 – Industrial Control Panels.
 - 4. 845 – Motor Control Centers.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components. For each type of controller and each type of motor-control center. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings and finishes.

- C. Shop Drawings:
 - 1. Specify front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time and current curves of equipment and components.
 - D. Coordination Drawings:
 - 1. Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around motor-control centers where pipe and ducts are prohibited. Show motor-control center layout and relationships between electrical components and adjacent structural and mechanical elements. As specified in NFPA 70, Article 240.24 height limitation of overcurrent device operating handles. Show support locations, type of support and weight on each support. Specify field measurements.
 - E. Qualification Data:
 - 1. For manufacturer and testing agency.
 - F. Field quality-control test reports.
 - G. Operation and Maintenance Data:
 - 1. For motor-control centers, all installed devices and components to include in emergency, operation, and maintenance manuals.
 - 2. In addition to items specified in Division 01 – General Requirements, include:
 - a. Routine maintenance requirements for motor-control centers and all installed components.
 - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - H. Load-Current and Overload-Relay heater List:
 - 1. Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
 - I. Load-Current and List of Settings of Adjustable Overload Relays:
 - 1. Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.
 - J. Test and Evaluation Reports:
 - 1. Specify field test and inspection procedures and test results.
 - K. Source Quality Control Submittals:
 - 1. Specify results of factory tests and inspections.
- 1.5 QUALITY ASSURANCE
- A. Manufacturer Qualifications:
 - 1. A qualified manufacturer. Maintain, within 250 miles of Project site, a service center capable of providing training, parts and emergency maintenance and repairs.
 - B. Source Limitations:
 - 1. Obtain motor-control centers and controllers of a single type through one source from a single manufacturer.
 - C. Electrical Components, Devices and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
- D. Comply with NFPA 70.
- E. Field Quality Control Submittals:
 1. Specified results of Contractor furnished tests and inspections.
- F. Closeout Submittals:
 1. Operation and Maintenance Data: Submit replacement parts list for controllers.
 2. Project Record Documents: Record actual locations, configurations, and ratings of motor control centers and major components.
- 1.6 QUALIFICATIONS
 - A. Manufacturer:
 1. Company specializing in manufacturing products specified in this section with minimum five years of experience.
- 1.7 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver in 60 in. maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.
 - B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
 - C. Handle as specified in NEMA ICS 2.3. Lift only with lugs provided. Handle carefully to avoid damage to motor control center components, enclosure, and finish. See NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
- 1.8 AMBIENT CONDITIONS
 - A. See NEMA ICS 2 service conditions during and after installation of motor control centers.
- 1.9 COORDINATION
 - A. Coordinate layout and installation of motor-control centers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
 - B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
 - C. Coordinate features of motor-control centers, installed units, and accessory devices with pilot devices and control circuits to which they connect.
 - D. Coordinate features, accessories, and functions of each motor-control center, each controller, and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.
- 1.10 EXTRA MATERIALS
 - A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MOTOR CONTROL CENTER

- A. Manufacturers:
 1. Square D; by Schneider Electric.
 2. Eaton.
 3. ABB.
 4. Allen-Bradley.
 5. Siemens.
- B. Description:
 1. NEMA ICS 3, Class I, Type B motor control center.
 2. Main Overcurrent Protection: Molded case circuit breaker.
- C. Enclosures:
 1. Flush-mounting or surface-mounting cabinets as specified. Standard, 20 in. depth.
 2. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners. Interlocks on combination controller units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
 3. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in motor-control center; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
 4. Final installation height of disconnect devices, accounting for pad height under the motor control center, shall be in compliance with NFPA 70, Article 240.24.
 5. Wiring spaces: Wiring channel in each vertical section for vertical and horizontal wiring to each unit compartment; supports to hold wiring in place.
- D. NEMA enclosure type to meet environmental conditions at the installed location.
 1. Interior Dedicated Locations (Electrical Rooms): Type 1
 2. Interior Dry Locations (Nondedicated Spaces subject to Dust, Dirt only): Type 12.
 3. Interior Wet Locations (Wash-Down or Corrosive): Type 4 Stainless Steel
 4. Exterior Locations: Type 3R
- E. Operation:
 1. Voltage Rating: As specified in Contract Drawings.
 2. Integrated Equipment Short Circuit Rating: As specified in Contract Drawings. If no rating listed, provide 42kAIC minimum.
- F. Materials:
 1. Horizontal Bus:
 - a. Copper, with continuous current ratings as specified in Drawings.
 - b. Material:
 - 1) Plated hard-drawn copper, 98% conductivity.
 - 2) Include copper ground bus entire length of control center.
 2. Vertical Bus: Copper.
- G. Ampacity Ratings:

1. As specified for horizontal main buses.
- H. Neutral Buses:
 1. Full size or as available relative to the main ampacity.
- I. Equipment Ground Bus:
 1. Uninsulated, horizontal configuration; adequate for equipment ground conductors; bonded to enclosure.
- J. Horizontal Bus Arrangement:
 1. Main phase, neutral and ground buses extended with same capacity the entire length of motor-control center, with provision for future extension at both ends by bolt holes and captive bus splice sections or equivalent.
- K. Short-Circuit Withstand Rating:
 1. Same as short-circuit current rating of section.
- L. Fabrication
 1. Configuration: Units front mounting only, accessible from front only.
- M. Finishes
 1. Manufacturer's standard gray enamel.
- N. Future Devices:
 1. Provide unused bucket space for each MCC reserved for future use, equivalent to a minimum of 12" per vertical section, in addition to any buckets specified in the Contract Drawings as spares.
 2. Equip compartments with blank covers and all appurtenances required for future bucket installation.

2.2 FUNCTIONAL FEATURES

- A. Description:
 1. Modular arrangement of controllers, control devices, overcurrent protective devices, transformers, panelboards, instruments, specifying panels, blank panels, and other items mounted in compartments of motor-control center.
- B. Controller Units:
 1. Combination controller units of types and with features, ratings and circuit assignments specified:
 - a. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 - b. Provide units with short-circuit current ratings equal to or greater than short-circuit current rating of motor-control center sections.
 - c. Equip units in Type B and Type C motor-control centers with pull-apart terminal strips or drawout terminal boards for external control connections.
 - d. Controller Disconnecting Means: Factory-assembled combination disconnect and controller.
 - e. Circuit-Breaker Disconnecting Means: NEMA AB1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- C. Overcurrent Protective Devices:
 1. Individual feeder-tap units through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being

racked into their normal, energized positions. Installed height, including that of the concrete base, of operating handles of overcurrent protective devices shall not exceed the height limitation of NFPA 70, Article 240.24.

- D. Surge Protective Devices:
 - 1. Connect to motor-control center bus.
- E. Spaces and Blank Units:
 - 1. Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.
- F. Spare Units:
 - 1. Type, sizes, and ratings specified; installed in compartments specified "spare."
- G. Key Interlocking:
 - 1. Where specified in Drawings, provide a key interlocking system for specified circuit breakers to prevent simultaneous energization of multiple sources.

2.3 FULL-VOLTAGE NON-REVERSING CONTROLLERS

- A. Description:
 - 1. NEMA ICS 2, AC general-purpose Class A solid-state controller for induction motors rated in horsepower.
- B. Combination Magnetic Controller:
 - 1. Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
 - 2. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary NO/NC contact that operates to specify "ON" or "OFF".
- C. Overloads:
 - 1. Solid state type, electronic design with a 5:1 adjustment range, current based measurement protection, thermal memory, integrated I/O points, and enhanced phase loss protection.
- D. Operation:
 - 1. Control Voltage: 120 V, 60 Hz.
 - a. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, specifying and control devices, plus 100% spare capacity.
- E. Materials:
 - 1. Overload Relay: NEMA ICS 2.
 - 2. Product Options and Features:
 - a. Auxiliary Contacts: NEMA ICS 2, 2 each field convertible contacts in addition to seal-in contact.
 - b. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oiltight type.
 - c. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
 - d. Indicating Lights: LED type.
 - e. Selector Switches: Rotary type.

- f. Relays: NEMA ICS 5.
- g. Control Power Transformers: 120 V secondary, 100% spare capacity minimum. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

- F. Motor controller buckets shall include control features as specified in Contract Documents, which may include but not limited to:
 - 1. Motor control selector switch
 - 2. Remote start input
 - 3. Stop pushbutton (normally closed)
 - 4. Start pushbutton (normally open)
 - 5. Running indicator light
 - 6. Overload reset pushbutton
 - 7. Dry status contacts for motor running and overload
 - 8. Other indication and control devices as specified in Contract Drawings

2.4 FULL-VOLTAGE REVERSING CONTROLLERS

- A. Description:
 - 1. NEMA ICS 2, AC general-purpose Class A solid-state controller for induction motors rated in horsepower. Include electrical interlock and integral time delay transition between FORWARD and REVERSE rotation.
- B. Operation:
 - 1. Control Voltage: 120 V, 60 Hz.
- C. Materials:
 - 1. Overload Relay: NEMA ICS 2.
 - 2. Product Options and Features:
 - a. Auxiliary Contacts: NEMA ICS 2, 2 each field convertible contacts in addition to seal-in contact.
 - b. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oiltight type.
 - c. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
 - d. Indicating Lights: LED type.
 - e. Selector Switches: Rotary type.
 - f. Relays: NEMA ICS 5.
 - g. Control Power Transformers: 120 V secondary, 100% spare capacity minimum. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

2.5 FUSIBLE SWITCH ASSEMBLIES

- A. Description:
 - 1. NEMA KS 1, Type HD, load interrupter knife switch. Handle lockable in OFF position.
- B. Materials:
 - 1. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.

2.6 MOLDED CASE CIRCUIT BREAKER

- A. Description:
 - 1. UL 489, molded-case circuit breaker: Standard frame sizes, trip ratings and number of poles.
 - 2. Lugs: Mechanical Compression style, suitable for number, size, trip ratings and material of conductors.

3. Application Listing: Appropriate for application: Type SWD for switching fluorescent lighting loads; type HACR for heating, air-conditioning, and refrigerating equipment.
4. Interrupting capacity to match the rating of the motor control center assembly.

B. Thermal Magnetic Trip Circuit Breaker:

1. Circuit breakers specified in Drawings as "TM", or 250 amps and smaller not designated with adjustable electronic trip features, shall be thermal magnetic type with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Thermal magnetic breakers larger than 150-amp frame size shall have changeable trip units with adjustable magnetic trip settings.

C. Solid State Electronic Trip Circuit Breaker:

1. Circuit breakers specified in Drawings with long-time (L), short-time (S), instantaneous (I), or ground fault (G) trip features, or any circuit breaker larger than 250-amp frame size, shall be electronic trip type with the features identified on drawings. If no trip features are identified on the drawings, provide LSI as standard for electronic trip breakers less than 800-amp frame size, and provide LSIG for breakers 800-amps and larger.

D. Arc Reduction Maintenance Mode:

1. Provide arc reduction maintenance mode (ARMS) feature for all circuit breakers rated 1200 amps and larger, or where specified in Drawings.

2.7 ELECTRONIC METERING UNIT

A. Include microprocessor-based power meter factory-installed integral to each motor control center, whether specified or not in Contract Drawings.

B. Electronic Metering Unit:

1. Digital, multifunction, programmable, meter; UL listed and CE marked.
2. Input: Accept input from 5 amps secondary current transformers and 120 V secondary potential transformers.
3. Voltage Monitoring Range: Up to 600 V, phase to phase.
4. Configuration: Capable of connection to three phase, four wire wye system and three phase, three wire, delta system.
5. Monitor: Three phase real time amps, volts, power, energy, power factor, and frequency.
6. PT and CT Ratios: User programmable.
7. Display: 3-line LED to display volts, amps, and power simultaneously; selectable to specify instantaneous, average, maximum, and minimum measurements for all phases.
8. Mounting: Flush or semi-flush in motor control center instrument compartment face.

C. Meter Measurement Capability:

1. Continuously meter electrical loads with plus or minus 1% accuracy.
2. True RMS Measurements:
 - a. Voltage phase to neutral.
 - b. Voltage phase to phase.
 - c. Current per phase.
 - d. Neutral current.
 - e. Real power
 - f. Reactive power.
 - g. Apparent power.
3. Other Measurements: Power factor and frequency.

D. Unit to have ethernet port for connection to external monitoring system.

2.8 SURGE PROTECTION DEVICES

- A. Include surge protective devices factory-installed integral to each motor control center, whether specified or not in Contract Drawings:
 - 1. See UL 1449, Type 2.
 - 2. Provide SPD in dedicated bucket and connect through circuit breaker for disconnection.
 - 3. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 160 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
 - 4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed:
 - a. Line to Neutral: 1200 V.
 - b. Line to Ground: 1200 V.
 - c. Line to Line: 2000 V.
 - 5. SCCR: Equal or exceed the short circuit current rating of the motor control center.
 - 6. Nominal Rating: 20 kA.

2.9 COMMUNICATIONS

- A. Ethernet Devices:
 - 1. Motor Control Center assemblies shall be provided with a factory assembled Ethernet field bus communications network providing direct connectivity between MCC devices and the plant SCADA system.
 - 2. Ethernet 10/100/1000 auto negotiate layer 2 managed industrial switches shall be provided as required in the MCC lineup. The Ethernet switch shall have sufficient ports available to connect to each ethernet-capable device and have at least 2 open ports for a customer connection and a PC connection for maintenance. The Ethernet switch shall be mounted in the top removable unit of each vertical section or shipping split and not in the vertical wireway. If required by the application, the switch shall be capable of connecting to multiple sections.
 - 3. The Ethernet system installed in the MCC shall include a complete and tested cabling system. The cabling system shall be 600V Cat 6 and consist of home run connections from the device to a switch located in the MCC and as specified in Ethernet specifications. Nonstandard, non-shielded cable will not be accepted.
 - 4. All cabling shall be securely supported and attached to the MCC structure as specified in Contract Drawings and the manufacturer's recommendations.
 - 5. Ethernet communications modules shall be provided at each device interfacing to the Ethernet field bus. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the Ethernet cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated Ethernet device.

2.10 ACCESSORIES

- A. Control Relays:
 - 1. Auxiliary and adjustable time-delay relays.
- B. Elapsed Time Meters:
 - 1. Heavy duty, LED type, with digital readout in hours.
- C. Current-Sensing, Phase-Failure Relays:
 - 1. Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40%, or loss of supply voltage; with adjustable response delay.

2.11 SOURCE QUALITY CONTROL

- A. Shop inspect and perform standard productions tests for each controller as specified in manufacturer's standards.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify surfaces are suitable for motor control center installation.
- B. Examine areas and surfaces to receive motor-control centers for compliance with requirements, installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. Install motor control centers on minimum 4 in. tall concrete housekeeping pads under the provision of Section 03 30 00 – Cast-in-Place Concrete. Anchor each motor control center assembly as specified in manufacturer's written instructions.
- B. Install as specified in NEMA ICS 2.3 and NEMA 7.1.
- C. Tighten accessible bus connections and mechanical fasteners after placing motor control center.
- D. Install fuses in fusible switches.
- E. Select and install heater elements in motor controllers to match installed motor characteristics.
- F. Install engraved plastic nameplates as specified in Section 26 05 53 – Identification for Electrical Systems.
- G. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage rating, and phase rating. Place label in clear plastic holder. Specify method of identifying phase conductors.
- H. Ground and bond motor control centers as specified in Section 26 05 26 – Grounding and Bonding for Electrical Systems.

3.4 FIELD QUALITY CONTROL

- A. Inspect and test as specified in NETA ATS.
- B. Perform inspections and tests specified in NETA ATS, Section 7.16.
- C. Inspect and test variable frequency controllers as specified in NEMA ICS 7.1.

- D. Prepare for acceptance tests:
 - 1. Test insulation resistance for each motor-control center element, bus, component, connecting supply, feeder and control circuit.
 - 2. Test continuity of each circuit.
- E. Manufacturer's Field Service:
 - 1. Engage a factory-authorized service representative to perform:
 - a. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components and equipment.
 - b. To assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
 - c. Report results in writing.
- F. Perform field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection tests, specified in NETA ATS "Motor Control Centers." Certify compliance with test parameters.
 - 2. Correct malfunctioning units onsite, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain components of motor-control centers including solid-state controllers and variable frequency controllers.

END OF SECTION

SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Wall switches; wall dimmers; receptacles; multioutlet assembly; and device plates and decorative box covers.
- B. Related Sections:
 - 1. Section 26 05 33 – Raceway and Boxes for Electrical Systems.

1.2 REFERENCES

- A. NEMA (National Electrical Manufacturers Association):
 - 1. WD 1 – General Requirements for Wiring Devices.
 - 2. WD 6 – Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Samples:
 - 1. Submit two samples of each wiring device and wall plate illustrating materials, construction, color, and finish.

1.4 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Source Limitations:
 - 1. Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as type are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- C. Electrical Components, Devices and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
- D. Comply with NFPA 70.

1.5 EXTRA MATERIALS

- A. Furnish two of each style, size, and finish wall plate.

1.6 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Wiring devices shall be specification grade, with special devices as specified in Drawings. Should the Drawings specify a device other than those listed in this section without reference to catalog number, such device shall be of the same grade and manufacturer as specified below. Furnish a matching cap for all special purpose devices that DO NOT have the common 120 V NEMA 5-15R or 5-20R configuration.
- B. All lighting switches and duplex receptacles installed shall be by the same manufacturer and shall be identical in appearance, unless noted otherwise.

2.2 WALL SWITCHES

- A. Manufacturers:
 - 1. Arrow-Hart
 - 2. Bryant
 - 3. General Electric
 - 4. Hubbell, Inc.
 - 5. Leviton Manufacturing Co., Inc.
 - 6. Pass & Seymour, Lagrand North America, Inc.
 - 7. Or equal.
- B. Product Description:
 - 1. All switches and associated materials shall bear a UL 20 and as specified in NEMA WD 1.
 - 2. Provide all necessary wiring and accessories as required for complete installation.
- C. All single-pole, double-pole, three-way, and four-way switches as specified.
- D. Flush and Surface Mounted, Tumbler, Self-Grounding, Heavy-Duty Switches:
 - 1. "Specification" grade, Fed. Spec. W-S-896.
 - 2. White toggle and "Specification" grade white thermoplastic wall plate with matching screws in finished areas.
 - 3. Gray toggle in all other areas with 302 stainless steel wall plates.
 - 4. With grounding lug.
- E. Ratings:
 - 1. Voltage: 120 VAC – 277 VAC.
 - 2. Current: 20 amps.
- F. Weatherproof, Self-Grounding, Heavy-Duty Switches:
 - 1. Flush or surface mounted as specified.
 - 2. "Specification" grade, Fed. Spec. W-S-896
 - 3. Lever-type, cast aluminum, gasketed cover plate.
 - a. Crouse-Hinds DS185 or equal.
 - 4. Locations: All exterior or interior wet locations, or as specified in Drawings.
- G. Dimmers:
 - 1. Solid State Dimmer for LED dimmable driver: Captive linear-slide dimmer for a traditional cover plate opening.
 - 2. Output 0 V – 10 V for control of dimmable LED drivers.
 - 3. Provide power supply as required.
 - 4. For indoor use only.

5. Finish shall match wall switches.
6. UL Listed.

H. Occupancy Sensors:

1. Adjustable occupancy sensor settings:
 - a. Time delay.
 - b. Walkthrough mode.
 - c. Sensitivity.
 - d. Occupancy mode (auto-on/auto-off).
2. Occupancy Sensor shall use dual technology (Passive Infrared and Ultrasonic).
3. Ceiling or wall-mount as specified.
4. Output 0 V – 10 V for control of dimmable LED drivers.
5. Provide power supply as specified.
6. For indoor use only.
7. Finish shall match wall switches.
8. UL Listed.

2.3 RECEPTACLES

A. Manufacturers:

1. Arrow-Hart.
2. Bryant.
3. General Electric.
4. Hubbell, Inc.
5. Leviton Manufacturing Co., Inc.
6. Pass & Seymour, Lagrand North America, Inc.
7. Or equal.

B. Product Description:

1. All receptables shall be heavy-duty type and shall bear a UL 498 label and comply with NEMA WD 1 and WD 6 as applicable. Provide all necessary wiring and accessories as required for complete installation.

C. Flush Mounted and Surface Mounted Receptacles:

1. Duplex, arc-resistant, back and side-wired, 3-wire grounding type. NEMA reference 5-20R. "Specification" grade type 5362, Fed. Spec. W-C-596 compliant.
2. Receptacle and wall plates shall be as follows:
 - a. Flush mounted white receptacle and "Specification" grade white thermoplastic wall plate with matching screws in finished areas.
 - b. Receptacles in all other areas shall be gray with 302 stainless steel wall plates.
 - c. Receptacles fed from UPS circuits in finished areas shall be red with "Specification" grade red thermoplastic wall plates with matching screws.
 - d. Receptacles fed from UPS circuits in other areas shall be red with 302 stainless steel wall plates.
 - e. Locations as specified.
 - f. When specified provide GFCI type as specified.

D. Ground Fault Circuit Interrupter (GFCI) Receptacles:

1. Flush or Surface mounted as specified.
2. NEMA reference 5-20R. Rated 20A at 125 VAC, Fed. Spec. W-C-596.
3. Back and side wired terminals with feed-through design. Terminal installation unless specified otherwise.
4. UL Standard 943 Class A, Group 1.
5. Leakage current sensitivity: 5mA plus or minus 1mA.

E. Opens circuit within 25 milliseconds of reaching 5 mA.

1. Duplex, arc resistant and prewired.
 2. Cover plate materials and colors shall match standard receptacles as specified this section.
 3. All exterior or interior wet locations, or as specified in Drawings.
- F. Weatherproof Receptacles:
1. Flush or Surface mounted as specified.
 2. Rated 20A at 125 VAC, Fed. Spec. W-C-596. NEMA reference 5-20R.
 3. GFCI receptacle as specified in this Section when specified.
 4. Provide a gray receptacle with a cast aluminum weatherproof cover.
- G. Provide while-in-use cover for outdoor locations.
1. Provide hinged self-closing, gasketed type covers for indoor locations.
 2. All exterior or interior wet locations, or as specified in Drawings.
- H. Floor Receptacles:
1. Receptacles shall be compatible with the recessed box assembly. Provide 20-amp, 125 V, 2-pole, 3-wire, grounding, gray duplex receptacles, NEMA configuration 5-20R.
 2. Recessed boxes shall include duplex receptacles and network keystone jacks as specified.
- I. Poke-Through Floor Devices:
1. Factory-fabricated poke-through assembly devices with modular, flush or above-floor service outlets (as required), multi-channeled thru-floor service fitting (or flush carpet flange) of die cast, satin finished aluminum with 20-amp, 125 VAC, 2-pole, 3-wire, grounding gray duplex NEMA 5-20R receptacle and modular communication/data service outlet with separation barrier between power and low-voltage section. Provide integral assembly UL listed as a total unit, with fire rating of 1, 2, or 4 hours as required to be consistent with that of floor penetrated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify outlet boxes are installed at proper height.
- B. Verify wall openings are neatly cut and completely covered by wall plates.
- C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 COORDINATION WITH OTHER TRADES:

- A. Take steps to ensure that devices and their boxes are protected. DO NOT place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
- B. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables. Clean all debris from outlet boxes.
- C. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
- D. Install wiring devices after all wall preparation, including painting is complete.

3.3 CONDUCTORS:

- A. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
- B. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
- C. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
- D. Existing Conductors:
 - 1. Cut back and pigtail or replace all damaged conductors.
 - 2. Straighten conductors that remain and remove corrosion and foreign matter.
 - 3. Pigtailing existing conductors is permitted provided the outlet box is large enough.

3.4 INSTALLATION

- A. Install devices plumb and level.
- B. Install switches with OFF position down.
- C. Install wall dimmers to achieve full rating specified after derating for ganging as instructed by manufacturer.
- D. DO NOT share neutral conductor on load side of dimmers.
- E. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection such as plastic film and smudge covers until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15-A or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- F. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.
- G. Install wall plates on flush mounted switches, receptacles, and blank outlets.
- H. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- I. Connect wiring devices by wrapping solid conductor around screw terminal. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.

- J. Use jumbo size plates for outlets installed in masonry walls.
- K. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes to obtain mounting heights as specified and as specified in Drawings.
- B. Install wall switch 48 in. above finished floor.
- C. Install convenience receptacle 24 in. above finished floor.
- D. Install convenience receptacle 6 in. above counter and back splash of counter.
- E. Install dimmer 48 in. above finished floor.

3.6 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.
- F. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- G. Tests for Convenience Receptacles:
 - 1. Line voltage: Acceptable range is 110 V – 125 V.
 - 2. Percent Voltage Drop under 15 A Load: A value of 6% or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. The tests shall be diagnostic, specifying damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- H. Test straight blade for the retention force of the grounding blade as specified in NFPA 99. Retention force shall be not less than 4 oz.

3.7 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.8 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 26 67 05 – COMMUNICATION CABLE AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Wiring System Components:
 - a. Communication cable.
 - 2. Ethernet cabling.
 - 3. Instrumentation cable.
- B. Related Sections:
 - 1. Division 26.

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Provide for each material or equipment item specified.
- C. Shop Drawings:
 - 1. Point-to-point wiring diagrams for cables installed under this Section.
 - 2. Detailed plan views and elevations of telecommunications spaces showing termination equipment, and cable paths.
 - 3. Minimum Scale for Details: 1/4 in.
- D. Termination Schedule:
 - 1. Cable identification number.
 - 2. Room location.
- E. Assurance/Control Submittals:
 - 1. Certificates: Manufacturer's certificate that Products meet or exceed specified requirements.
 - 2. Qualification Documentation: Submit documentation of experience as specified in qualification requirements.
- F. Certification:
 - 1. Comprehensive test results for category 6, and fiber optic certification of cable plant per specifications of TIA/EIA 568A. Test results shall be provided on 8.5 in. by 11 in. sheets of paper, and furnished in electronic PDF format.
- G. Project Record Documents:
 - 1. Cable pulling schedules, in printed form and on CD-R data disks.
 - 2. Labeling shall be as specified in ANSI/TIA/EIA-606 guidelines.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Company specializing in manufacturing Products specified with minimum 5 years documented experience.
 - 2. Installer: Company specializing in the installation of category 6, and fiber optic structured wiring systems with minimum 5 years documented experience. Contractor shall always

have a minimum of one person on job site with documented formal training in the installation of category 6, and fiber optic cabling systems if fiber optic cabling is required.

- B. Regulatory Requirements:
 - 1. See requirements of NFPA 70.
 - 2. Products: Listed and classified by Underwriter's Laboratories Incorporated as suitable for the purpose specified.
- C. Preinstallation Meetings:
 - 1. Convene a preinstallation meeting one week prior to commencing Work of this Section.
 - 2. Require attendance of parties directly affecting Work of this Section.
 - 3. Review conditions of operations, procedures, and coordination with related work.
 - 4. Agenda:
 - a. Tour, inspect, and discuss conditions relating to communications cable.
 - b. Review exact location of each item within building construction, casework, and fixtures and their requirements.
 - c. Review required submittals, both completed and yet to be completed.
 - d. Review Drawings and Specifications.
 - e. Review and finalize construction schedule and verify availability of materials, personnel, equipment, and facilities needed to make progress and avoid delays.
 - f. Review cable routing and support.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Transport, handle, store, and protect products.
- B. Deliver as specified in NEMA WC 26.

1.5 REFERENCES

- A. TIA/EIA (Telecommunication Industry Association / Electronic Industries Association):
 - 1. 568-A – Commercial Building Telecommunications Cabling Standard
 - 2. 569 – Commercial Building Standard for Telecommunications Pathways
 - 3. 606 – Administration Standard for the Telecommunications Wiring Standard
 - 4. 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications
- B. NEMA (National Electrical Manufacturer's Association):
 - 1. WC 26 – Wire and Cable Packaging.
- C. NFPA (National Fire Protection Association):
 - 1. 70 – National Electrical Code.

PART 2 - PRODUCTS

2.1 PATCH CORDS

- A. Approved Manufacturers (Subject to project requirements):
 - 1. AMP Incorporated.
 - 2. Interlink Technologies.
 - 3. Lucent Technologies.
 - 4. NORDX/CDT, Incorporated.
 - 5. Siemon Company.
 - 6. Or Equal.

- B. Conductors:
 - 1. Straight through type 4 twisted pair – 24 AWG, stranded copper.
 - 2. Terminated with male 8-pin modular plugs.
 - 3. As specified in individual characteristics established in TIA for category 6a cable performance specification.

2.2 INSTRUMENTATION CABLE

- A. Approved Manufacturers (Subject to requirements):
 - 1. Belden
 - 2. Approved equal.
- B. Conductors:
 - 1. For all 4 mA – 20 mA signals, use 20 AWG stranded tinned copper, two pair minimum, wet location rated.
 - 2. Individually shielded with shield drain wire.
 - 3. Insulation to be polyethylene PE or PVC.
 - 4. Outer jacket to be polyvinyl chloride PVC.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Report in writing to the Engineer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. DO NOT proceed with Work until unsatisfactory conditions have been corrected.
- C. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2 INSTALLATION

- A. Cross electrical cables with communications cable at 90 degrees only.
- B. Run communication cables and power cables in separate conduits.
- C. See cable manufacturers minimum bend radius requirements:
 - 1. DO NOT stretch, stress, tightly coil, bend or crimp cables.
 - 2. Replace cables that are severely stressed during installation at no additional cost to Owner.
- D. Furnish and install machine generated labels.
 - 1. Communications Cables:
 - a. Display cable identification number in black uppercase lettering on permanent adhesive white label stock covered with water resistant sealer.
 - b. Place labels on each end of cable, maximum 6 in. from cable termination.

3.3 CONSTRUCTION

- A. Interface with Other Work:
 - 1. Provide information to affected trades regarding requirements and responsibilities for preparation of Work of a particular trade for installation of Work installed under this Section.

3.4 FIELD QUALITY REQUIREMENTS

- A. Field testing and inspection.
- B. Inspect installation of cables and equipment during and at completion of installation.
- C. Perform end-to-end tests of each cable as follows:
 - 1. Pair/conductor for proper pinouts and continuity.
 - 2. Ground fault.
 - 3. Proper termination, shorts, and crossed pairs.
 - 4. Channel attenuation per ANSI/TIA/EIA-568-A, Annex E or later.
 - 5. Channel bidirectional worst case near end cross talk (NEXT) at frequencies up to 100 MHz, per ANSI/TIA/EIA-568-A, Annex E or later.
 - 6. Measured effective cable run length.

END OF SECTION

DIVISION 31
EARTHWORK

SECTION 31 32 00 – SOIL EROSION STABILIZATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work and materials required to minimize erosion and comply with Storm Water Pollution Prevention Plan.

1.2 REFERENCES

- A. ASTM
 - 1. D3776 – Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
 - 2. D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
 - 3. D5035 – Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
 - 4. D3786 – Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
 - 5. D4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus
 - 6. D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings and/or Product Data:
 - 1. Erosion control rock.
 - 2. Fertilizer.
 - 3. Seed.
 - 4. Mulch.
 - 5. Erosion control rock.
 - 6. Soil tackifier.
 - 7. Reinforced plastic covering.
 - 8. Silt fence.
 - 9. Straw bales.
 - 10. Posts for straw bales.
 - 11. Dust controller.
 - 12. Wire mesh.

1.4 STABILIZATION

- A. Soil Erosion Stabilization:
 - 1. Ground surfaces exposed during the wet weather conditions:
 - 2. Areas which shall NOT be subjected to heavy wear by ongoing construction traffic.
 - 3. Temporary and long-term stabilization of new or disturbed ditches, swales, detention ponds, or disturbed ground with intermittence construction traffic.
- B. Permanent Stabilization:
 - 1. Permanently stabilize exposed soil surfaces at finished grades.
 - 2. Permanent stabilization methods include, but are NOT limited to, seeding (permanent), mulching, and landscaping.
 - 3. Immediately perform permanent stabilization at each completed excavation and areas except for areas that are scheduled to be re-disturbed.

4. Incorporate all permanent erosion control features into the project at the earliest practical time.
- C. Buffer Zone:
1. Undisturbed area or strip of natural vegetation or an established suitable planting adjacent to a disturbed area that reduces erosion and runoff.
- D. Standard Specification:
1. The latest edition, including supplements of the Oklahoma Options: Oklahoma Department of Transportation (ODOT) Standard Specifications for Highway Construction.

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. General:
1. Prevent or reduce the discharge of pollutants to stormwater from all material delivery and storage by minimizing the storage of hazardous materials storing materials in a designated area, installing Secondary containment, conducting regular inspection, and training employees and Subcontractors.
- B. Seed:
1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
 2. Keep dry during storage.
- C. Hydroseeding Mulch:
1. Mark package of wood fiber mulch to show air dry weight.

1.6 SEQUENCING AND SCHEDULING

- A. Install erosion and sediment control devices before starting earth disturbance activities and as drainage facilities get constructed.
- B. Complete Soil Preparation:
1. Seeding, fertilizing, mulching, and matting on disturbed areas that shall require stabilization either because the area has reached final grade (permanent landscaping) or because the area shall remain unworked for over 14 days (temporary seeding) during the wet season.
- C. Notify Engineer at least 3 days in advance of:
1. Materials delivery.
 2. Start of stabilization activity.
- D. Seeding:
1. Perform between March 15 and September 15.

1.7 MAINTENANCE

- A. Operations:
1. Seeded Areas: Perform during maintenance period to include:
 - a. Watering: Keep seeded surface moist.
 - b. Washouts: Repair by filling with topsoil, fertilizing, seeding, and mulching.
 - c. Mulch: Replace wherever and whenever washed or blown away.
 - d. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has NOT been produced.

- e. Reseed during next planting season if scheduled end of maintenance period falls after September 15.
 - f. Reseed entire area if satisfactory stand does NOT develop by July 1 of the following year.
 - g. Mowing: Mow to 2 in. after grass height reaches 3 in, and mow to maintain grass height from exceeding 3 1/2 in.
 - 2. Inspect, repair, and replace as necessary all erosion control measures during the time period from start of construction to completion of construction.
 - 3. Inspect a minimum of at least once every 7 days or after a 1/2 in. storm event in a 24-hr period.
 - 4. Furnish and install a rain gauge at the project site to monitor rainfall. At no time shall more than 1 ft depth of sediment be allowed to accumulate in any erosion control device.
- B. Sediment Removal:
- 1. Remove sediment from erosion control devices and work into the grading plan at least once a week as required to maintain proper operation of devices. The cleaning operation shall NOT dispose of sediment offsite.
 - 2. Sediment shall be removed, and the controls upgraded or repaired as soon as practicable, but NOT later than 2 days after the surrounding exposed ground has dried sufficiently to prevent further damage from equipment needed for repair operations.
 - 3. In the event of continuous rainfall over a 24-hr. period, or other circumstances that preclude equipment operation in the area, hand carry and install additional sediment controls as approved by the Engineer.

1.8 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 FERTILIZER

- A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.
- B. Fertilizer shall have the following minimum percentage of plant food by weight:
 - 1. Summer Hydroseed Mix:
 - a. Nitrogen:
 - 1) 20%.
 - b. Phosphoric Acid:
 - 1) 10%.
 - c. Potash:
 - 1) 10%.
 - 2. Winter Hydroseed Mix:
 - a. Nitrogen:
 - 1) 16%.
 - b. Phosphoric Acid:
 - 1) 8%.
 - c. Potash:
 - 1) 0%.

2.2 SEED

- A. Common Bermuda grass as specified in Section 232 of the Oklahoma Department of Transportation (ODOT) Standard Specifications for Highway Construction.

2.3 MULCH

- A. Wood Cellulose Fiber Mulch:
 - 1. Specially processed wood fiber containing no growth or germination inhibiting factors.
 - 2. Dyed a suitable color to facilitate inspection of material placement.
 - 3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers shall become uniformly suspended to form a homogenous slurry.
 - 4. When hydraulically sprayed on ground, material shall allow absorption and percolation of moisture.
- B. Straw:
 - 1. Clean salt hay or threshed straw of oats, wheat, barley, or rye, free from seed of noxious weeds. Suitable for spreading with mulch blower equipment.
 - 2. Average Stalk Length: 6 in.
 - 3. Seasoned before baling or loading.

2.4 EROSION CONTROL MATTING

- A. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.
- B. Manufacturers and Products:
 - 1. American Excelsior Company,
Arlington, TX;
Curlex Mat.
 - 2. North American Green,
Evansville, IN;
S150 blanket.
 - 3. Other Approved Equal.

2.5 REINFORCED PLASTIC COVERING

- A. Coextruded, copolymer laminate reinforced with a nonwoven grid of high strength nylon cord submersed in a permanently flexible adhesive media allowing for equal tear resistance in all directions.
- B. Black in color and ultraviolet stabilized.
- C. Physical Requirement (Minimum Average Roll Values):
 - 1. Tear Strength: 130 pounds.
 - 2. Elongation: 620%.
 - 3. Minimum Thickness: 6 mil.
- D. Manufacturers:
 - 1. Reef Industries, Inc./Griffolyn Co,
Houston, TX.
 - 2. Other Approved Equal.

2.6 SILT FENCE

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

- C. Filter Fabric:
1. Polyester, polypropylene, or nylon filaments, woven into a uniform pattern, distinct and measurable openings.
 2. Filaments: Resistant to damage from exposure to ultraviolet rays and heat.
 3. Material Edges: Finish so that, filaments retain their relative positions under stress.

- D. Filter Fabric Table:

Table No. 1 – Filter Fabric		
Physical Property	Required Value	Test Method
Weight, oz/yd ² , min.	4	ASTM D3776
Equivalent Opening Size, max	50 – 70	U.S. Standard Sieve
Grab Tensile Strength, lb, min. ARV	160	ASTM D4632
Elongation, % max.	25	ASTM D5035
Mullen Burst Strength, psi, min. ARV	200	ASTM D3786
Ultraviolet Radiation Resistance, % Strength Retention	70	ASTM D4355
Flow Rate, gpm/sf, min. ARV	30 – 50	ASTM D4491

- E. Manufacturers:
1. Dupont Co.
Wilmington, DE.
 2. Tencate Mirafi, Inc.
Pendergrass, GA.

2.7 STRAW BALES

- A. Machine baled clean salt hay or straw of oats, wheat, barley, or rye, free from seed of noxious weeds, using standard baling wire or string.

2.8 POSTS FOR STRAW BALES

- A. 2 in. by 2 in. untreated wood or commercially manufactured metal.

2.9 DUST CONTROLLER

- A. Nontoxic materials that DO NOT have an adverse effect on soil structure or establishment and growth of vegetation.

PART 3 - EXECUTION

3.1 GENERAL

- A. Erosion control measures are required during all construction and site disturbance activity and shall remain until permanent site ground covers are in place.
- B. The implementation of the erosion control plan and the construction maintenance, replacement and upgrading the erosion control devices are the responsibility of the Contractor until all construction is completed and landscaping established and approved. During the construction period, the erosion control devices shall be upgraded for unexpected storm events and to ensure that sediment and sediment laden water DO NOT leave the site.
- C. Maintain existing buffer zones adjacent to project limits. Keep all construction equipment, debris and soils out of the natural buffer zone.

3.2 GRAVEL CONSTRUCTION ENTRANCES

- A. Provide a graveled construction access at each access point between the site and any public or private road or other paved surface.
- B. Place subgrade geotextile, as specified, on the ground prior to erosion control rock placement.
- C. Place erosion control rock over the geotextile to a minimum thickness of 8 in.
- D. Minimum dimensions for construction entrances are 50 ft in length by 16 ft width.
- E. Contractor shall provide a minimum of 4 in. of erosion control rock for each entrance three times during the project at times directed by the Engineer to maintain proper function. More frequent applications of rock may be required, and if so, shall be considered as incidental work.

3.3 SOIL PREPARATION

- A. Before start of hydroseeding, and after surface has been shaped and graded, and lightly compacted to uniform grade, scarify soil surface to minimum depth of 1 in.

3.4 FERTILIZER

- A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 1 in. of soil.
- B. Application Rate:
 - 1. 5 lbs. per 1,000 ft² over areas to be seeded. Use of approved hydraulic equipment to sow seed and distribute fertilizer at the same time shall be acceptable.

3.5 SEEDING

- A. Prepare 1 in. depth seed bed; obtain Engineer's acceptance prior to proceeding.
- B. Apply by hydroseeding method on moist soil, but only after free surface water has drained away. Prevent drift and displacement of mixture into other areas.
- C. Summer Application:
 - 1. Prepare and apply slurry:

Item	Rate
Seed Mix	200 pounds per acre
Fertilizer	750 pounds per acre
Wood Cellulose Fiber Mulch	As recommended by manufacturer
Water	As necessary

- 2. Irrigation: 1 in. per week to seeded areas.

3.6 MULCHING

- A. Apply uniformly on disturbed areas that shall remain undisturbed for 7 days or more, as requested by Engineer, and on all seeded areas.
- B. Application:
 - 1. Sufficiently loose to permit penetration of sunlight and air circulation, and sufficiently dense to shade ground, reduce evaporation rate, and prevent or materially reduce erosion of underlying soil.

2. Straw: Apply by hand or mechanical means to minimum depth of 2 in.
3. Wood Cellulose Fiber: 1,000 lbs. – 1,500 lbs. per acre.

3.7 EROSION CONTROL MATTING

- A. Place on seeded slopes 4H:1V and steeper.
- B. Apply seed and fertilizer prior to matting.
- C. At top of slope, entrench material in a 6 in. by 6 in. trench and staple at 1 ft intervals. At the bottom of the slope, extend the mat 2 ft beyond the toe of slope, turn material under 4 in. and staple at 1 ft intervals.
- D. Mats shall be stapled in place as they are installed down the slope face. The mat shall have direct contact with the soil surface.
- E. Overlap:
 1. Lengthwise: 1 ft minimum.
 2. Crosswise: 6 in. minimum.

3.8 REINFORCED PLASTIC COVERING

- A. Place on areas where hydroseeding and erosion control matting have NOT controlled erosion and over all temporary stockpiles.
- B. Install in single thickness, strips parallel to direction of drainage. Anchor plastic in 6 in. by 6 in. trench backfilled with compacted native materials.
- C. Maintain tightly in place by using sandbags on ropes with a maximum 10 ft grid spacing in all directions.
- D. Tape or weight down full length, overlap seams at least 12 in.
- E. Remove at final acceptance unless notified otherwise by Engineer.

3.9 SILT FENCE

- A. Install prior to starting earth disturbing activities upslope of fence.
- B. One-piece filter fabric or continuously sewn to make one-piece filter fabric for full height of the fence, including portion buried in the toe trench.
- C. When joints are necessary, splice filter fabric together only at a support post, with a minimum 6 in. overlap, and securely fasten both ends to support post.
- D. Filter fabric shall NOT extend more than 24 in. above the ground surface. Securely fasten to upslope side of each support post using ties. Filter fabric shall NOT be stapled to existing trees.
- E. Fasten wire mesh material support fence securely to upslope side of post fasteners. Extend wire into the trench a minimum of 4 in, and NOT more than 36 in. above the ground surface.
- F. Take precaution NOT to puncture filter fabric during installation. Repair or replace damaged area.

- G. Remove silt fence after upslope area has been permanently stabilized. Immediately dress sediment deposits remaining after the silt fence has been removed to conform to existing grade. Prepare and seed graded area.

3.10 TEMPORARY SOIL STOCKPILES

- A. Cover with reinforced plastic covering, as directed in Paragraph 2.5 REINFORCED PLASTIC COVERING.
- B. Protect perimeter of stockpile from erosion with ditches.

3.11 STRAW BALES

- A. Embed minimum of 4 in. in flat-bottomed trench. Place across swales or ditches to reduce velocities of concentrated flows. Space bales a minimum of 100 ft spacing.
- B. Place with ends tightly abutting or overlapped. Corner abutment is NOT acceptable.
- C. Install so that bale bindings are oriented around the sides and NOT over the top and bottom of the bale.
- D. Use two posts for each bale. Drive posts through the bale until top of post is flush with top of bale.
- E. Wedge loose straws in any gaps between bales.

3.12 DUST CONTROL

- A. Apply appropriate dust control measures on a continuous basis until permanent stabilization measures are in place.
- B. Apply on construction routes and other disturbed areas subject to surface dust movement and where offsite damage may occur if dust is NOT controlled.
- C. Avoid creating erosion when using water as a dust controller.

3.13 CLEANUP

- A. Sediment trapped in erosion control devices shall be regraded into the slopes onsite. DO NOT flush sediment-laden water into the drainage system.
- B. After site restoration is complete and when approved by the Engineer, all temporary erosion control measures shall be completely removed. Immediately shape and permanently stabilize areas affected by the removal process.
- C. Silt fence, straw bales, reinforced plastic covering, and any other erosion control devices shall be disposed of offsite to locations that are approved by federal, state, and local authorities.

END OF SECTION

DIVISION 32
EXTERIOR IMPROVEMENTS

SECTION 32 91 13 – SODDING, SEEDING, FERTILIZING, AND MULCHING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Sodding.
 - 2. Fertilizer.
 - 3. Mulch.
 - 4. Seed.
 - 5. Preparation.
 - 6. Maintenance.
- B. Related Sections:
 - 1. Section 31 23 16 – Excavation
- C. Alternate Methods and Products:
 - 1. Alternate methods from those specified shall be considered for use, provided that in the Engineer's opinion the product shall be equal to or exceed that which would result from the specified methods and products.

1.2 DEFINITIONS

- A. Weeds:
 - 1. Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wold Garlic, Perennial Sorrel, and Brome Grass.

1.3 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.4 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.5 MAINTENANCE DATA

- A. Submit Maintenance Data for Continuing Owner Maintenance.
- B. Include maintenance instruction, cutting method, maximum grass height, types, application frequency, and recommended coverage of fertilizer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is NOT acceptable.
- B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.7 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 AGRICULTURAL LIMESTONE

- A. Shall be agricultural limestone with NOT less than 90% passing the No. 4 sieve and containing NOT less than 40% calcium carbonate equivalent. Lime shall be applied at the rate recommended by soil test.

2.2 FERTILIZER

- A. Shall be a standard commercial product which when applied at the proper rate will supply the equivalent quantity of total nitrogen, available phosphoric acid and soluble potash specified. Fertilizer shall be delivered to the site in bags or other suitable containers, each fully labeled, conforming to applicable state fertilizer laws, and bearing the name, trade name or trademark, and warranty of the producer.
- B. Requirements Per Acre:
 - 1. 600 lbs. of 17-17-17 grade fertilizer or equivalent.

2.3 MULCH

- A. Shall be vegetative mulch consisting of cereal straw from stalks of oats, rye, wheat, or barley. Straw shall be free of prohibited weed seeds as stated in State Seed Law and shall be relatively free of all other noxious and undesirable seeds. Straw shall be clean and bright, relatively free of foreign material and be dry enough to be spread properly.

2.4 SEED

- A. Seed shall be a mixture with the specified minimum purity and germination requirements:

Seed Type	% Mix (By Wt.)	Purity (%)	Germination (%)
Kentucky K-31 Fescue	52	97	85
Creeping Red Fescue	18	85	80
Rye Grass	8	98	85
Rye Grain	22	—	—

Variation in the above mix to suit local conditions or time of year may be required.

- B. Seed shall be labeled as specified in USDA regulations. Care shall be taken during transportation to avoid segregation of seed mixtures.
- C. Seed shall be sown at a rate of 217 lbs. of seed mix per acre for drill seeding. Seed mixture shall be thoroughly mixed prior to application.

2.5 SODDING

- A. Sodding shall consist of furnishing and placing sod at all locations shown on the Plans, where directed by the Engineer, and in conformity with these Specifications. Sod shall consist of a live, dense, well-rooted growth of permanent grasses, free of weeds and weedy grasses. All sod shall be cleanly cut in strips having a reasonably uniform thickness of NOT less than 1 in, a

reasonable uniform width of NOT less than 8 in, and a length NOT less than 12 in. Sod shall be Kentucky 31 Fescue, Bluegrass, or Bermuda grass. It shall be the obligation of the Contractor to secure a satisfactory growth of grass before final acceptance of the project.

PART 3 - EXECUTION

3.1 GENERAL

- A. The application of fertilizer, seed, and mulch shall follow each other in successive sequence as closely as possible. Seeding shall be accomplished in the first of the following two periods after completion of earthwork.
 - 1. February 15 to May 1st
 - 2. September 1st to October 1st
- B. Seeding outside the specified seeding periods may be permitted at the Engineer's option, provided the Contractor is willing to make appropriate modifications to his seeding operations, and will guarantee the crop.

3.2 INSPECTION

- A. Contractor shall request that Engineer inspect site grading, cleanup, and surface preparation to determine if site is ready for the seeding, fertilizing and mulching operations.
- B. Upon Engineer's Approval Operations May Begin.

3.3 SURFACE PREPARATION

- A. Immediately in advance of fertilizing, the surface to be seeded shall be repaired, if necessary, to eliminate all damage from erosion or construction operations. The surface shall then be loosened and thoroughly pulverized by discing, harrowing, and raking or other approved methods, to such an extent that it is free from sod, stones, clods, or roots. All growth of vegetation that will seriously interfere with planting operations shall be removed and disposed of as directed. The final surface shall be smooth and uniform, and left in such a condition as to prevent formation of low places and pockets.

3.4 FERTILIZING

- A. Fertilizer and lime shall be dressed evenly over the areas to be seeded using approved mechanical type spreading equipment.
- B. Fertilizer and lime after spreading shall be immediately incorporated into the soil to a depth of approximately 2 in, by chisel, spike tooth harrow, or other approved methods.

3.5 SEEDING METHODS

- A. General Methods:
 - 1. The Contractor shall employ a satisfactory method of sowing by use of either approved mechanical hand seeders or mechanical power-driven drills. When delays in operation carry the work beyond the specified planting seasons, or when conditions are such that by reason of drought, high winds, excessive moisture, or other factors, satisfactory results are NOT likely to be obtained, seeding shall stop. It shall be resumed only where the desired results are probable or when approved alternate procedures have been adopted.
- B. Broadcast Seeding:

1. When broadcast seeding is utilized, the seed shall be uniformly broadcast by mechanical hand seeder, in two directions at right-angles to each other and at 1/2 of the specified rate per acre in each direction. After the seed is broadcast it shall be covered by an approved method to a depth of 1/3 in. – 3/4 in. Broadcast seeding shall NOT be done in windy weather.
- C. Drill Seeding:
 1. When drilling is utilized, it shall be done with approved equipment best suited to perform the work under prevailing conditions. The seed shall be uniformly drilled to a depth of 1/3 in. – 3/4 in. at the rate per acre specified. Drill seeding may be required in windy weather.
- D. Prior to start of seeding, the Contractor shall demonstrate that the application of seed is being made at the specified rate. A final check of the total quantity of seed used shall be made against the area seeded. If the check shows that the Contractor has NOT applied seed at the specified rate, he shall uniformly distribute seed at a rate calculated to meet the shortage.
- E. The Contractor shall maintain the seeded areas until all fertilizing, seeding and mulching is complete and the work accepted by the Engineer. Areas damaged from the Contractor's own operations shall be repaired at his expense. After acceptance of the work the Contractor shall NOT be held responsible for erosion due to weather, or conditions NOT due to the Contractor's own operations or negligence. The Contractor is NOT required to guarantee a crop, if seeding is done during the specified seeding periods.

3.6 MULCHING

- A. Immediately after seeding, the Contractor shall apply vegetative mulch at a rate of 1.5 tons – 2.5 tons per acre to all seeded areas. Quantity of mulch shall be adjusted within the above limits, as directed by the Engineer, to the area or slope being mulched. Total application of mulch for the project shall average approximately 2 tons per acre. Mulch shall be applied by mechanical mulch spreaders equipped to eject by means of a constant air stream controlled quantities of the vegetative mulch.
- B. Mulch shall be embedded by a disc type roller having flat serrated discs spaced NOT more than 10 in. apart, with cleaning scrapers for each disc.
- C. Where specified, or in areas of the project where soil conditions are NOT suitable for satisfactory crimping, asphalt emulsion shall be applied with the mulching operation. The normal rate of application shall be 100 gallons per 1 ton of straw; however, this rate may be varied as directed by the Engineer to suit the area or slope conditions.
- D. All mulch shall be distributed evenly over the areas to be mulched within 24 hours after the seeding operation. Following the mulching operation, suitable precautions shall be taken to prohibit traffic over mulched areas. Displaced mulch shall be replaced immediately, including repair of the underlying seed bed, if damaged as well.

3.7 MAINTENANCE

- A. The Contractor shall maintain all seeded areas until the grass is properly established (not less than 90 days) until satisfactory development. Maintenance shall be continued until final acceptance of the work.
- B. Maintenance of seeded areas shall include protecting, watering, mowing, fertilizing, and such other work as may be necessary to establish a permanent lawn. The Contractor shall reseed

those seeded areas in which a satisfactory growth is NOT obtained, and shall refill any areas which become eroded prior to final acceptance of the work.

- C. Paved areas shall be kept clean while maintenance operations are in progress.

3.8 REPLACEMENT

- A. The Contractor shall replace all trees, shrubs, and flowers damaged by construction activities in the areas designated on the construction plans. The replacement trees and shrubs shall be equal in size to the damaged or removed specimen.

END OF SECTION

DIVISION 33
UTILITIES

SECTION 33 13 00 – DISINFECTION OF WATER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Work, material, and procedures for disinfection of installed potable water lines.

1.2 REFERENCES

- A. AWWA (American Water Works Association):
 - 1. B300 – Hypochlorites
 - 2. B301 – Liquid Chlorine
 - 3. B303 – Sodium Chlorite
 - 4. C651 – Disinfecting Water Mains
 - 5. C652 – Disinfection of Water-Storage Facilities
 - 6. C653 – Disinfection of Water Treatment Plants
 - 7. C654 – Disinfection of Wells

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Quality Requirements Submittals:
 - 1. Procedures and plans for disinfection and testing.
 - 2. Type of disinfecting solution and method of preparation.

1.4 SEQUENCING AND SCHEDULING

- A. Completion and acceptance of internal painting of system(s).
- B. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing, and acceptance of pipelines, pumping systems, structures, and equipment.
- C. Commence Disinfection.

1.5 WARRANTIES

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 WATER FOR DISINFECTION AND TESTING

- A. Clean, uncontaminated, and potable.
- B. Owner shall supply potable quality water, Contractor shall convey in disinfected pipelines or containers.

2.2 CONTRACTOR'S EQUIPMENT

- A. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.

2.3 MIXING DISINFECTANT

- A. Preparation:
 - 1. The purpose of the stock solution is to facilitate mixing and dilution to make sure of a uniform disinfecting solution.
 - 2. The Contractor shall NOT be required to mix a stock solution if a liquid chlorine gas feed system is used that can accurately feed a desired amount of chlorine to mix a final (dilute) disinfecting solution.
 - 3. Prepare solution by mixing:
 - a. Liquid chlorine gas as specified in AWWA B301 and water mixture.
 - b. Dry chlorine gas as specified in AWWA B301.
 - c. Calcium hypochlorite as specified in AWWA B300
or
Sodium hypochlorite as specified in AWWA B303 powder or liquid and water mixture.
- B. Feed dry chlorine gas through devices to regulate the rate of flow and make sure of uniform diffusion of gas into water within the pipe or vessel being treated. Chlorinating devices for feeding chlorine gas solution or the gas itself shall prevent water entering into chlorine cylinder.
- C. Use proportions of hypochlorite or chlorine to water:
 - 1. Chlorine Gas or Liquid (100% Cl): 1 lb. per 1 1.75 gal water.
 - a. Apply liquid chlorine gas-water solution by means of a solution feed chlorinating device.
 - 2. Calcium Hypochlorite (65 to 70% Cl): 1 lb. per 7.5 gal. water.
 - a. If calcium hypochlorite is used, first mix dry powder with water to make a thick paste, then thin to a 1% solution (10,000 ppm chlorine).
 - 3. Sodium Hypochlorite (5.25% Cl): 1 gal per 4.25 gal water.
 - a. If sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1% solution.

PART 3 - EXECUTION

3.1 GENERAL

- A. Disinfect pumps and pipelines, installed, or modified under this Project, intended to hold, transport, or otherwise contact potable water:
 - 1. Disinfect new pipelines that connect to existing pipelines up to the point of connection.
 - 2. Disinfect surfaces of materials that will contact finished water, both during and after construction using spray method described below.
 - 3. Disinfect prior to contact with finished water. Prevent and avoid recontamination.
- B. Prior to application of disinfectants, clean equipment and pipelines of loose and suspended material. Flush pipelines until clear of suspended solids and color. Use water suitable for flushing and disinfecting.
- C. As specified, unless modified in these sections:
 - 1. AWWA C651 for pipes and pipelines
 - 2. AWWAC652 for tanks and reservoirs
 - 3. AWWA C654 for wells
- D. Allow freshwater and stock disinfectant solution to flow into the pipe or vessel at a measured rate so that the chlorine-water solution is at the specified strength. DO NOT place concentrated commercial disinfectant in the pipeline or vessel before it is filled with water.

3.2 PIPING AND PIPELINES

- A. Flushing:
 - 1. Before disinfecting, flush all foreign matter from pipeline. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 2.5 fps. For large diameter pipe, where it is impractical or impossible to flush the pipe at specified velocity, clean the pipeline in-place from the inside by brushing and sweeping, then flush the line.
 - 2. Flush pipelines through flushing branches and remove branches after flushing is completed. Operate valves during flushing process at least twice during each flush.
 - 3. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections.
- B. Disinfecting Solution:
 - 1. Chlorine-water solution having a free chlorine concentration of NOT less than 50 ppm.
- C. Disinfecting Procedure:
 - 1. As specified in AWWA C651, unless modified in this section.
- D. Point of Application:
 - 1. Inject chlorine mixture into pipeline to be treated at beginning of line through corporation stop or suitable tap in top of pipeline.
 - 2. Control water from existing system to flow slowly into pipeline during application of chlorine.
 - 3. Control rate of chlorine solution flow in proportion to rate of water entering pipe so that combined mixture shall contain NOT less than 50 ppm of free available chlorine.
 - 4. Prevent backflow of chlorine solution into line supplying water.
- E. Retention Period:
 - 1. Retain treated water in pipeline for at least 24 hours to destroy all nonspore-forming bacteria. At end of 24 hour period, disinfecting solution shall contain at least 10 ppm of free chlorine or the pipeline shall be recleaned, disinfecting solution shall be reapplied, and specified procedure repeated.
 - 2. Operate valves, hydrants, and appurtenances during disinfection to ensure that disinfecting solution is dispersed into all parts of pipeline, including dead-ends and areas that otherwise may NOT be treated.
 - 3. After disinfection, flush water from the permanent source until water through the pipeline is equal chemically and bacteriologically to permanent source of supply.

3.3 PUMPS

- A. Disinfecting Solutions:
 - 1. Minimum free chlorine concentration of 200 ppm.
- B. Disinfecting Procedure:
 - 1. As specified in AWWA unless modified in this section.
- C. Application:
 - 1. Inject the disinfecting solution into the pump and associated piping and circulate for a minimum 2 hour period of time. At the end of the 2 hour period, the solution shall have a strength of at least 100 ppm free chlorine.
 - 2. Operate valves and/or pump appurtenances during disinfection to ensure that the disinfecting solution is dispersed into all parts of the pumps and lines.

3. If the disinfecting solution contained in the pumps has a residual free chlorine concentration less than 100 ppm after the 2 hour retention period, reclean the pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.
4. After chlorination, flush the water from the pumps until the water through the units is chemically and bacteriologically equal to the permanent source of supply.

3.4 DISPOSAL OF DISINFECTING WASTEWATER

- A. DO NOT allow flow into a waterway without neutralizing disinfectant residual.
 1. See AWWA C652 for acceptable neutralization methods.

3.5 TESTING

- A. Test Equipment:
 1. Clean containers and equipment used in sampling and assure they are free of contamination.
 2. Obtain sampling bottles with instructions for handling from laboratory.
- B. Chlorine Concentration Sampling and Analysis:
 1. Sampling Frequency for Disinfecting Solution: Two samples per disinfecting procedure.
 2. Residual Free Chlorine Samples: Two samples per disinfecting procedure.
 3. Dechlorinated Disinfecting Wastewater Residual Samples: Two samples per disinfecting procedure.
 4. Sampling Locations: Each 1,000 ft of pipeline or each building.
 5. Analysis to be performed by the Owner's laboratory.
- C. After pipelines have been cleaned, disinfected, and refilled with potable water, Owner shall take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies. Samples shall be analyzed for coliform concentrations as specified in the latest edition of Standard Methods for the Examination of Water and Wastewater.
 1. A minimum of two Samples on each of two consecutive days from each separable structure every 1,000 ft of pipeline shall be obtained and analyzed by standard procedures outlined by state and local regulatory agencies.
- D. If the minimum Samples required above are NOT bacterially negative, the disinfecting procedures and bacteriological testing shall be repeated on the respective facilities until bacterial limits are met.

END OF SECTION

DIVISION 40
PROCESS INTEGRATION

SECTION 40 05 00 – PIPING SYSTEMS TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Test requirements for piping systems.
- B. Related Sections:
 - 1. Section 40 23 39.1 – Process Piping Schedule.

1.2 REFERENCES

- A. NFGC (National Fuel Gas Code):
 - 1. ANSI Z 223.1 or NFPA 54.
- B. ASME (American Society of Mechanical Engineers):
 - 1. B31.8 – Gas Transmission and Distribution Piping Systems.
 - 2. B31.1 – Power Piping.
 - 3. B31.3 – Process Piping.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Schedule and Notification of Tests:
 - 1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
 - 2. Notification of Readiness to Test:
 - a. Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.4 TESTING REQUIREMENTS

- A. General Requirements:
 - 1. Testing requirements:
 - a. As stipulated in Laws and Regulations.
 - b. As specified in Section 40 23 39.1 – Process Piping Schedule.
 - c. As specified in the sections covering the various types of piping.
 - d. As specified in this section.
 - 2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
 - 3. Test plumbing piping as specified in Laws and Regulations and UL requirements.
 - 4. Test Natural Gas or Gas Piping:
 - a. For less than 125 psi gauge working pressure, test as specified in National Fuel Gas Code.
 - b. For 125 psi gauge or greater working pressure, test per ASME B31.3 or ASME B31.8, whichever is more stringent.
 - 5. When testing with water for High-Head and Low-Head:
 - a. The specified test pressure is the pressure at the highest point of the piping section under test. Lower the test pressure as necessary to prevent testing the lowest point above a safe test pressure.

- b. PVC piping shall NOT be tested with air within the pipe.
 - c. Test pressures shall be 1.5 times the maximum operating pressure or rounded up to 100 psig for high head pressure testing. Low head pressure testing shall be round up to the nearest 5 psig.
 - B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.
 - C. Water for Testing, Cleaning, and Disinfecting:
 - 1. Water for testing, cleaning, and disinfecting will be provided as specified in Section 01 50 00 – Temporary Facilities and Controls.
 - D. Pipes to be Tested:
 - 1. Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. DO NOT use existing valves as test plug or bulkhead.
 - E. Unsuccessful Tests:
 - 1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
 - 2. Repeat testing until tests are successful.
 - F. Test Completion:
 - 1. Drain and leave piping clean after successful testing.
 - G. Test Water Disposal:
 - 1. Dispose of testing water at the facility as specified in federal, state, county, and city regulations governing disposal of waste in the location of the Project and disposal site.
- 1.5 SEQUENCE
- A. Clean piping before pressure or leak tests.
 - B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.
 - C. Underground pressure piping may be tested before or after backfilling when not specified otherwise.
 - D. Backfill and compact trench or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.
 - E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING, ALIGNMENT, GRADE, AND DEFLECTION

- A. Alignment and Grade:

1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
2. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection Test:

1. Pull a mandrel through the clean piping section under test.
2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
3. Use a 9-rod mandrel with a contact length of not less than the nominal diameter of the pipe within plus or minus 1%.
4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.2 AIR TESTING METHOD FOR PRESSURE PIPING

- A. Air test piping, specified in "AM" of Section 40 23 39.1 – Process Piping Schedule, with air or another nonflammable or inert gas.
- B. Test gas, air, liquefied petroleum gas, liquid chlorine, and chlorine gas piping by the air test method:
 1. Test chlorine piping with dry air or nitrogen having a dew point of (-40)°F or less. Supply temporary air dryers as necessary.
- C. Test at pressure as specified in Section 40 23 39.1– Process Piping Schedule:
 1. Provide temporary pressure relief valve for piping under test. Set at the lesser of 110% of the test pressure or 50 psi gauge over the test pressure.
 2. Air method test pressures shall not exceed 110% of the piping maximum allowable working pressure calculated as specified in ASME B31.1, ASME B31.3, ASE B31.8, or the pipe manufacturer's stated maximum working pressure.
 3. Gradually increase test pressure to an initial test pressure equal to the lesser of 1/2 the test pressure or 25 psi gauge.
 4. Perform initial check of joints and fittings for leakage.
 5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage at each step increase until test pressure is reached.
 6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
 7. Consider examination complete when piping section under test holds the test pressure for 15 min without losses.

3.3 TESTING GRAVITY FLOW PIPING

- A. Test Gravity Flow Piping as specified in "G" of the 40 23 39.1 – Process Piping Schedule:
 1. Unless specified otherwise, subject gravity flow piping to:
 - a. Alignment and grade tests.
 - b. Plastic piping test for deflection.
 - c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.
 2. Inspect piping for visible leaks before backfilling. Provide temporary restraints when needed to prevent movement of piping. Pressure test piping with maximum leakage allowance after backfilling.
 3. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours.
 - a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.

- b. Maintain piping with water or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
- c. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of four hours while accurately measuring the volume of water added to maintain the test pressure.
 - 1) maximum leakage allowances; tests are complete when leakage is equal to or less than:
 - a) For Concrete Piping with Rubber Gasket Joints:
 - i. 80 gpd per inch of diameter per mile of piping under test.
 - b) Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.
 - c) For Vitrified Clay and Other Piping:
 - i. 500 gpd per inch of diameter per mile of piping under test.

3.4 TESTING HIGH-HEAD PRESSURE PIPING

- A. Test piping for which the specified test pressure in Section 40 23 39.1 – Process Piping Schedule is 20 psi gauge or greater, by the high head pressure test method, specified in “HH” of Section 40 23 39.1 – Process Piping Schedule.
- B. General:
 - 1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
 - 2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
 - 3. Do not include valves, equipment, or piping specialties in test sections if test pressure exceeds the valve, equipment or piping specialty safe test pressure allowed by the item's manufacturer.
 - 4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 psi gauge with respect to the specified test pressure.
 - 5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
 - 6. When test results show failure of selected sections, limit tests to piping:
 - a. Between valves.
 - b. Between a valve and the end of the piping.
 - c. Less than 500 ft long.
 - 7. Test piping for a minimum of 2 hours for visible leaks test and minimum of 2 hours for the pressure test with maximum leakage allowance.
- C. Testing Procedures:
 - 1. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where specified in Section 40 23 39.1 – Process Piping Schedule.
 - 2. Before pressurizing for the test, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
 - 3. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider visible leakage testing complete when no visible leaks are observed.
- D. Pressure Test with Maximum Leakage Allowance:
 - 1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
 - 2. Pressure test piping after completion of visible leaks test.
 - 3. For piping systems using joint designs other than flanged threaded or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.

- a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
- b. Successful completion of the pressure test with maximum leakage allowance shall have been achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
- c. Successful completion of the pressure test with maximum leakage allowance shall have been achieved with the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
- d. When leakage is allowed, calculate the allowable leakage by:

$$L = \frac{S D \sqrt{P}}{148,000}$$

Where:

L = testing allowance (makeup water) (gph)

S = length of pipe tested (ft)

D = nominal diameter of the pipe (in.)

P = average test pressure during the hydrostatic test (psi [gauge])

3.5 TESTING LOW-HEAD PRESSURE PIPING

- A. Test piping for which the specified test pressure is less than 20 psi gauge, by the low head pressure test method, specified in "LH" of Section 40 23 39.1 – Process Piping Schedule.
- B. General:
 1. Test pressures shall be as scheduled in Section 40 23 39.1 – Process Piping Schedule.
 2. During the performance of the tests, test pressure shall not vary more than plus or minus 2 psi gauge with respect to the specified test pressure.
 3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
 4. Test piping for a minimum of 2 hours for visible leaks test and minimum of 2 hours for the pressure test with maximum leakage allowance.
- C. Visible Leaks Test:
 1. Subject piping under test to the specified pressure measured at the lowest end.
 2. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where specified in 40 23 39.1 – Process Piping Schedule.
 3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
 4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.
- D. Pressure Test with Maximum Leakage Allowance:
 1. Pressure test piping after completion of visible leaks test.
 2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
 - a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours and no damage to piping and appurtenances has occurred.
 - b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
- E. Optional Joint Test:

1. When Joint Testing Is Allowed by Note as specified in Section 40 23 39.1 – Process Piping Schedule, the Procedure Shall Be:
 - a. Joint testing will be allowed only for low head pressure piping.
2. Joint testing may be performed with water or air.
3. Joint test piping after completion of backfill and compaction to the top of the trench.
4. Joint Testing with Water:
 - a. Measure test pressure at the invert of the pipe. Apply pressure of 4 ft plus the inside diameter of the pipe in water column within 0.20 ft in water column.
 - b. Maintain test pressure for 1 min.
 - c. Base the allowable leakage per joint on 80 gal/in. nominal diameter, per mile of piping, per 24 hours equally distributed to the actual number of joints per mile for the type of piping.
 - d. Consider the pressure test to be complete when makeup water added is less than the allowable leakage.
 - e. Successful completion of the joint test with water shall have been achieved when the observed leakage is equal or less than the allowable leakage.
5. Joint Testing with Air:
 - a. Apply test pressure of 3 psi gauge with an allowed variation of 0.00 psi – 0.20 psi.
 - b. Maintain test pressure for 2 min.
 - c. Consider the pressure test to be complete when the test pressure does not drop below 2.7 psi for the duration of the test.

3.6 PNEUMATIC TEST FOR PRESSURE PIPING

- A. Test piping as specified in pipe schedule.
- B. DO NOT perform on:
 1. PVC or CPVC pipe.
 2. Piping larger than 18 in.
 3. Buried and other nonexposed piping.
- C. Fluid:
 1. Oil-free, dry air.
- D. Procedure:
 1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections, examine for leakage.
 2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
 3. Gradually increase pressure in system to half of specified test pressure. Thereafter increase pressure in steps of approximately 1/10 of specified test pressure until required test pressure is reached.
 4. Maintain pneumatic test pressure continuously for minimum of 10 min and for such additional time as necessary to conduct soap bubble examination for leakage.
 5. Correct visible leakage and retest as specified.
- E. Allowable Leakage:
 1. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.
- F. After testing and final cleaning, purge with nitrogen those lines that shall carry flammable gases to assure no explosive mixtures shall be present in system during filling process.

3.7 PNEUMATIC TEST FOR GRAVITY PIPING 12 IN. AND SMALLER

- A. Equipment:
1. Calibrate gauges with standardized test gauge at start of each testing day.
 2. Install gauges, air piping manifolds, and valves at ground surface.
 3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
 4. Restrain plugs used to close sewer lines to prevent blowoff.
- B. Procedure:
1. Require that no person enter manhole where pipe is under pressure.
 2. Slowly introduce air into pipe section until internal air pressure reached 4 psi greater than average back pressure of groundwater submerging pipe.
 3. Allow 2 min minimum for air temperature to stabilize.
- C. Allowable Leakage:
1. Test section shall be considered “defective” when time required for pressure to decrease from 3.5 psi – 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed utilizing values:

TABLE 1*					
A	B	C	D	E	F
Pipe Diameter (Inches)	Time per Foot up to Length in Col C (Seconds)	Test Length (Feet)	Test Time Between Col C & E (for any Length)	Length (Col F Applies) (Feet)	Time per Foot for Total Length (Seconds)
	0.18	636	1:54	1,114	0.10
	0.40	424	2:50	743	0.23
	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81
24	6.42	106	11:20	187	3.67
EXAMPLE: 15 in. diameter pipe: For 150 ft, T = 2.50 sec (Col B) x 150 ft = 375 sec – 6:15 For 250 ft, T = 7:05 (Col D) For 500 ft, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50					
* Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.					

- D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration shall be considered “defective” even if pipe previously passed a leakage test.
- E. “Defective” Piping Sections:
1. Replace or test and seal individual joints, and retest as specified.

3.8 FIELD QUALITY REQUIREMENTS

- A. Test Report Documentation:
1. Test date.
 2. Description and identification of piping tested.
 3. Test fluid.

4. Test pressure.
5. Remarks, including:
 - a. Leaks (type, location).
 - b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 40 05 06 – PROCESS PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe penetrations.
 - 2. Restrained joints.
 - 3. Flexible metal hose connections.
 - 4. Expansion joints.
 - 5. Expansion loops.
 - 6. Sleeve-type couplings.
 - 7. Unrestrained Flanged Coupling Adapters.
 - 8. Restrained Flanged Coupling Adapters.
 - 9. Restrained dismantling joints.
 - 10. Service saddles.
 - 11. Annular pressure seals.
 - 12. Insulating flanges, couplings, and unions.
 - 13. Strainers.
 - 14. Spray nozzles.
 - 15. Quick couplings.
 - 16. Quick disconnect cam operating couplings for chemical service.
 - 17. Chemical injection quills.
- B. Related Sections:
 - 1. Section 09 96 00 – High Performance Coatings.
 - 2. Section 40 23 39 – Process Piping General.

1.2 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System):
 - 1. The sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire-rated construction.
- B. FM:
 - 1. Factory Mutual Insurance Company; FM Global is the communicative name of the company.
- C. WH:
 - 1. Warnock Hersey; indicates compliance to relevant building codes, association criteria, and product safety and performance standards.

1.3 REFERENCES

- A. American Water Works Association:
 - 1. AWWA C219 – Bolted, Sleeve-Type Couplings for Plain-End Pipe.
- B. American Welding Society:
 - 1. AWS D1.1 – Structural Welding Code – Steel.
- C. ASME International:
 - 1. ASME A13.1 – Scheme for the Identification of Piping Systems.
 - 2. ASME B31.3 – Process Piping.

3. ASME B31.9 – Building Services Piping.
 4. ASME Boiler and Pressure Vessel Code (BPVC), Section IX – Welding, Brazing, and Fusing Qualifications.
- D. ASTM International:
1. D2000 – Standard Classification System for Rubber Products in Automotive Applications.
 2. E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 3. E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
 4. E814 – Standard Test Method for Fire Tests of Penetration Firestop Systems.
 5. E1966 – Standard Test Method for Fire-Resistive Joint Systems.
- E. EJMA Standards (Expansion Joint Manufacturers Association, Inc.):
- F. NSF International:
1. 61 – Drinking Water System Components – Health Effects.
 2. 372 – Drinking Water System Components – Lead Content.
- G. UL:
1. 263 – Fire Tests of Building Construction and Materials.
 2. 1479 – Fire Tests of Through-Penetration Firestops.
 3. 2079 – Tests for Fire Resistance of Building Joint Systems.
- 1.4 SUBMITTALS
- A. Section 01 33 00 – Submittal Procedures: Requirements for submittals.
- B. Product Data:
1. Submit manufacturer catalog information for each specified product.
 2. Firestopping: Submit data on product characteristics, performance, and limitation criteria.
 3. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 4. Expansion Joints: Indicate maximum temperature, pressure rating, and expansion compensation.
- C. Shop Drawings:
1. Identification:
 - a. Submit list of wording, symbols, letter size, and color coding for pipe identification.
 - b. Comply with ASME A13.1.
 2. Indicate restrained joint details and materials.
 3. Submit layout drawings showing piece numbers and location, indicating restrained joint locations.
 4. Indicate layout of piping systems, including flexible connectors, expansion joints and compensators, loops, offsets, and swing joints.
- D. Firestopping Schedule:
1. Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings for maintenance of fire-resistance rating of adjacent assembly.
- E. Include following Paragraph for submission of physical samples for selection of finish, color, texture, and other properties.
- F. Manufacturer's Certificate:

1. Certify that products meet or exceed specified requirements.
- G. Welder Certificates:
1. Certify welders and welding procedures employed on Work, verifying ASME qualification within previous 12 months.
 2. Include separate Paragraphs for additional certifications.
 3. Include following Paragraph when Contractor is responsible for designing products or assemblies. List affected products when Section specifies more than one product.
- H. Delegated Design Submittals:
1. Submit signed and sealed Shop Drawings with design calculations and assumptions for:
 - a. Flexible connectors.
 - b. Expansion joints.
 - c. Pipe Restraints:
 - 1) Determine restrained lengths and submit joint restraint details.
 - 2) Use joint restraint devices specifically designed for applications as described in manufacturer data.
 - d. Firestopping Engineering Judgments: For conditions not covered by UL- or WH-listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction to accept as meeting fire-protection code requirements.
- I. Manufacturer Instructions:
1. Submit special procedures and setting dimensions.
- J. Source Quality-Control Submittals:
1. Specify results of shop tests and inspections.
- K. Field Quality-Control Submittals:
1. Specify results of Contractor-furnished tests and inspections.
- L. Qualifications Statements:
1. Submit qualifications for manufacturer, installer, and licensed professional.
 2. Submit manufacturer's approval of installer.
 3. Welders: Qualify procedures and personnel as specified in ASME BPVC-IX.
- M. Closeout Submittals:
1. Project Record Documents:
 - a. Record actual locations of piping appurtenances.
 2. Identify and describe unexpected variations to pipe routing or discovery of uncharted utilities.
- 1.5 COORDINATION
- A. Coordinate Work of this Section with installation of valves and equipment.
- 1.6 QUALITY ASSURANCE
- A. Materials in Contact with Potable Water:
1. Certified to NSF Standards 61 and 372.
- B. Perform Work according to ASME B31.9 for installation of piping systems and according to ASME BPVC-IX for welding materials and procedures.

- C. Perform Work according to ASME B31.3, ASME B31.9, and Local Building Codes for installation of piping systems.
- D. Through-Penetration Firestopping of Fire-Rated Assemblies:
 - 1. Comply with UL 1479 or ASTM E814.
 - 2. Minimum Positive Pressure Differential: 0.1 in. WG to achieve fire F-ratings and temperature T-ratings as indicated on Drawings, but not less than one hour.
 - 3. Wall Penetrations: Fire F-ratings as indicated on Drawings, but not less than one hour.
 - 4. Fire-rated firestopping may not be required for non-rated floors and roofs. Coordinate with following non-fire-rated assemblies.
 - 5. Floor and Roof Penetrations:
 - a. Fire F-ratings and Temperature T-ratings: As indicated on Drawings, but not less than one hour.
 - b. Floor Penetrations within Wall Cavities: T-rating is not required.
- E. Through-Penetration Firestopping of Non-fire-rated Floor and Roof Assemblies:
 - 1. Materials to resist free passage of flame and products of combustion.
 - 2. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 3. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- F. Fire-Resistive Joints in Fire-Rated Floor, Roof, and Wall Assemblies:
 - 1. Comply with ASTM E1966 or UL 2079.
 - 2. Rating: As indicated on Drawings for assembly in which joint is installed.
- G. Fire-Resistive Joints between Floor Slabs and Exterior Walls:
 - 1. Comply with ASTM E119.
 - 2. Minimum Positive Pressure Differential: 0.1 in. WG to achieve fire-resistance rating as indicated on Drawings for floor assembly.
- H. Surface-Burning Characteristics:
 - 1. Maximum 25/450 flame-spread/smoke-developed index when tested according to ASTM E84.

1.7 QUALIFICATIONS

- A. Coordinate following Paragraphs with requirements specified in SUBMITTALS Article.
- B. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this Section with minimum three years of experience.
- C. Installer:
 - 1. Company specializing in performing Work of this Section with minimum three years of experience and approved by manufacturer.
- D. Welders:
 - 1. ASME qualified within previous 12 months for employed weld types.
- E. Licensed Professional:
 - 1. Professional engineer experienced in design of specified Work and licensed in State of Texas.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 – Product Requirements for transporting, handling, storing, and protecting products requirements.
- B. Inspection:
 - 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
 - 3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

- A. Furnish 1-year manufacturer's warranty.
- B. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 PIPE PENETRATIONS

- A. Performance and Design Criteria:
 - 1. Firestopping Materials: Per manufacturer's recommendation.
 - 2. Firestop interruptions to fire-rated assemblies, materials, and components.
 - 3. Firestopping: Provide certificate of compliance from authority having jurisdiction, indicating approval of materials used.
- B. Flashing:
 - 1. Metal Flashing:
 - a. Material: Galvanized steel.
 - b. Thickness: 26 gage.
 - 2. Metal Counterflashing:
 - a. Material: Galvanized steel.
 - b. Thickness: 22 gage.
 - 3. Lead Flashing:
 - a. Material: Sheet lead.
 - b. Weight:
 - 1) Waterproofing: 5 psf.
 - 2) Soundproofing: 1 psf.
 - 4. Flexible Flashing Materials:
 - a. Material: Compatible with service conditions.
 - b. Thickness: 47 mils.
 - 5. Caps:

- a. Material: Steel.
 - b. Minimum Thickness: 22 gage, and 16 gage at fire-resistive elements.
- C. Sleeves:
 - 1. Sleeves for Pipes through Non-fire-rated Floors:
 - a. Material: Galvanized steel.
 - b. Thickness: 18 gage.
 - 2. Sleeves for Pipes through Non-fire-rated Beams, Walls, Footings, and Potentially Wet Floors:
 - a. Steel pipe.
 - b. 18 gage galvanized steel.
 - 3. Sleeves for Pipes through water bearing structure, and where mechanical seals are specified:
 - a. Steel pipe.
 - b. 3/16 in. minimum galvanized steel.
 - c. Seep Ring:
 - 1) 3/16 in. minimum thickness center steel flange for water stoppage on sleeves in exterior or water-bearing walls.
 - 2) Outside Diameter: 3 in. greater than pipe sleeve outside diameter.
 - 3) Continuously fillet weld on each side all around.
 - d. Factory Finish:
 - 1) Galvanizing:
 - a) Hot-dip applied, meeting requirements of ASTM A153.
 - b) Electroplated zinc or cadmium plating is unacceptable.
 - 2) Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 96 00 – High Performance Coatings.
 - 4. Insulated and Encased Pipe Sleeve:
 - a. Manufacturer: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.
 - 5. Sealant:
 - a. Type: Acrylic.
- D. Mechanical Sleeve Seals:
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Fernco Inc.
 - c. Flexicraft Industries.
 - d. GPT; an EnPro Industries Company
 - e. Substitutions: As specified in Section 01 60 00 – Product Requirements.
 - 2. Description:
 - a. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve.
 - b. Connection: Bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
 - c. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts, nuts, and pressure plates.
 - d. Size: According to Manufacturer's instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 ft of water.
- E. Wall Pipes:
 - 1. Ductile Iron Wall Pipe:
 - a. For penetrations through concrete walls, floors, slabs, or roofs that are to be watertight.
 - b. Diameter and Ends: Same as connecting ductile iron pipe.
 - c. Thickness: Equal to or greater than remainder of pipe in line.

- d. Fittings: In accordance with applicable Pipe Data Sheet.
- e. Thrust Collars:
 - 1) Provide for all wall pipes.
 - 2) Rated for thrust load developed at 250 psi.
 - 3) Safety Factor: 2, minimum.
 - 4) Material and Construction:
 - a) Ductile iron or cast iron, cast integral with wall pipe wherever possible.
 - b) Fabricate welded attachment of ductile iron thrust collar to pipe where casting impossible. Perform in pipe manufacturer's shop by qualified welders. Electric arc welds of ductile iron with NI-55 or FC-55 nickel-iron-carbon weld rod. Continuously weld on each side all around.
- f. Manufacturers: American Cast Iron Pipe Co.; U.S. Pipe and Foundry Co.
- g. Coating After Fabrication: Prepare and coat wall pipe in accordance with and as specified in Section 09 90 00 – Painting and Coating.
- 2. Steel or Stainless-Steel Wall Pipe:
 - a. Same material and thickness as connecting pipe, except 1/4 in. minimum thickness.
 - b. Lining: Same as connecting pipe.
 - c. Thrust Collar: Unless otherwise shown, 3 in. greater than outside diameter of wall pipe. Continuously fillet weld on each side all around.
 - d. Coating After Fabrication: Prepare and coat wall pipe in accordance with and as specified in Section 09 96 00 – High Performance Coatings.
 - e. Restraint: Provide lugs for use with thrust ties as specified.

2.2 RESTRAINED JOINTS

- A. As specified in Pipe Specifications.

2.3 FLEXIBLE METAL HOSE CONNECTIONS

- A. Manufacturers:
 - 1. Flexicraft Industries.
 - 2. Flex-Weld, Inc.
 - 3. Hyspan Precision Products, Inc.
 - 4. Senior Flexonics.
 - 5. Substitutions: As specified in Section 01 60 00 – Product Requirements.
- B. Steel Piping:
 - 1. Inner Hose: Stainless steel.
 - 2. Exterior Sleeve: Single-braided stainless steel.
 - 3. Pressure Rating: 200 psig WOG at 250°F.
 - 4. Joints: Flanged, Threaded, or Threaded with union As specified for pipe joints.
 - 5. Size: 1/4 – 16 in.
 - 6. Maximum Offset: 1 in. on each side of installed center line.
- C. Copper Piping:
 - 1. Inner Hose: Bronze.
 - 2. Exterior Sleeve: Braided bronze.
 - 3. Pressure Rating: 125 psig WSP at 450°F.
 - 4. Joints: Flanged Threaded with union Soldered As specified for pipe joints.
 - 5. Size: 1/4 – 4 in.
 - 6. Maximum Offset: 1 in. on each side of installed center line.

2.4 EXPANSION JOINTS

- A. Manufacturers:
 - 1. Flexicraft Industries.
 - 2. Flex-Weld, Inc.
 - 3. Hyspan Precision Products, Inc.
 - 4. Mason Industries.
 - 5. Metraflex Company.
 - 6. U.S. Bellows, Inc.
 - 7. Senior Flexonics.
 - 8. Victaulic.
 - 9. Red Valve.
 - 10. General Rubber.
 - 11. Mercer.
 - 12. Substitutions: As specified in Section 01 60 00 – Product Requirements.
- B. Performance and Design Criteria:
 - 1. Bellow Design: According to Section C of EJMA Standards.
- C. Stainless-Steel Bellows Type – 3 in. and smaller:
 - 1. 3 in. and smaller:
 - a. Pressure Rating: 125 psig WSP at 400°F.
 - b. Maximum Compression: 1 3/4 in.
 - c. Maximum Extension: 1/4 in.
 - d. Joint: Flanged or Welded as specified for pipe joints.
- D. External Ring-Controlled Stainless-Steel Bellows Type – 4 in. and larger:
 - 1. Pressure Rating: 125 psig WSP at 400°F.
 - 2. Maximum Compression: 1 1/4 in.
 - 3. Maximum Extension: 3/8 in.
 - 4. Maximum Offset: 5/16 in.
 - 5. Joint: Flanged, grooved, or welded as specified for pipe joints.
 - 6. Accessories: Internal flow liner.
 - 7. Application: Steel piping 3 in. and larger.
- E. Single-Sphere Flexible Compensators:
 - 1. Body: EPDM.
 - 2. Working Pressure:
 - a. 2 in. – 12 in.: 150 psig.
 - b. 14 in. – 36 in.: 110 psig
 - 3. Maximum Temperature: 250°F.
 - 4. Maximum Compression: 1 1/8 in. or greater.
 - 5. Maximum Elongation: 3/4 in. or greater.
 - 6. Maximum Offset: 3/4 in. or greater.
 - 7. Joint: Tapped steel flanges.
 - 8. Size: 2 in – 36 in.
 - 9. Accessories: Control rods.
 - 10. Application: Steel or Ductile Iron piping 2 in. and larger.
- F. Double-Sphere Flexible Compensators:
 - 1. Body: EPDM.
 - 2. Working Pressure:
 - a. 2 in. – 12 in.: 150 psig.
 - b. 14 in. – 20 in.: 110 psig
 - 3. Maximum Temperature: 220°F.
 - 4. Maximum Compression: 2 in. or greater.

5. Maximum Elongation: 1/4 in. or greater.
6. Maximum Offset: 3/4 in. or greater.
7. Maximum Angular Movement: 30 degrees.
8. Joint: Tapped steel flanges.
9. Accessories: Control rods.
10. Application: Steel and Ductile Iron piping 2 in. and larger.

G. Two-Ply Bronze Bellows Type:

1. Description: Bronze with antitorque device, limit stops, and internal guides.
2. Pressure Rating: 125 psig WSP at 400°F.
3. Maximum Compression: 1 3/4 in.
4. Maximum Extension: 1/4 in.
5. Application: Copper piping.

H. Low-Pressure Compensators with Two-Ply Bronze Bellows:

1. Working Pressure: 80 psig.
2. Maximum Temperature: 400°F.
3. Maximum Compression: 1/2 in.
4. Maximum Extension: 5/32 in.
5. Joint: Soldered.
6. Application: Copper or steel piping 2 in and smaller.

2.5 EXPANSION LOOPS

- A. Provide expansion loops as indicated on Drawings.

2.6 SLEEVE-TYPE FLEXIBLE COUPLINGS

A. Manufacturers:

1. Romac.
2. Smith-Blair.
3. JCM Industries.
4. Ford Meter Box Company.
5. Substitutions: As specified in Section 01 60 00 – Product Requirements.

B. Description:

1. Comply with AWWA C219.
2. Middle Ring: Greater or equal to 12 in. diameter Steel, less than 12 in. diameter Ductile iron.
3. Followers: Greater or equal to 12 in. diameter Steel, less than 12 in. diameter Ductile iron.
4. Gaskets:
 - a. Material: Buna-N, or EPDM, or SBR, Compatible with service conditions and NSF 61 certified.
 - b. Comply with ASTM D2000 and AWWA C219.
5. Bolts: 304 Stainless Steel.

C. Finishes:

1. Buried Couplings: Fusion bonded epoxy.
2. Exposed: Match connecting pipe.

2.7 UNRESTRAINED FLANGED COUPLING ADAPTERS

- A. Provide flange coupling adapters with anchor lugs or anchor wedge restraints.

B. Manufacturers and Products:

1. Steel Pipe:
 - a. Smith-Blair – Series 913 (3 in. & Larger)
 - b. Dresser Industries, Inc. – Style 128-W (2 in. – 24 in.)
 - c. Romac – FC400 (12 in. – 96 in.)
 2. Ductile Iron Pipe:
 - a. Smith-Blair – Series 912 (3 in. – 12 in.)
 - b. Dresser Industries, Inc.; Style 128-W (3 in. – 12 in.)
 - c. Romac – FCA501 (3 in. – 16 in.)
 - d. EBAA Iron Series 1000 E-Z Flange Adapter
- C. Pressure Rating:
1. When properly installed on a pipe that is within the coupling manufacturer's tolerances, Flanged Coupling Adapters can work at pressures up to the maximum rating of the flange. Flanges are rated for a maximum working pressure of 300 psi.

2.8 RESTRAINED FLANGED COUPLING ADAPTERS

- A. Provide flange coupling adapters with anchor lugs or anchor wedge restraints.
- B. Manufacturers and Products:
1. Steel Pipe:
 - a. Smith-Blair – Model 911 (3 in. – 12 in.)
 - b. Romac – RFCA (3 in. – 24 in.)
 2. Ductile Iron Pipe:
 - a. Smith-Blair – Model 911 (3 in. – 48 in.)
 - b. Romac – RFCA (3 in. – 24 in.)
- C. Pressure Rating:
1. When properly installed on a pipe that is within the coupling manufacturer's tolerances, Flanged Coupling Adapters can work at pressures up to the maximum rating of the flange. Flanges are rated for a maximum working pressure of 275 psi.

2.9 RESTRAINED DISMANTLING JOINTS

- A. Manufacturers and Products:
1. Steel or Ductile Iron Pipe:
 - a. Smith-Blair – Series 975 (3 in. & Larger)
 - b. Dresser Industries, Inc. – Style 131 (2 in. – 24 in.)
 - c. Romac – DJ400 (3 in. – 72 in.)
- B. Pressure Rating:
1. Capable of withstanding a maximum working pressure of 300 psi.

2.10 SERVICE SADDLES

- A. Double-Strap Iron:
1. Pressure Rating: Capable of withstanding a maximum of 300 psi internal pressure without leakage or over stressing.
 2. Run Diameter: Compatible with the outside diameter of the pipe on which the saddle is installed.
 3. Taps: Iron pipe threads.
 4. Materials:
 - a. Body: Malleable or ductile iron.
 - b. Straps: Galvanized steel.
 - c. Hex Nuts and Washers: Steel.

- d. Seal: Rubber.
- 5. Manufacturers and Products:
 - a. Smith-Blair – Series 313 (1.25 in. – 24 in.) or 366 (19.25 in. – 43.15 in. O.D. range)
 - b. Dresser – Style 91 (2 in. – 12 in.)
- B. Nylon-Coated Iron:
 - 1. Pressure Rating:
 - a. Capable of withstanding a maximum of 300 psi internal pressure without leakage or over stressing.
 - 2. Run Diameter:
 - a. Compatible with the outside diameter of the pipe on which the saddle is installed.
 - 3. Materials:
 - a. Body: Nylon-coated iron.
 - b. Seal: Buna-N.
 - c. Clamps and Nuts: Stainless steel.
 - 4. Manufacturer and Product:
 - a. Smith-Blair; Style 315 (1 in. – 14 in.) or 317 (1.25 in. – 24 in.)

2.11 ANNULAR PRESSURE SEALS

- A. Provide annular isolation seals for pressure measurement where indicated on drawings or required by instrumentation specifications.
- B. Seals shall be full flange design with outside diameter matching the outside diameter of the mating flange. Seal to be retained between Class 150 pipe flanges, with flange bolts passing through sensor body and flanges.
- C. Seals shall be flow through design with flexible elastomer sensing ring around the full circumference.
- D. Seal Body:
 - 1. Carbon Steel. Provide 316 Stainless Steel if installed with stainless pipe material.
- E. Sensing Ring Material:
 - 1. Buna-N or EPDM, rated for process fluid temperature.
- F. Fill Fluid:
 - 1. Silicone oil.
- G. Manufacturers and Products:
 - 1. Ashcroft Series 81
 - 2. Winters D81
 - 3. Red Valve Series 40
 - 4. Onyx Valve PSR
- H. See Section 40 70 00 – Process and Analytical Instruments for pressure gauges, switches, and transmitters connected to pressure seals.

2.12 INSULATING FLANGES, COUPLINGS, AND UNIONS

- A. Materials:
 - 1. In accordance with the applicable piping material specified in the Pipe Data Sheets.
 - 2. Galvanically compatible with piping.
- B. Connection:

1. 2 in. and Smaller: Screwed or solder-joint.
2. 2 1/2 in. and Larger: Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.

C. Working Pressure Rating:

1. Suitable for specified system working pressure.

D. Manufacturers and Products:

1. Dielectric Flanges and Unions:
 - a. Epco Sales, Inc.
 - b. Capitol Insulation Unions.
2. Insulating Couplings:
 - a. Dresser – Style 39.
 - b. R. H. Baker – Series 216.

2.13 STRAINERS

A. Strainers for Process Water Service, 4 in. and Smaller:

1. Type: Bronze Body, Y-Pattern, 200 psi non-shock rated, with screwed gasketed bronze cap.
2. Screen: Heavy gauge Type 304 stainless steel or Monel, 20-mesh
3. Manufacturers:
 - a. Armstrong International, Inc. – F Series
 - b. Mueller Steam Specialty – Series 351M

B. Strainers for CPVC, Plastic Piping Systems, 4 in. and Smaller:

1. Type: Y-pattern CPVC body, 150 psi non-shock rated, with screwed CPVC cap; and PTFE Teflon seals as recommended by manufacturer for service.
2. End Connections: Screwed or solvent weld, 2 in. and smaller. Class 150 ANSI flanged, 1 1/2 in. and larger.
3. Screen: Heavy-gauge CPVC, 1/32 in. mesh, minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturers and Products:
 - a. Hayward Flow Control.
 - b. Or preapproved equal.

2.14 SPRAY NOZZLES

1. Scum Spray Nozzle Type 1:
 - a. Spray Pattern: Even
 - b. Spray Angle: 140° at 60 psi
 - c. Material: 316 stainless steel
 - d. Deflection Angle: 75 degrees
 - e. Capacity: 8 gpm at 40 psi
 - f. Size: 1/2 in. NPT
 - g. Provide nozzle with adjustable ball fitting: Spray System Company Series 36275
 - h. Manufacturer and Product:
 - 1) Spraying System Co. – Nozzle Type K
 - 2) Or preapproved equal.
2. Scum Spray Nozzle Type 2:
 - a. Spray Pattern: Solid narrow angle cone-shaped spray pattern with round impact area
 - b. Spray Angle: 15° at 40 psi
 - c. Material: 316 stainless steel
 - d. Capacity: 3 gpm at 40 psi
 - e. Size: 1/4 in. NPT
 - f. Provide nozzle with adjustable ball fitting: Spray System Company Series 36275

- g. Manufacturer and Product:
 - 1) Spraying System Co. – Nozzle Type G-15
 - 2) Or preapproved equal.
- 3. Scum Spray Nozzle Type 3:
 - a. Spray Pattern: Deflected flat spray pattern at low pressure
 - b. Spray Angle: 105° at 10 psi
 - c. Counterweight lever which when lifted, allows the solid stream flow to purge nozzle.
 - d. Material: Brass with elastomeric seat
 - e. Capacity: 3.5 gpm at 10 psi
 - f. Size: 1/4 in. NPT
 - g. Provide nozzle with adjustable ball fitting: Spray System Company Series 36275
 - h. Manufacturer and Product:
 - 1) Spraying System Co. – 22561 Foam Control Spray Nozzles
 - 2) Or preapproved equal.

2.15 QUICK COUPLINGS

- A. Provide female NPT by male quick-connect hose adaptors. All adapters and couplers shall satisfy dimensional requirements of MIL-C-27487E and shall be cast iron and sized shown on the Drawings.
- B. Manufacturers and Products:
 - 1. Swagelok – QM Series

2.16 QUICK DISCONNECT CAM OPERATING COUPLINGS FOR CHEMICAL SERVICE

- A. Type:
 - 1. Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
- B. Material:
 - 1. Glass-filled polypropylene and PVDF with Teflon gaskets and as recommended for the service by Manufacturer.
- C. End Connections:
 - 1. NPT threaded or flanged to match piping connections.
- D. Hose shanks for chemical installations.
- E. Plugs and Caps:
 - 1. Female dust cap for each male end, male dust plug for each female end.
- F. Pressure Rating:
 - 1. 125 psi, minimum at 70° F.
- G. Manufacturers:
 - 1. OPW – Kamlok (3/4 in. – 4 in.)
 - 2. Ryan Herco – 1300 Series
 - 3. Goodall – Basic Eight

2.17 CHEMICAL INJECTION QUILLS

- A. Retractable injection quill, service rated for 250 psi, including stainless steel check valve, ball valve, solution tube adaptor, packing nut, restraint system, and limit chains, and 300 Series O-ring gaskets.

- B. Manufacturer and Products: SAF-T-FLO; or preapproved equal.

2.18 VENT CAPS

- A. Type:
 - 1. Mushroom-style vent cap.
- B. Material:
 - 1. Schedule 40 PVC housing and cap. Polypropylene screen.
- C. Screen Size:
 - 1. 17 by 17 mesh for sizes 2 in. and smaller. 10 by 10 mesh for sizes 3 in. – 6 in.
- D. Open Area:
 - 1. Minimum 40%.
- E. End Connections:
 - 1. NPT treaded.
- F. Coatings:
 - 1. As specified in Section 09 90 00 – Painting and Protective Coatings.
- G. Manufacturer and Products:
 - 1. Gizmo (1/16 in. – 8 in.)
 - 2. Or preapproved equal.

2.19 INSULATION

- A. As indicated on Drawings or pipe schedule.

2.20 FINISHES

- A. Prepare piping appurtenances for field finishes as specified in Section 09 90 00 – Painting and Protective Coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field dimensions are as indicated on Drawings.
- B. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flanges mate properly.
- C. Verify that openings are ready to receive sleeves and firestopping.
- D. Verify that pipe plain ends to receive sleeve-type couplings are smooth and round for 12 in. from pipe ends.
- E. Verify that pipe outside diameter conforms to sleeve manufacturer's requirements.

3.2 PREPARATION

- A. Cleaning:
 - 1. Thoroughly clean end connections before installation.

- B. Close pipe and equipment openings with caps or plugs during installation.
- C. Surface Preparation:
 - 1. Clean surfaces to remove foreign substances.

3.3 INSTALLATION

- A. According to ASME B31.3.
- B. Coating:
 - 1. Finish piping appurtenances as specified in Section 09 90 00 – Painting and Protective Coating.
- C. Pipe Penetrations:
 - 1. Flashing:
 - a. Provide flexible flashing and metal counterflashing where piping penetrates weatherproofed or waterproofed walls, floors, and roofs.
 - b. Flash floor drains with topping over finished areas with lead, 10 in. clear on sides, with minimum 36 in. by 36 in. sheet size.
 - c. Fasten flashing to drain clamp device.
 - 2. Sleeves:
 - a. Exterior Watertight Entries: Seal with mechanical sleeve seals.
 - b. Set sleeves in position in forms and provide reinforcement around sleeves.
 - c. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.
 - d. Extend sleeves through floors 1 in. above finished floor level and calk sleeves.
 - e. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent Work with firestopping insulation and calk airtight.
 - f. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
 - g. Install stainless-steel escutcheons at finished surfaces.
- D. Firestopping:
 - 1. Materials: Per manufacturer's recommendation.
 - 2. Placement:
 - a. Place foamed material in layers to ensure homogenous density, filling cavities and spaces.
 - b. Place sealant to completely seal junctions with adjacent dissimilar materials.
 - 3. Fire-Rated Surfaces:
 - a. Seal opening at floor wall partition ceiling and roof.
 - b. Install sleeve through opening and extend beyond minimum of 1 in. on both sides of building element.
 - c. Size sleeve, allowing minimum of 1 in. void between sleeve and building element.
 - d. Pack voids with backing material.
 - e. Seal ends of sleeve with UL-listed, fire-resistive silicone compound to meet fire rating of structure penetrated.
 - 4. Non-rated Surfaces:
 - a. Seal opening through non-fire-rated wall partition floor ceiling and roof.
 - b. Install sleeve through opening and extend beyond minimum of 1 in. on both sides of building element.
 - c. Size sleeve to allow minimum of 1 in. void between sleeve and building element.
 - d. Install type of firestopping material recommended by manufacturer.
 - e. Occupied Spaces:
 - 1) Install escutcheons floor plates or ceiling plates where conduit penetrates non-fire-rated surfaces in occupied spaces.
 - 2) Occupied spaces include rooms with finished ceilings and rooms where penetration occurs below finished ceiling.

- f. Exterior Wall Openings below Grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place according to manufacturer instructions.
 - g. Interior Partitions:
 - 1) Seal pipe penetrations at clean rooms, laboratories, computer rooms, telecommunication rooms, and data rooms.
 - 2) Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.
- E. Flexible Connections:
 - 1. Install flexible couplings at connections to equipment and where specified in Drawings or as required by equipment or piping manufacturer.
- F. Expansion Joints:
 - 1. Install flexible couplings and expansion joints at connections to equipment and where specified in Drawings or as required by equipment or piping manufacturer.
 - 2. If expansion joint is supplied with internal sleeve, indicate flow direction on outside of joint.
- G. Air Release and Vacuum Breakers:
 - 1. Provide vacuum breakers as specified in Drawings.
- H. Backflow Preventers:
 - 1. Install with nameplate and test cock accessible.
 - 2. Install according to local code requirements.
 - 3. Do not install in vertical position.

3.4 PIPING FLEXIBILITY PROVISIONS

- A. General:
 - 1. Install thrust protection.
 - 2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.
- B. Flexible Joints at Concrete Backfill or Encasement:
 - 1. Install within 18 in. or 1/2 pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.
- C. Flexible Joints at Concrete Structures:
 - 1. Install 18 in. or less from the face of structures; joint may be flush with face.
 - 2. Install a second flexible joint, whether shown or not.
 - a. Pipe Diameter 18 in. and smaller: Within 18 in. of the first joint.
 - b. Pipe Diameter Larger than 18 in.: Within one pipe diameter of the first joint.

3.5 PIPING TRANSITION

- A. Applications:
 - 1. Provide complete closure assembly where pipes meet other pipes or structures.
 - 2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
 - 3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown or in accordance with NFPA 24.
 - 4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
 - 5. Concrete Closures: Use to make connections between dissimilar pipes where standard rubber gasketed joints or flexible couplings are impractical, as approved.
 - 6. Elastomer sleeves bonded to pipe ends are not acceptable.

- B. Installation:
 - 1. Flexible Transition Couplings:
 - a. Install in accordance with coupling Manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
 - 2. Concrete Closures:
 - a. Locate away from structures so that there are at least two flexible joints between the closure and pipe entering the structure.
 - b. Clean pipe surface before closure collars are placed.
 - c. Wet nonmetallic pipe thoroughly prior to pouring collars.
 - d. Prevent concrete from entering pipe.
 - e. Extend collar a minimum of 12 in. on each side of joint with minimum thickness of 6 in. around outside diameter of pipe.
 - f. Make entire collar in one placement.
 - g. After concrete has reached initial set, cure by covering with well-moistened earth.

3.6 PIPING EXPANSION

- A. Piping Installation:
 - 1. Allow for thermal expansion due to differences between installation and operating temperatures.
- B. Expansion Joints:
 - 1. Grooved Joint and Flanged Piping Systems: Elastomer Bellows Expansion Joint.
 - 2. Nonmetallic Pipe: Teflon Bellows Expansion Joint.
 - 3. Screwed and Soldered Piping Systems: Copper or Galvanized and Black Steel Pipe Expansion Compensator, as applicable.
 - 4. Pipe Run Offset: Flexible Metal Hose.
- C. Bellows Type Expansion joints:
 - 1. Install bellows type expansion control joints at piping connections to mechanical equipment to prevent damaging stresses due to normal expansion and contraction with temperature changes in piping and connected equipment.
 - 2. Install bellows type expansion joints to allow 2 1/4 in. expansion per 100 LF of piping.
 - 3. Install expansion joints adjacent to an anchor and provide 1 concentric guide on piping within 12 pipe diameters, but not more than 5 ft, from the end of the joint opposite the anchor.
 - a. Locate a similar guide approximately 30 diameters but not more than 10 ft from the first.
 - 4. For expansion joints not installed adjacent to an anchor provide 2 concentric guides similarly located at each end of the joint.
 - 5. Space intermediate supports a minimum of 10 ft, and tack weld the protective saddles to the pipe.
- D. Anchors and Anchor Walls:
 - 1. Install to withstand expansion thrust loads and to direct and control thermal expansion.

3.7 SERVICE SADDLES AND THRUST TIES

- A. Service Saddles:
 - 1. Ferrous Metal Piping (except stainless steel): Double-strap iron.
 - 2. Plastic Piping: Nylon-coated iron.
 - 3. All service saddles shall be provided with a corporation stop.
- B. Thrust Ties:
 - 1. Install where shown and where required to restrain the force developed by the specified test pressure.

2. Steel Pipe: Attach with fabricated lugs.
3. Ductile Iron Pipe: Attach with socket clamps against a grooved joint coupling or flange.
4. Flanged Coupling Adapters: For exposed installations, install Manufacturer's anchor studs through the coupling sleeve.

C. Installation:

1. Install in accordance with Manufacturer's written instructions.
2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
3. Remove pipe coating, if necessary, to present smooth surface.

3.8 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Tie Bolts:

1. Tighten snug prior to applying any pressure to the system.

3.9 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. Applications:

1. Copper to ferrous metal piping connections.
2. Catholically protected piping penetration to buildings and watertight structures.
3. Submerged to unsubmerged metallic piping connections.
4. Where required for electrically insulated connection.

B. Installation of Insulating Kits:

1. Drill oversize to accommodate insulating sleeves through the bolt holes, assuming standard bolt sizes.

C. Pipe Installation:

1. Insulating joints connecting immersed piping to non-immersed piping shall be installed above maximum water surface elevation.
2. All submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete basins shall be isolated from the concrete reinforcement steel.

3.10 WALL PIPES

A. Applications:

1. As specified in Section 40 23 39 – Process Piping – General.
2. Watertight and Below Ground Penetrations:
 - a. Wall pipes with thrust collars.
 - b. Provide taps for stud bolts in flanges to be set flush with wall face.
 - c. Existing Walls: Rotary drilled holes.
3. Wall Pipe Installation:
 - a. Isolate embedded metallic piping from concrete reinforcement.
 - b. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.11 PIPE SLEEVES

A. Application:

1. As specified in Section 40 23 39 – Process Piping – General.
2. Above Grade in Non-submerged Areas: Hot-dip galvanized after fabrication.
3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.

B. Installation:

1. Support non-insulating type securely in form work to prevent contact with reinforcing steel and tie-wires.
2. Caulk joint with rubber sealant or seal with wall penetration seal.

3.12 MISCELLANEOUS SPECIALTIES

- A. Install as specified in manufacturer's instructions.

3.13 FIELD QUALITY CONTROL

- A. After installation, inspect for proper supports and interferences.
- B. Repair damaged coatings with material equal to original coating.

3.14 CLEANING

- A. Keep equipment interior clean as installation progresses.

END OF SECTION

SECTION 40 05 07 – HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Pipe hangers and supports.
 - 2. Hanger rods.
 - 3. Structural attachments.
 - 4. Pipe guides.
 - 5. Formed steel channel.
 - 6. The Work for Contractor to provide pipe support design by a pipe support design engineer.
- B. Related Section:
 - 1. Section 40 05 51 – Common Requirements for Process Valves.
 - 2. Section 40 23 39 – Process Piping – General.
 - 3. Section 40 23 39.43 – Polyvinyl Chloride Pipe and Fittings Data Sheet.
 - 4. Section 40 23 39.46 - Chlorinated Polyvinyl Pipe and Fittings Data Sheet

1.2 REFERENCES

- A. ASME (American Society of Mechanical Engineers):
 - 1. B31.1 – Power Piping.
 - 2. B31.9 – Building Services Piping.
- B. ASTM International:
 - 1. A36 – Standard Specification for Carbon Structural Steel.
 - 2. A47 – Standard Specification for Ferritic Malleable Iron Castings.
 - 3. A576 – Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
 - 4. A181 – Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
- C. AWS (American Welding Society):
 - 1. D1.1 – Structural Welding Code Steel – Reference Manual.
- D. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP-58 – Pipe Hangers and Supports – Materials, Design, Manufacturer, Selection, Application, and Installation.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit manufacturer's catalog data including load capacity.
- C. Shop Drawings:
 - 1. Indicate system layout with location:
 - a. Include critical dimensions, sizes, and pipe hanger and support locations.
 - b. Include detail of trapeze hangers, anchors, and guides.
- D. Welder's Certificate:

1. Submit welder's certification of compliance with ASME Section IX, verifying qualification within previous 12 months.
- E. Delegated Design Submittals:
1. Engage the services of an independent registered professional engineer licensed in the State of Work ordinarily engaged in the business of pipe support systems analysis and design, to analyze system piping and service conditions, and to develop a detailed support system design, specific to the piping material, pipe joints, valves, and piping appurtenances proposed for use.
 - a. The proposed support system engineer shall have at least 5 years of experience in the analysis and design of similar systems, including the use of commercial and custom pipe supports and in the use of commercial pipe stress software programs.
 - b. The Contractor shall provide Certification of Compliance with these requirements.
 2. The Support System Design Includes:
 - a. Criteria by piping system.
 - b. Summary of related components including joints, class, valves, appurtenances, etc., and commercial supports and especially including pipe materials.
 - c. Dead weight and dynamic analysis, including system thermal effects and pressure thrusts.
 - 1) Show the resolved and resultant force and moment systems, as well as all recommended hangers, supports, anchors, restraints, and expansion/flexible joints.
 - d. Submit signed and sealed support system design to the Engineer for review.
 - e. All aspects of the analysis and design comply with the provisions of ANSI B31.3 and the referenced standards.
 3. Coordinate support arrangements to eliminate interference with similar systems to be installed under HVAC, Plumbing, and Electrical; to account for structural expansion joints and to maintain access for both personnel and for the removal of equipment.
- F. Manufacturer's Instructions:
1. Submit special procedures and assembly of components.
- G. Qualifications Statements:
1. Submit qualifications for manufacturer, fabricator, installer, and licensed professional.
 2. Submit manufacturer's approval of installer.
- H. Maintenance Material Submittals:
1. See Section 01 77 00 – Closeout Procedures for maintenance material requirements.
 2. Spare Parts:
 - a. Furnish one set of manufacturer's recommended spare parts.
 3. Tools:
 - a. Furnish special tools and other devices required for Owner to maintain the supplied products.
- 1.4 COORDINATION
- A. See Section 01 30 00 – Administrative Requirements for coordination requirements.
 - B. Coordinate Work of this section with piping and equipment connections specified in other sections and in Drawings.
- 1.5 QUALITY ASSURANCE
- A. Perform Work as specified in AWS D1.1 for welding hanger and support attachments to building structure.

- B. Perform Work as specified in AWWA standards, State and Local building codes.

1.6 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing Products specified in this section with minimum three years of experience.
- B. Fabricator:
 - 1. Company specializing in fabricating products specified in this section with minimum three years of experience.
- C. Installer:
 - 1. Company specializing in performing Work of this section with minimum three years of documented experience and approved by manufacturer.
- D. Licensed Professional:
 - 1. Professional engineer experienced in design of specified Work and licensed in the State of the Work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 – Product Requirements for transporting, handling, storing, and protecting products.
- B. Inspection:
 - 1. Accept materials onsite in original factory packaging, labeled with manufacturer's identification.
- C. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

1.8 AMBIENT CONDITIONS

- A. See Section 01 50 00 – Temporary Facilities and Controls for requirements on ambient condition control facilities for product storage and installation.

1.9 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. All piping shall be adequately supported by the Contractor as determined by their design engineer's calculations and as specified in this section. Where the Drawings show support types and/or locations, they shall be analyzed for adequacy to support loads and stresses calculated by the pipe support design engineer, modified if required, installed generally where shown, and

integrated with the pipe support system design provided by the Contractor. Additional supports may be required and shall be the responsibility of the Contractor.

- B. Design supports for multiple pipes, capable of supporting combined weight of supported systems, system contents, and test water.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Design seismic-restraint hangers and supports for piping and equipment.
- E. Support pipe and appurtenances connected to equipment to prevent any strain being imposed on the equipment. Comply with manufacturer's requirements regarding piping loads being or not being transmitted to their equipment.
- F. Design all supports to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. Any structural steel members required to brace any piping from excessive dislocation shall be as specified in Section 05 50 00 – Metal Fabrications and shall be furnished and installed under this section.
- G. Contractor may propose minor adjustments to the piping arrangements in order to simplify the supports, or in order to resolve minor conflicts in the work. Such an adjustment might involve minor change to a pipe centerline elevation so that a single trapeze support may be used.
- H. Pipe supports:
 - 1. Shall not induce point loadings but shall distribute pipe loads evenly along the pipe circumference.
 - 2. Provide supports at changes in direction and elsewhere as specified in Drawings or this section.
 - 3. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless specifically directed or authorized by the Engineer.
 - 4. Provide pipe supports to minimize lateral forces through valves, both sides of flexible split ring type couplings and sleeve type couplings, and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.
 - 5. Effects of thermal expansion and contraction of the pipe to be accounted for in the pipe support selection and installation.
- I. Design Criteria:
 - 1. Consider the content of the pipes in load calculations. All items shall be designed with strength and stiffness to support, restrain, and allow expansion of the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement and pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces.
 - 2. Minimum Gauge Thickness:
 - a. 12 gauge.
 - 3. Allowable Stress of Channels:
 - a. Steel Channels: The lesser of 25,000 psi, or 0.66 times yield stress of steel.
 - b. Stainless Steel Channels: 0.66 times the yield stress of the stainless-steel alloy.
 - 4. Maximum Deflection: 1/240 of span.
 - 5. Allowable Column Loads: As recommended by manufacturer in published instruction for column's unsupported height and "K" value for calculating effective column length of not less than 1.0.
 - 6. Future Loads:

- a. Support systems specified in Drawings may include spaces intended to accommodate future pipes.
 - b. Assume such spaces are occupied by 6 in. diameter ductile iron pipes. Only the number of pipes that would physically fit into the space need be considered.
 - c. Include the weight of the pipe contents in determining future loads. Assume pipe contents are water.
 7. Seismic Design Criteria: As specified in Division 01 – General Requirements for mechanical equipment.
 8. Spacing of Supports: As required to comply with design requirements.
- J. Supports below the top of walls of water bearing structures: Use Type 316 stainless steel for support system components.
1. Supports in other locations: Use hot-dipped galvanized components unless other materials are specifically indicated on the Drawings.

2.2 DESIGN REQUIREMENTS

- A. General:
1. Contractor shall be responsible for the design, size, and location of process piping support systems in accordance with the requirements specified in this section and in general conformance with the Drawings and the Design Details. The design shall be provided by a company specifically specializing in the design of support systems. The pipe support system design company shall demonstrate that they have at least five years of experience in pipe support design and have successfully completed at least three designs in the previous year. The Contractor shall provide Certification of Compliance with these requirements.
 2. Seismic Load:
 - a. See Division 01 – General Requirements and structural notes from the Drawings.
 3. Piping smaller than 30 in:
 - a. Supports are shown only where specific types and locations are required; additional pipe supports may be required.
 4. Piping 30 in. and larger: Support systems have been designed for piping shown.
 5. Meet requirements of MSS SP 58, MSS SP 69, and MSS SP 89.
- B. Pipe Support Systems:
1. Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation and capable of supporting combined weight of supported systems, system contents, and test water.
 2. Maximum Support Spacing and Minimum Rod Size:
 - a. Steel or Ductile Iron Piping:

Pipe Nominal Diameter (in.)	Support Span (ft.)	Length of channel (in.)	Channel Depth (in.)	Support Bolt Size (in.)
3	20	–	–	3/4
4	20	–	–	3/4
6	20	–	–	3/4
8	20	–	–	3/4
10	20	–	–	1
12	20	–	–	1
14	20	–	–	1 1/4

Pipe Nominal Diameter (in.)	Support Span (ft.)	Length of channel (in.)	Channel Depth (in.)	Support Bolt Size (in.)
16	20	—	—	1 1/4
18	20	—	—	1 1/4
20 ¹	19	—	—	1 1/4
24	15	26	5	1 1/2
30	12	36	6	1 7/8
36	9	42	6	1 7/8
42	7	48	8	1 7/8
48	5	54	8	1 7/8

Note:

1. All piping 20 in. diameter and smaller shall be supported by clevis style hangers, all larger pipe shall be supported by trapeze style hangers.
2. Channel length indicates the distance between the two support bolts holding up either end of the channel. Channel depth is the vertical distance from where the pipe is supported by the channel to the This is only applicable to trapeze style hangers.
3. Refer to standard details for clevis style and trapeze style hangers.
4. This table assumes one pipe support for one pipe. Submit design and calculations to support multiple pipes per trapeze.

- b. Copper Piping:
 - 1) Maximum Support Spacing: 2 ft less per size than listed for steel pipe, with 1 in. and smaller pipe supported every 5 ft.
 - 2) Minimum Hanger Rod Sizing: Same as listed for steel pipe.
- c. Plastic and Fiberglass Piping:
 - 1) Maximum support spacing: As recommended by manufacturer for flow temperature in pipe.
 - 2) Minimum Hanger Rod Sizing: Same as listed for steel pipe.

2.3 FRAMING SUPPORT SYSTEM:

- A. Beams:
 1. Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
- B. Column Members:
 1. Size in accordance with Manufacturer's recommended method.
- C. Support Loads:
 1. Calculate using weight of pipes filled with water.
- D. Maximum Spans:
 1. Steel and Ductile Iron Pipe, 3 in. Diameter and Larger:
 - a. 10 ft centers, unless otherwise shown.
 2. Other Pipelines and Special Situations:
 - a. May require supplementary hangers and supports.
- E. Electrical Conduit Support:
 1. Include in design of framing support system.
- F. Anchoring Devices:

1. Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.
- G. Vertical Sway Bracing:
1. 10 ft maximum centers, or as shown.
- H. Existing Support Systems:
1. Use existing supports systems to support new piping only if Contractor can show that they are adequate for additional load, or if they are strengthened to support the additional load.

2.4 GENERAL

- A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs.
- B. Special support and hanger details are shown for cases where standard catalog supports are inapplicable.
- C. Materials:
1. Wetted and Submerged: 304 Stainless steel.
 2. Corrosive Areas: FRP or 304 Stainless Steel.
 3. Stainless Steel (Type 304):
 - a. Use in all submerged locations or chemical storage areas, above water level but below top of wall inside water bearing structures, and where specifically indicated on the Drawings:
 - b. Shop-Fabricate: At the shop, perform pickling and passivation on all surfaces inside and out.
 - c. Field welding is prohibited.
 4. Plastic, aluminum, FRP, and other miscellaneous materials:
 - a. Use where specifically indicated on the Drawings.
 5. Nonmetallic pipe support systems shall be used in areas where exposed to reactive chemicals such as chemical pumping area and chemical storage area..
 6. Fiberglass Resin:
 - a. Corrosion resistant premium grade vinylester.
 7. Injection Molded Components:
 - a. Polyurethane thermoplastics.
 8. Flame Spread of Fiberglass:
 - a. Vinylester Fiberglass (Series VF): Class 1, ASTM E84.
 - b. Polyurethane: V-O UL 94V.
9. Physical Properties of Fiberglass:

	Longitudinal	Transverse
Tensile Strength	37,500 psi	10,000 psi
Tensile Modules	3.0 x 10 ⁶ psi	1.0 x 10 ⁶ psi
Flexural Strength	37,500 psi	14,000 psi
Flexural Modules	2.0 x 10 ⁶ psi	1.0 x 10 ⁶ psi
Compressive Strength	37,500 psi	20,000 psi
Shear Strength	6,000 psi	5,500 psi
Izod Impact	30 ft-psi	5 ft-psi

10. Surface Veil:
 - a. Fiberglass channel shall have polyester surface veil over 100% of the surface to provide protection against degradation from ultraviolet light.
11. Touch-Up Resin:
 - a. Manufacturers (Choose ONE):
 - 1) Krylon, 7006-Satin Polyurethane Clear Finish.
 - 2) Or Approved Equal.

2.5 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 1. Carpenter & Paterson, Inc.
 2. Empire Industries, Inc.
 3. Globe Pipe Hanger Products Incorporated.
 4. Haydon Corporation.
 5. Hilti, Inc.
 6. PHD Manufacturing, Inc.
 7. Anvil International.
 8. Substitutions: See Section 01 60 00 – Product Requirements.
- B. Description:
 1. Conform to MSS SP58.
 2. Provide means of vertical adjustment after erection.
 3. Pipe Sizes 1/2 – 1 1/2 in: ASTM A36, steel, adjustable swivel, split ring.
 4. Pipe Sizes 2 in and Larger: ASTM A36, steel, adjustable, clevis.
 5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 6. Wall Support for Pipe Sizes 3 in and Smaller: Cast iron J-hook.
 7. Wall Support for Pipe Sizes 4 in and Larger: Welded steel bracket.
 8. Vertical Support: Riser clamp.
 9. Floor Supports: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- C. Performance and Design Criteria:
 1. Pipe Hangers:
 - a. Allow for expansion and contraction of piping while eliminating undue stress on piping appurtenances and equipment.
 - b. Provide linkage to permit lateral or axial movement where anticipated.
 - c. Where horizontal pipe movement is greater than 1/2 in, or where hanger rod deflection from the vertical is greater than 4 degrees from cold to hot position of pipe, hanger rod and structural attachment shall be offset to maintain rod vertical in hot position.
 2. Heat Transmission:
 - a. Design supports, hangers, anchors, and guides to prevent excessive heat from being transmitted to building structure, equipment, or piping appurtenances.
 3. Riser Supports:
 - a. Support risers on each floor with riser clamps and lugs, independent of connected horizontal piping.
 4. Point Loads:
 - a. Support plastic piping containing meters, valves, appurtenances, and other point loads on both sides.
 - b. Avoid point loads on plastic piping by providing extra wide pipe saddles or galvanized steel shields.
 5. Noise Reduction:
 - a. Wrap copper tubes located within buildings with a 2 in. wide strip of rubber at each pipe support, bracket, clip, or hanger.

2.6 HANGER RODS

- A. Hanger Rods:
 - 1. 304 Stainless Steel, ASTM A193 Grade B8.
 - 2. All-thread.
 - 3. Diameter: ASME B31.1.

2.7 STRUCTURAL ATTACHMENTS

- A. Manufacturers:
 - 1. ERICO International Corporation.
 - 2. Grinnell Mechanical Products.
 - 3. Unistrut; Part of Atkore International.
 - 4. Anvil International.
 - 5. Substitutions: See Section 01 60 00 – Product Requirements.
- B. Concrete Inserts:
 - 1. Manufacturers:
 - a. Carpenter & Patterson, Inc.
 - b. National Pipe Hanger Corporation
 - c. Piping Technology & Products, Inc.
 - d. Rilco Manufacturing Co.
 - e. Value Engineered Products, Inc.
 - f. Anvil International.
 - g. Substitutions: See Section 01 60 00 – Product Requirements.
 - 2. Description:
 - a. Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
 - b. Size inserts to suit threaded hanger rods.
- C. Mounting Brackets:
 - 1. ASTM A36, welded steel.
- D. Beam Clamps:
 - 1. Manufacturers:
 - a. B-line, an Eaton Business.
 - b. ERICO International Corporation.
 - c. Grinnell Mechanical Products.
 - d. Anvil International.
 - e. Substitutions: Section 01 60 00 – Product Requirements.
 - 2. Description:
 - a. ASTM A36, steel or ASTM A181, forged steel; MSS SP-58.
 - b. Clamp Size: Based on load to be supported and load configuration.
 - c. Anchoring: Locknuts and cup-point set screws.
 - d. Reversible top or bottom flange.
- E. Riser Clamps:
 - 1. Manufacturers:
 - a. B-line, an Eaton Business.
 - b. ERICO International Corporation.
 - c. Grinnell Mechanical Products.
 - d. Substitutions:
 - 1) See Section 01 60 00 – Product Requirements.
 - 2. Description:
 - a. ASTM A36, steel.

- b. Support of Copper Tubing: Provide copper-plated clamps.
- F. Offset Clamps:
 - 1. Manufacturers:
 - a. B-line, an Eaton Business,
 - b. ERICO International Corporation, or
 - c. Grinnell Mechanical Products.
 - d. Anvil International.
 - e. Substitutions:
 - 1) See Section 01 60 00 – Product Requirements.
 - 2. Description: Double leg, two-piece.

2.8 PIPE GUIDES

- A. Intermediate Guides:
 - 1. Pipes 6 in and Smaller: Pipe clamp with oversize pipe sleeve.
 - 2. Pipes 8 in and Larger: U-bolts with double nuts.
- B. Alignment Guides:
 - 1. Pipes 8 in and Smaller: Galvanized steel Spider type.
 - 2. Pipes 10 in and Larger: Galvanized steel Roller type.

2.9 FORMED STEEL CHANNEL

- A. Fabricate preformed channel pipe support system using, at minimum, parts specified under Design Criteria and below:
 - 1. Manufacturers (Choose ONE):
 - a. Unistrut, Series P1000 or P1001; P5500 or P5501.
 - b. Allied Support Systems, Power Strut, Figure PS-200 or PS-200 2TS; PS-150 or PS-150 2TS.
 - c. B-Line Systems, Inc., Channel Type B22 or B22A; B12 or B12A.
 - d. Anvil, Figure 45
 - e. Or Approved Equal.
- B. Preformed Channel Concrete Inserts:
 - 1. Minimum 12 in. long.
 - 2. Manufacturers (Choose ONE):
 - a. Unistrut, Series P-3200.
 - b. Allied Support Systems, Figure 282.
 - c. B-Line Systems, Series B32I.
 - d. or approved equal.
- C. 90-Degree Angle Fittings:
 - 1. Manufacturers (Choose ONE):
 - a. Unistrut, P1026.
 - b. Allied Support Systems, Power Strut, P603.
 - c. Or Approved Equal.
- D. Pipe Straps:
 - 1. For Pipes 8 in. in Diameter and Smaller:
 - a. Use 2-piece universal strap with slotted hex head screw and nut.
 - 2. Manufacturers (Choose ONE):
 - a. Unistrut, Series P1109 through P1126.
 - b. Allied Support Systems, PS1100.
 - c. B-Line Systems, Inc., Series B2000.

- d. Or Approved Equal.
- 3. For Pipes Greater Than 8 In. in Diameter:
 - a. Unless different material is specified in Drawings, use 1-piece 1 in. wide by 1/8 in. thick steel strap, hot-dip galvanized after fabrication.
- 4. For Stainless Steel Pipes:
 - a. Use type of strap required for the pipe sizes specified above but use Type 316 stainless steel materials.

2.10 NONMETALLIC PIPE SUPPORT SYSTEM

- A. Manufacturers:
 - 1. StrutTech.
 - 2. Unistrut.
- B. Supply all materials from one manufacturer with sole responsibility for the pipe support system.
- C. The supplied system, including pipe clamps, shall be interchangeable with industry standard 1 5/8 in. steel and fiberglass channel framing systems.
- D. Channel Framing:
 - 1. All channel framing shall be supplied with integral notches 1 in. on center.
 - 2. Locate notches on interior flange to prevent slippage of pipe clamps and fittings after installation.
- E. Pipe Clamps:
 - 1. Adjustable Type:
 - a. Nonmetallic and nonconductive.
 - 2. Fixed Type:
 - a. Pipe clamps for pipe less than 6 in. in diameter shall be nonmetallic and nonconductive.
 - b. Pipe clamps for pipe equal to and greater than 6 in. in diameter shall be fiberglass.
- F. Channel Fittings:
 - 1. Make fittings and post bases from glass-filled polyurethane or polyester.
- G. Fasteners:
 - 1. Make one type of fastener:
 - a. Glass-filled polyurethane.
 - b. Vinylester fiberglass.

2.11 TRAPEZE PIPE HANGERS

- A. Description:
 - 1. MSS SP-69, Type 59, shop/field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.12 METAL FRAMING SYSTEMS

- A. Description:
 - 1. MFMA-3, shop/field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Power-Strut Div.; Tyco International, Ltd.

3. Thomas & Betts Corporation.
4. Tolco Inc.
5. Unistrut Corp.; Tyco International, Ltd.

C. Coatings:

1. Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings:

1. Plastic coating, jacket, or liner.

2.13 THERMAL HANGER SHIELD INSERTS

A. Description:

1. 100 psig minimum, compressive strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation Insert Material for Cold Piping (Choose ONE):

1. Water-repellent treated, ASTM C533
2. Water-repellent treated, ASTM C533, Type I calcium silicate
3. ASTM C552, Type II cellular glass with vapor barrier.

D. Insulation Insert Material for Hot Piping:

1. Water-repellent treated (Choose ONE):
 - a. ASTM C533, Type I calcium silicate
 - b. ASTM C552, Type II cellular glass

E. Trapeze or Clamped Systems:

1. Insert and shield shall cover entire circumference of pipe.

F. Clevis or Band Hangers:

1. Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length:

1. Extend 2 in. beyond sheet metal shield for piping operating below ambient air temperature.

2.14 FASTENER SYSTEMS

A. Powder-Actuated Fasteners:

1. Threaded steel stud, for use in hardened Portland cement concrete with pullout, tension, and shear capacities appropriate for supported loads and building materials where used.
2. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Masterset Fastening Systems, Inc.
 - d. MKT Fastening, LLC.
 - e. Powers Fasteners.

- B. Mechanical-Expansion Anchors:
 - 1. Insert-wedge-type stainless steel:
 - a. For use in hardened Portland cement concrete with pullout, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 2. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.
 - f. Powers Fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. See Section 01 60 00 – Product Requirements for installation examination requirements.
- B. Verify field dimensions as indicated on Drawings.

3.2 HANGER AND SUPPORT APPLICATIONS

- A. Building Attachment Installation (Unless otherwise specified in Piping System Sections):
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18):
 - a. For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19):
 - a. For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20):
 - a. For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21):
 - a. For attaching to center of bottom flange of beams.
 - 5. Welded Beam Attachments (MSS Type 22):
 - a. For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - 6. C-Clamps (MSS Type 23):
 - a. For structural shapes.
 - 7. Top-Beam Clamps (MSS Type 25):
 - a. For top of beams if hanger rod is required tangent to flange edge.
 - 8. Side-Beam Clamps (MSS Type 27):
 - a. For bottom of steel I-Beams.
 - 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28):
 - a. For attaching to bottom of steel I-Beams for heavy loads.
 - 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29):
 - a. For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 - 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30):
 - a. For attaching to structural steel.
 - 12. Welded-Steel Brackets:
 - a. For support of pipes from below, or for suspending from above by using clip and rod.
 - b. Use ONE for indicated loads:
 - 1) Light (MSS Type 31): 750 lb.
 - 2) Medium (MSS Type 32): 1500 lb.
 - 3) Heavy (MSS Type 33): 3000 lb.
 - 13. Side-Beam Brackets (MSS Type 34):
 - a. For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57):
 - a. For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58):
 - a. For supporting piping systems subject to linear horizontal movement where headroom is limited.
- B. Saddles and Shields Installation (Unless otherwise specified in Piping System Sections):
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- C. Pipe Hangers and Supports:
1. Install as specified in MSS SP 58.
 2. Support horizontal piping as indicated on Drawings or as indicated on Shop Drawings.
 3. Install hangers with minimum 1/2 in. space between finished covering and adjacent Work.
 4. Place hangers within 12 in. of each horizontal elbow.
 5. Use hangers with 1 1/2 in. minimum vertical adjustment.
 6. Support horizontal cast iron pipe adjacent to each hub, with 5 ft maximum spacing between hangers.
 7. Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
 8. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
 9. Support riser piping independently of connected horizontal piping.
 10. Provide copper-plated hangers and supports for copper piping.
 11. Design hangers for pipe movement without disengagement of supported pipe.
 12. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.
 13. Provide welded steel brackets where piping is to be run adjacent to building walls or columns.
 14. Use beam clamps where piping is to be suspended from building steel.
 15. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
 16. Use offset clamps where pipes are indicated as offset from wall surfaces.
- D. Spring Hangers and Supports Installation (Unless otherwise specified in Piping System Sections):
1. Restraint-Control Devices (MSS Type 47): Where specified to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1 1/4 in.
 3. Spring Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from hanger.
 6. Variable Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from base support.
 7. Variable Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports:
 - a. For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment.

- b. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability.
- c. These supports include:
 - 1) Horizontal (MSS Type 54): Mounted horizontally.
 - 2) Vertical (MSS Type 55): Mounted vertically.
 - 3) Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation:
 - 1. Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation:
 - 1. Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 2. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 3. Field fabricate from ASTM A36, steel shapes selected for loads being supported. Weld steel as specified in AWS D1.1.
- C. Fiberglass Pipe Hanger Installation:
 - 1. Comply with applicable portions of MSS SP-69 and MSS SP-89.
 - 2. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation:
 - 1. Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- E. Thermal Hanger Shield Installation:
 - 1. Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 in. thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool Manufacturer. Install fasteners according to powder-actuated tool Manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to Manufacturer's written instructions.
- G. Pipe Positioning System Installation:
 - 1. Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation:
 - 1. Fabricate from welded-structural-steel shapes.

- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2 1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution:
 - 1. Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes:
 - 1. Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- O. Insulated Piping Compliancy:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature:
 - 1) Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature:
 - 1) Use thermal hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option:
 - 1) Thermal hanger shield inserts may be used. Include steel weight distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option:
 - 1) Thermal hanger shield inserts may be used. Include steel weight distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Minimum Shield Dimensions for Pipe:
 - a. NPS 1/4 to NPS 3 1/2: 12 in. long and 0.048 in. thick.
 - b. NPS 4: 12 in. long and 0.06 in. thick.
 - c. NPS 5 and NPS 6: 18 in. long and 0.06 in. thick.
 - d. NPS 8 to NPS 14: 24 in. long and 0.075 in. thick.
 - e. NPS 16 to NPS 24: 24 in. long and 0.105 in. thick.
 - 5. Pipes NPS 8 and Larger:
 - a. Include wood inserts.
 - 6. Insert Material:
 - a. Length at least as long as protective shield.
 - 7. Thermal Hanger Shields:
 - a. Install with insulation same thickness as piping insulation.

3.4 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

- B. Grouting:
 - 1. Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.5 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding:
 - 1. Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.
 - 2. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 3. Obtain fusion without undercut or overlap.
 - 4. Remove welding flux immediately.
- D. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

- A. Hanger Adjustments:
 - 1. Adjust hangers to distribute loads equally on attachments and to achieve specified slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1 1/2 in.

3.7 INSTALLATION

- A. General:
 - 1. Obtain permission from Engineer before using powder-actuated anchors.
 - 2. DO NOT drill or cut structural members.
 - 3. Install support systems in accordance with MSS SP 69, Pipe Hangers and Supports-Selection and Application and MSS SP 89, Pipe Hangers and Supports-Fabrication and Installation, unless shown otherwise.
 - 4. Support piping connections to equipment by pipe support and NOT by the equipment.
 - 5. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
 - 6. Support no pipe from the pipe above it.
 - 7. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
 - 8. DO NOT install pipe supports and hangers in equipment access areas or bridge crane runs.
 - 9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.
 - 10. Install lateral supports for seismic loads at all changes in direction.
 - 11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
 - 12. Repair mounting surfaces to original condition after attachments are made.

13. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in Piping System Sections.
14. Comply with MFMA-102 for metal framing system selections and applications that are not specified in Piping System Sections.
15. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
16. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

B. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to Section 03 20 00 – Concrete Reinforcing for inserts carrying pipe 4 in. and larger.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

C. Insulation:

1. Provide clearance in hangers and from structure and other equipment for installation of insulation.
2. See Section 40 42 00 – Process Mechanical Insulation.

D. Equipment Bases and Supports:

1. Suspended Equipment:
 - a. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
 - b. Provide lateral bracing, to prevent swaying, for equipment supports.
2. Ground Mounted Equipment:
 - a. Provide housekeeping pads of concrete, minimum 6 in thick and extending 6 in beyond supported equipment and valves or as specified in Drawings. See Section 03 30 00 – Cast-in-Place Concrete.
 - b. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.8 PAINTING

A. Prime Coat:

1. Prime coat exposed steel hangers and supports.
2. See Section 09 96 00 – High-Performance Coatings.
3. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

B. Paint exposed surfaces immediately after erecting hangers and supports as specified in Section 09 96 00 – High-Performance Coatings.

C. Galvanized Surfaces:

1. Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint as specified in ASTM A780.

END OF SECTION

SECTION 40 05 51 – COMMON REQUIREMENTS FOR PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Valves.
 - 2. Valve actuators.
- B. Related Section:
 - 1. Section 40 05 07 – Hangers and Supports for Process Piping.
 - 2. Section 40 05 57 – Actuators for Process Valves and Gates.
 - 3. Division 40 Valve Specifications

1.2 REFERENCES

- A. AWWA (American Water Works Association):
 - 1. C541 – Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
 - 2. C542 – Electric Motor Actuators for Valves and Slide Gates.
 - 3. C550 – Protective Interior Coatings for Valves and Hydrants.
- B. ASTM International:
 - 1. B62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
 - 2. B584 – Standard Specification for Copper Alloy Sand Castings for General Applications.
- C. MSS (Manufacturers Standardization Society):
 - 1. SP-25 – Standard Marking System for Valves, Fittings, Flanges, and Unions.
- D. NEMA (National Electrical Manufacturers Association):
 - 1. 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NFPA:
 - 1. 70 – National Electrical Code (NEC).
- F. NSF International:
 - 1. 61 – Drinking Water System Components – Health Effects.
 - 2. 372 – Drinking Water System Components – Lead Content.
- G. UL:
 - 1. Equipment Directory.

1.3 SUBMITTALS

- A. See Section 01 33 00 – Submittal Procedures for general submittal requirements.
- B. Action Submittals:
 - 1. Product Data:
 - a. Submit manufacturer information for actuator with model number and size specified.
 - b. Submit valve cavitation limits.
 - 2. Shop Drawings:
 - a. Specify parts list, materials, sizes, position indicators, limit switches, actuator mounting, wiring diagrams, and control system schematics.

- C. Informational Submittals:
1. Valve-Labeling Schedule:
 - a. Specify valve locations and nametag text.
 2. Manufacturer's Certificate:
 - a. Certify that products meet or exceed specified requirements.
 3. Certification of Valves Larger Than 12 in:
 - a. Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.
 4. Include separate Paragraphs for additional certifications.
 5. Include following Paragraph when Contractor is responsible for designing products or assemblies. List affected products when section specifies more than one product.
 6. Delegated Design Submittals:
 - a. Submit signed and sealed Shop Drawings with design calculations and assumptions for sizing of control valves.
 7. Manufacturer Instructions:
 - a. Submit installation instructions and special requirements.
 8. Source Quality-Control Submittals:
 - a. Indicate results of factory tests and inspections.
 9. Field Quality-Control Submittals:
 - a. Specify results of Contractor-furnished tests and inspections, including factory-applied coatings.
 10. Manufacturer Reports:
 - a. Certify that equipment has been installed according to manufacturer instructions.
 11. Qualifications Statement:
 - a. Submit qualifications for manufacturer and licensed professional.
 12. Closeout Submittals:
 - a. Project Record Documents:
 - 1) Record actual locations of valves and actuators.
 - b. See Section 01 77 00 – Closeout Procedures for additional requirements.

1.4 COORDINATION

- A. Coordinate Work of this section with piping, equipment, and appurtenances.

1.5 QUALITY ASSURANCE

- A. Maintain clearances as indicated on Drawings and Shop Drawings.
- B. Ensure that materials of construction of wetted parts are compatible with process liquid.
- C. Materials in Contact with Potable Water:
 1. Certified to NSF 61 and NSF 372.

1.6 QUALIFICATIONS

- A. Manufacturer:
 1. Company specializing in manufacturing products specified in this section with minimum three years of experience.
- B. Licensed Professional:
 1. Professional engineer experienced in design of specified Work and licensed in State of Work.

1.7 SOURCE QUALITY CONTROL

- A. Requirements for testing, inspection, and analysis as specified in Section 01 40 00 – Quality Requirements.
- B. Test and install valves as specified in AWWA valve standards.

1.8 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.9 WARRANTY

- A. Furnish manufacturer's warranty for valves and actuators as indicated in valve specification sections.
- B. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.
- B. Like items of equipment shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.
- C. Design Requirements:
 - 1. Valve class shall meet the requirements of the connecting line or as specified in the valve schedule or in Drawings.
 - 2. Bubble-tight at rated pressure, or any pressure lower than rated, applied from either side with the valve mounted in any orientation.
 - 3. Suitable for applications involving frequent throttling and applications requiring valve actuation after long periods of inactivity.

2.2 VALVES

- A. Description:
 - 1. Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.
- B. Valve Ends:
 - 1. Compatible with adjacent piping system.
- C. Operation:
 - 1. Open by turning counterclockwise; close by turning clockwise.
 - 2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.
- D. Valve Marking and Labeling:

1. Marking: Comply with MSS SP-25.
 2. Provide buried valves with valve boxes, covers, and extensions.
- E. Valve Construction:
1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
 2. Bonnets:
 - a. Clamped, screwed, or flanged to body and of same material and pressure rating as body.
 - b. Furnish glands, packing nuts, or yokes as specified in valve Sections.
 3. Stems and Stem Guides:
 - a. Materials and Seals: As specified in valve Sections.
 - b. If subject to dezincification, consider specifying bronze valve stems to conform to ASTM B62. Where dezincification is not a problem, bronze conforming to ASTM B584 may be considered.
 - c. Bronze Valve Stems: According to ASTM B62.
 - d. Space stem guides 10 ft o.c.
 - e. Submerged Stem Guides: Type 304 stainless steel.
 4. Nuts and Bolts: As specified in Section 05 50 00 – Metal Fabrications.

2.3 VALVE ACTUATORS

- A. As specified in Section 40 05 57 – Actuators for Process Valves and Gates.

2.4 FINISHES

- A. Valve Lining and Coating:
1. Comply with AWWA C550.
- B. Exposed Valves:
1. As specified in individual valve specifications. In the absence of specification, provide manufacturer's standard.
- C. Do not coat flange faces of valves unless otherwise specified.

2.5 SOURCE QUALITY CONTROL

- A. Section 01 60 00 – Product Requirements: Requirements for testing, inspection, and analysis.
- B. Testing:
1. Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.
- C. Include one or both of following Paragraphs to require Owner's inspection or witnessing of test at factory.
- D. Owner Witnessing:
1. Allow witnessing of factory inspections and test at manufacturer's test facility as requested by the Owner.
 2. Notify Owner at least seven days before inspections and tests are scheduled.
- E. Certificate of Compliance:
1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements for transporting, handling, storing, and protecting products requirements.
- B. Inspection:
 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
 3. Provide additional protection according to manufacturer instructions.

3.2 EXAMINATION

- A. Verify that piping system is ready for valve installation.

3.3 INSTALLATION

- A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions.
- B. Firmly support valves to avoid undue stresses on piping.
- C. Coat studs, bolts, and nuts with anti-seizing lubricant.
- D. Clean field welds of slag and splatter to provide a smooth surface.
- E. Install valves with stems upright or horizontal, not inverted.
- F. Install brass male adapters on each side of valves in copper-piped system and solder adapters to pipe.
- G. Install 3/4 in. ball valves with cap for drains at main shutoff valves, low points of piping, bases of vertical risers, and equipment.
- H. Install valves with clearance for installation of insulation and to allow access.
- I. Provide access where valves and fittings are not accessible.
- J. Pipe Hangers and Supports:
 1. As specified in Section 40 05 07 – Hangers and Supports for Process Piping.
- K. Valve Applications:
 1. For connections at existing lines, tees, and connections to equipment less than 3 in, install ball valves for water service.

2. For connections at new/existing lines containing solids (i.e., tees and connections to equipment less than 3 in), install plug valves for wastewater service.

3.4 FIELD QUALITY CONTROL

- A. Section 01 60 00 – Product Requirements: Requirements for inspecting and testing.
- B. Valve Field Testing:
 1. Test for proper alignment.
 2. Field test equipment to demonstrate operation without undue noise, vibration, or overheating.
 3. Engineer will witness field testing.
 4. Valves may be either tested while testing pipelines, or as a separate step.
 5. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valves and applications.
 6. For multiturn valves, count, and record number of turns to open and close valve. Account for any discrepancies with Manufacturer's data.

3.5 MANUFACTURER'S SERVICES

- A. A Manufacturer's representative for each type of valve installed shall be present at the jobsite for the minimum person-days listed for the services herein under, travel time excluded:
 1. 1 person-days for installation assistance, inspection, and certification of the installation. Provide certificate.
 2. 1 person-days for functional and performance testing.
 3. 1 person-days for pre-startup classroom or jobsite training of Owner's personnel.
- B. Training of Owner's personnel shall be at such times and locations as requested by Owner.
- C. See Section 01 75 00 – Startup Testing and Training.

3.6 VALVE TYPE SCHEDULE

- A. The schedule lists valve identifiers and types that are referenced throughout the contract drawings and specifications. Not all valves listed are included on the project – refer to drawings and section schedules.

VALVE TYPE SCHEDULE		
Valve Type	Description	Section
V140	General Duty Gate Valves smaller than 3 in.	40 05 61 – Gate Valves
V141	Buried Resilient-Seated Gate Valves	40 05 61 – Gate Valves
V142	Exposed Resilient-Seated Gate Valves	40 05 61 – Gate Valves
V145	Resilient-Seated Knife Gate Valve, 2 in. – 36 in.	40 05 61 – Gate Valves
V200	Globe Valve – 3 in. and smaller	40 05 65.16 – Globe Valves
V201	Angle Pattern Valve – 3 in. and smaller	40 05 65.16 – Globe Valves
V235	Angle Type Hose Bibb Valve	40 05 65.16 – Globe Valves
V236	Angle Pattern Hose Valve – smaller than 3 in.	40 05 65.16 – Globe Valves
V237	High Performance Globe Valve	40 05 65.16 – Globe Valves
V300	Metal Body Ball Valve, less than 6 in.	40 05 63 – Ball Valves
V302	Metal Body Ball Valve, 6 in. and Larger	40 05 63 – Ball Valves
V303	Instrumentation Ball Valves	40 05 63 – Ball Valves
V330	PVC/CPVC Ball Valves	40 05 63 – Ball Valves
V331	3-Way PVC Ball Valve	40 05 63 – Ball Valves
V404	Eccentric Plug Valve, 1/2 in. – 3 in.	40 05 62 – Plug Valves
V405	Eccentric Plug Valve, 4 in. – 12 in.	40 05 62 – Plug Valves
V406	Eccentric Plug Valve, 14 in. and Larger	40 05 62 – Plug Valves
V500	3 in. and Larger Rubber-Seated Butterfly Valves – Exposed	40 05 64 – Butterfly Valves
V504	3 in. and Larger Rubber-Seated Butterfly Valves – Buried	40 05 64 – Butterfly Valves
V510	2 in. and Larger Lug-Style Butterfly Valves	40 05 64 – Butterfly Valves
V511	2 in. and Larger Wafer-Style Butterfly Valves	40 05 64 – Butterfly Valves
V512	12 in. and Smaller Plastic Butterfly Valves	40 05 64 – Butterfly Valves
V513	2 in. and Larger High-Performance Butterfly Valves	40 05 64 – Butterfly Valves
V600	Check Valve, 2 in. and Smaller	40 05 65.23 – Check Valves
V605	Resilient Seated Swing Check Valves, 3 in. and Larger	40 05 65.23 – Check Valves
V608	Swing Check Valve, 2 in. and Larger	40 05 65.23 – Check Valves
V612	Double Disc Check Valve, 2 in. and Larger	40 05 65.23 – Check Valves
V613	PVC Wafer Style Check Valve, 2 in. and Larger	40 05 65.23 – Check Valves
V614	Stainless Steel Check Valve, 2 in. and Smaller	40 05 65.23 – Check Valves
V615	Ductile Iron Globe Style Silent Check Valve, 2 in. – 42 in.	40 05 65.23 – Check Valves
V616	Stainless Steel Globe Style Silent Check Valve, 3 in. – 42 in.	40 05 65.23 – Check Valves
V617	Ductile Iron Wafer Style Silent Check Valve, 1 in. – 12 in.	40 05 65.23 – Check Valves
V618	Stainless Steel Wafer Style Silent Check Valve, 1 in. – 10 in.	40 05 65.23 – Check Valves
V625	Slanting Disc Check Valve, 2 in. and Larger	40 05 65.23 – Check Valves
V631	PVC/CPVC Ball Check Valve, 4 in. and Smaller	40 05 65.23 – Check Valves
V632	CPVC Foot Valve with Strainer, 4 in. and Smaller	40 05 65.23 – Check Valves
V633	PVC/CPVC Ball Check Valve, 4 in and Larger	40 05 65.23 – Check Valves
V634	Ball Check Valve , 2 in. and Larger	40 05 65.23 – Check Valves
V635	Check Valve for Air Service, 2 in. And Larger	40 05 65.23 – Check Valves
V641	Double Check Valve Assembly, 2 1/2 in. – 10 in.	40 05 65.23 – Check Valves

V642	Reduced Pressure Backflow Preventer, 3/4 in. and Larger	40 05 65.23 – Check Valves
V650	Stainless Steel Flap Valve	40 05 65.23 – Check Valves
V710	Pressure Regulating Valve, 2 1/2 in. and Smaller	40 05 67 – Specialized Pressure and Flow-Control Valves
V711	High-Pressure Regulating Valve, 2 in. and Smaller	40 05 67 – Specialized Pressure and Flow-Control Valves
V712	High-Pressure PVC Regulating Valve, 2 in and Smaller	40 05 67 – Specialized Pressure and Flow-Control Valves
V713	Pressure Reducing Valve, 1 in. – 4 in.	40 05 67 – Specialized Pressure and Flow-Control Valves
V714	Pressure-Reducing Valve, 4 in. and Larger	40 05 67 – Specialized Pressure and Flow-Control Valves
V730	Pressure Relief Valve, 2 in. and Smaller	40 05 67 – Specialized Pressure and Flow-Control Valves
V731	PVC Pressure Relief Valve, 1/4 in. – 2 in.	40 05 67 – Specialized Pressure and Flow-Control Valves
V732	Pressure Relief Valve, Pressure Sustaining Valve, 1 in. and Larger	40 05 67 – Specialized Pressure and Flow-Control Valves
V733	Surge Anticipator and Surge Relief Valves	40 05 67 – Specialized Pressure and Flow-Control Valves
V734	Pump Control Valve	40 05 67 – Specialized Pressure and Flow-Control Valves
V740	Freeze Protection Valve	40 05 67 – Specialized Pressure and Flow-Control Valves
V750	Well Service Air Valve, 1/2 in. and Larger	40 05 78 – Air Release Valves
V752	Wastewater Combination Air Valves, 1 in. and Larger	40 05 78 – Air Release Valves
V755	Clean Water Combination Air Valve, 1 in. and Larger	40 05 78 – Air Release Valves
V757	Air Release Valves for Water Service	40 05 78 – Air Release Valves
V780	Safety Relief Valve for Air Service, 1 1/2 in. – 3 in.	40 05 78 – Air Release Valves
V785	Safety Relief Valve for Air Service, 3 in. and Larger	40 05 78 – Air Release Valves
V901	Diaphragm Valve, 1/2 in. and Larger	40 05 73 – Special Application Process Valves
V902	Pinch Valve	40 05 73 – Special Application Process Valves
V903	Antisiphon/Back Pressure Valves, 4 in. and Smaller	40 05 73 – Special Application Process Valves
V910	Telescoping Valve, 4 in. – 36 in	40 05 73 – Special Application Process Valves
V915	Mud Valve	40 05 73 – Special Application Process Valves
V916	Stainless Steel Mud Valve	40 05 73 – Special Application Process Valves
V940	2 in. and Smaller Solenoid Valve	40 05 82 – Solenoid Valves For Process Service

END OF SECTION

SECTION 40 05 57 – ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manual actuators.
 - 2. Electric motor actuators.
- B. Related Sections:
 - 1. Section 05 50 00 – Metal Fabrications.
 - 2. Section 40 05 07 – Hangers and Supports for Process Piping.
 - 3. Section 40 05 51 – Common Requirements for Process Valves.
 - 4. Section 40 05 82 – Solenoid Valves.
- C. Requirements:
 - 1. The Contractor shall coordinate between the valve actuator/control valve supplier and the control system supplier to provide a complete and fully operational system. It will be the valve/actuator supplier's responsibility to provide actuators that can send and accept the necessary signals from the control system. The valve/actuator supplier shall provide any limit switches, positioners, or other devices necessary to enable the status of the valves to be monitored and controlled by the control system.
 - 2. Valve and gate operators may be provided as part of a vendor equipment package. The Contractor shall be responsible for test, inspection, and assisting the equipment suppliers in startup services as required to place the operators into continuous, reliable operation.

1.2 REFERENCES

- A. ABMA (American Bearing Manufacturers Association):
 - 1. 9 – Load Ratings and Fatigue Life for Ball Bearings.
 - 2. 11 – Load Ratings and Fatigue Life for Roller Bearings.
- B. AWWA (American Water Works Association):
 - 1. C500 – Metal-Seated Gate Valves for Water Supply Service.
 - 2. C541 – Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
 - 3. C542 – Electric Motor Actuators for Valves and Slide Gates.
- C. NFPA:
 - 1. 70 – National Electrical Code.
- D. NEMA (National Electrical Manufacturer's Association)

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit manufacturer information for actuator with model number and size specified.
- C. Shop Drawings:
 - 1. Specify parts list, materials, sizes, position indicators, limit switches, control system, actuator mounting, wiring diagrams, control system schematics on assembly drawings.

2. Submit actuator Shop Drawings with valve and gate submittal.
 3. Product data sheets for make and model.
 4. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 5. Complete motor nameplate data.
 6. Open/close and throttle actuators sizing calculations including factor of safety used and final torques used for actuation selection.
 7. Operating torque calculations, including factor of safety used and final torques used for actuation selection, for each gate size, valve size and class.
 8. Maximum starting and normal operating torques for the operators supplied. Size operator for maximum starting torque.
 9. Refer to specific valve type for additional submittal requirements.
- D. Quality Control Submittals:
1. Special shipping, storage and protection, and handling instructions.
 2. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
 3. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
- E. Manufacturer's Certificate:
1. Certify that products meet or exceed specified requirements.
- F. Include separate Paragraphs for additional certifications.
- G. Manufacturer Instructions:
1. Submit special procedures and placement requirements.
- H. Source Quality-Control Submittals:
1. Specify results of factory tests and inspections.
- I. Field Quality-Control Submittals:
1. Specify results of Contractor-furnished tests and inspections.
- J. Qualifications Statements:
1. Submit qualifications for manufacturer and installer.
 2. Submit manufacturer's approval of installer.
- K. Closeout Submittals
1. Project Record Documents:
 - a. Record actual locations and types of actuators.
 2. See Section 01 77 00 – Closeout Procedures for additional requirements.
- 1.4 COORDINATION
- A. Coordinate Work of this section with installation of valves and accessories.
- 1.5 QUALITY ASSURANCE
- A. Valve Actuators in NEC Class I, Group D, Division 1 or 2 Hazardous Locations:
1. Provide actuators bearing agency approvals for installed hazardous location.
- B. Perform Work as specified in AWWA standards.

- C. Actuator/operator manufacturer shall coordinate with the valve/gate manufacturer and submit calculations showing the maximum and normal operating torques for the valves/gates and operators supplied.

1.6 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this section with minimum five years of experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 – Product Requirements for transporting, handling, storing, and protecting products.
- B. Inspection:
 - 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Supplier shall provide storage instructions to ensure that materials are stored as specified in manufacturer instructions.
- D. Protection:
 - 1. Supplier shall provide storage instructions for General Contractor.
 - 2. General Contractor's basic storage requirements include:
 - a. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - b. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
 - c. Provide additional protection as specified in manufacturer instructions.

1.8 SOURCE QUALITY CONTROL

- A. See Section 01 60 00 – Product Requirements for testing, inspection, and analysis requirements.
- B. Provide shop inspection and testing of completed assemblies.

1.9 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Where required, Supplier shall verify field measurements prior to fabrication.
 - 2. Specify field measurements in Shop Drawings.

1.10 WARRANTY

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Furnish gear and power actuators with position indicators.
 - 1. Tail rods on hydraulic cylinders, or dial indicators with clear full-open and closed position indicators, calibrated in number of turns or percentage of opening.

- B. Valve handles to take a padlock and wheels a chain and padlock.
- C. Worm Gear Operators:
 - 1. 1. Provide gearing on worm gear operators that is self-locking with gear ratio such that torque more than 160 Ft-lbs. will not need to be applied to operate valve at most adverse conditions for which valve is designed.
- D. Traveling Nut Operators:
 - 1. Capable of requiring maximum 100 Ft-lbs of torque when operating valve under most adverse condition; limit stops on input shaft of manual operators for fully open and closed positions; nonmoving vertical axis of operating nut when opening or closing valve.
- E. Open Direction Indicator:
 - 1. Cast arrow and legend indicating direction to rotate operator on handwheel, chain wheel rim, crank, or other prominent place.
- F. Operation:
 - 1. Counterclockwise to open with suitable and adequate stops, capable of resisting at least twice normal operating force to prevent overrun of valve or gate in open or closed position.
- G. Provisions for Alternate Operation:
 - 1. Where specified in the Drawings or elsewhere, position and equip crank or handwheel-operated geared valve operators or lifts for alternate operation with tripod mounted portable gate operators.
- H. Manual or Power Operator Size:
 - 1. Sized to deliver maximum force required under most severe specified operating condition, including static and dynamic forces, seat and wedge friction, and seating and unseating forces with safety factor of 5, unless otherwise specified.
- I. Wall Brackets or Haunches:
 - 1. As specified in Drawings.
- J. Stems:
 - 1. Stainless steel; sized to match output of operator; minimum gate or valve operating stem diameter; maximum 200 slenderness ratio.
- K. Stem Couplings:
 - 1. Stainless steel; internally threaded to match stem; lockable to stem by set screw.
- L. Stem Guides:
 - 1. Cast iron with silicon bronze bushing; maximum 200 slenderness ratio; capable of being mounted with a wall bracket; adjustable in 2 directions.
- M. Wall Brackets:
 - 1. Cast iron, capable of withstanding the output of the operator; adjustable in 2 directions.
- N. Stem Stuffing Boxes:
 - 1. Cast iron, with adjustable gland and packing.
- O. Fasteners and Anchor Bolts:
 - 1. 316 stainless steel.
- P. Geared Valve Operators:

1. Provided with cut gears, either spur or worm; sized to operate valves at most adverse design condition; with maximum 40 lb. pull at handwheel or chain wheel rim.
- Q. Geared Valve Traveling Nut Operators:
1. Acceptable only where specified or as specified in Drawings.
- R. Accessory Equipment for Valves and Gates Requiring Remote Operators:
1. Operating stems, stem couplings, stem guides, wall brackets, and stem stuffing boxes.

2.2 MANUAL ACTUATORS

- A. Exposed Actuators
1. Valves Smaller than 6 in:
 - a. Infinite-position lever handle with memory stop.
 2. Valves 6 in and Larger:
 - a. Comply with AWWA C500-19.
 3. Drive Type:
 - a. Worm gear.
 4. Bearings:
 - a. Ball or roller type.
 - b. Bearing life is percent failure at rated hours; for example, L10 life at 50,000 hours means 10 percent of bearings may be expected to fail at 50,000 hours.
 - c. Minimum L10 Life: 100,000 hours.
 5. Gear-Assisted Manual Actuators:
 - a. Provide totally enclosed gears.
 - b. Maximum Operating Force: not to exceed 40 pounds under any operating condition, including initial breakaway, add gear reduction operator when force exceeds 40 pounds.
 - c. Bearings: Permanently lubricated bronze.
 - d. Packing: Accessible for adjustment without requiring removal of actuator from valve.
 - e. Gearing: Designed for 100 percent overload.
 6. Handwheel:
 - a. Manufacturers: One of the following, or preapproved equal:
 - 1) Rodney Hunt Company.
 - 2) Waterman Industries, Incorporated.
 - b. Minimum 24 in. diameter.
 - c. Galvanized and painted hand wheels
 - d. Mounting: Floor stand or bench stand. Unless otherwise specified in Drawings position operator 36 in. (nominal) above top of walkway surface.
 - e. Pull to Operate: Maximum 40 pounds pull at most adverse design condition.
 - f. Stem Travel Limiting Device: Setscrew locked stop nuts above and below lift nut.
 - g. Grease Fittings: Suitable for lubrication of bearings.
 7. Hand-Cranked Geared Operators
 - a. Cranks on gear type operators for gates or pedestal mounted gearing.
 - b. Type: Single removable crank; fully enclosed.
 - c. Mounting: Floor and Bench Stand. Unless otherwise specified in Drawings, position the operator 36 in. (nominal) above the top of the walkway surface.
 - d. Operating Nut: When scheduled for portable operators.
 - e. Geared Lifts: 2-speed with minimum ratio of 4 to 1.
 - f. Teeth on Gears, Spur Pinions, Bevel Gears, and Bevel Pinions: Cut.
 - g. Lift Nuts: Cast manganese bronze.
 - h. Exterior Surfaces on Cast Iron Lift Parts: Smooth.
 - i. Bearings above and below Flange on Lift Nuts: Ball or roller; capable of taking thrust developed by opening and closing of gates under maximum operating head;

with bronze sleeve bearings and sufficient grease fittings for lubrication of moving parts, including bearings and gears.

- j. Crank Rotation Indicator: Cast arrow with word OPEN in prominent, readily visible location indicating correct rotation of crank to open gate.
- k. Hand Cranks: 15 in. radius; requiring maximum 25 pounds pull to operate gate at maximum operating head with:
 - l. Revolving brass sleeves.
 - m. Gears, spur pinions, bevel gears, and bevel pinions with cut teeth.
 - n. Cast manganese bronze lift nuts.
 - o. Cast iron lift parts with smooth exterior surfaces.
 - p. Indicator: Dial position type mounted on gear operator; enclosed in cast-iron or aluminum housing with clear plastic cover; marked with fully open, 3/4, 1/2, 1/4, and closed positions.

B. Chain Actuators:

- 1. Description:
 - a. Chain actuators for shutoff valves mounted 6 ft 9 in. and greater above operating floor level.
 - b. Chain guides and hot-dip galvanized operating chain extending to 5 1/2 ft above operating floor level.
- 2. Chain Wheels: Sprocket rim type.
- 3. Furnish chain storage if chains may interfere with pedestrian traffic.
- 4. Chain:
 - a. Galvanized or cadmium-plated.
- 5. Manufacturers and Products:
 - a. Clow Valve – F-5680
 - b. Walworth Co. – Figure 804
 - c. DeZurik – G-Series

C. Buried Valves:

- 1. Comply with AWWA C500.
- 2. Buried Operator Housing: Oil and watertight, specifically designed for buried service, factory packed with suitable grease, completely enclosed space between operator housing and valve body so that no moving parts are exposed to soil; provide operators with 2 in. square AWWA operating nut.
- 3. Buried service operators on valves larger than 2 1/2 in. shall have a 2 in. AWWA operating nut. Buried operators on valves 2 in. and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
- 4. Design buried service operators for quarter-turn valves to withstand 450 Ft-lbs. of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 10 psi.
- 5. Buried valves shall have extension stems, bonnets, and valve boxes.
- 6. Floors:
 - a. Furnish extension stems to grade, and square nuts or floor stands with position indicators.
 - b. Cast-iron pipe extensions with valve boxes, covers, and operating keys.
 - c. Floor Boxes: Hot-dip galvanized cast iron or steel, with bronze cover.
 - d. Lid Inscription: Water.
- 7. Outdoors:
 - a. Material: Cast iron.
 - b. 12 in. Diameter Valves and Smaller: Two-piece, screw type.
 - c. Valves Larger than 12 in. Diameter: Three-piece, screw type.
 - d. Lid Inscription: Water.

D. Gate and Pedestal Mounted Valve Operators:

- a. Operator Size:
 - 1) Capable of supporting weight of suspended shafting unless carried by bottom thrust bearings; shaft guides with wall mounting brackets.
- b. Stem Covers:
 - 1) Aluminum pipe; threaded cap on top; bolted aluminum flange on bottom; 1 in. by 12 in. slots cut at 18 in. on center in front and back of pipe; capable of covering threaded portion of greased stems that project above operators when gates or valves are opened or closed.
- c. Stem Cover Flanges, Pipes and Caps:
 - 1) Etched and anodized to produce chemical finishes as specified in AA C 22, medium matte finish, and AA A 41 clear anodic coating, or described in AA publication 45, after fabrication.
- d. Gate Stem Covers:
 - 1) Concentric with stem

2.3 MOTORIZED ACTUATORS

- A. Motorized operators for gates and valves shall be the product of a single supplier for each type of gate or valve.
- B. Approved Manufacturers:
 - 1. Asahi America Series 19
 - 2. Valworx
 - 3. Assured Automation K-Series
- C. Design:
 - 1. Sized to move pvc or cpvc valves from full open to closed position at minimum 12 IPM, plus or minus 10%, under maximum load.
 - 2. Actuator:
 - a. Provide with built-in device to allow motor to reach full speed before engaging valve or gate load; in manual operating mode when motor is not energized; in electrical operating mode when motor is energized.
 - b. Actuators shall be suitable for indoor and outdoor use, in an ambient temperature ranging from (-10)°F – 160°F.
 - 3. Handwheels for Manual Operation:
 - a. Metallic with arrows to indicate “open” rotation; incapable of rotation during motor operation; unaffected by fused motor; maximum 80 lb. pull on rim when rotating.
 - 4. Declutch Lever:
 - a. Padlockable, capable of mechanically disengaging motor and related gearing positively when motor is deenergized and freeing handwheel for manual operation.
 - 5. Position Indication:
 - a. Shall be accomplished by means of a digital display in full step at all times with valve or slide gate travel during either power or manual operation.
- D. Actuator Gearing:
 - 1. Valve Actuator Gearing:
 - a. Multiple reduction type with hardened alloy steel spur or helical gears and self-locking, alloy bronze worm gear set in drive train to maintain valve position.
 - 2. Gate Actuator Gearing:
 - a. Multiple reduction type with hardened alloy steel spur gear, bevel pinion and bevel gears; self-locking to maintain gate position.
 - 3. Power Gearing:
 - a. Hardened alloy steel; accurately cut to assure minimum backlash; antifriction bearing with caged balls or rollers throughout.
 - 4. Stem Nuts:

- a. High tensile manganese bronze; accurately machined and mounted in heavy ball or roller bearings; minimum 2 1/4 times stem diameter for length of thread in lift nuts.
- 5. Actuator Gear Housing:
 - a. Ductile iron.
- 6. Lubrication:
 - a. Rotating power train components immersed in grease with provisions for inspection and relubrication without disassembly.
 - b. Lubricants:
 - 1) Suitable for ambient conditions of (-20)°F – 150°F.
 - c. Provide seals on shafting.
- E. Motors:
 - 1. Type: Specifically designed for valve actuator service with high starting torque, totally enclosed nonventilated construction.
 - 2. Motor Insulation: Minimum NEMA Class F, with a maximum continuous temperature rating of 311°F, rise plus ambient.
 - 3. Motor Windings: Epoxy treated.
 - 4. Thermal Protection: Provide winding thermal protection.
 - 5. Size: Sufficient to open and close valves at maximum stated torque.
 - 6. Voltage Tolerance: Capable of operating at within 10% of specified voltage.
 - 7. Motor Duty Ratings: 15-minute duty rating for open and close service; continuous duty rating for modulating service.
 - 8. Accessories: Internal thermal contacts, heaters in motor and switch compartment, and ground lug.
 - 9. Power Supply: As scheduled or as specified in Drawings.
 - 10. Enclosures for Motors, Switches, and Other Electrical Compartments:
 - a. Hazardous Locations: Where actuators are located within a hazardous location boundary, they shall bear agency approvals for the class, division, and group of the hazardous location defined in the contract documents.
 - b. Other Locations: Provide NEMA 4X enclosures.
- F. Controls:
 - 1. Voltage Transformer: As required to step down power supply to control voltage.
 - 2. Control Station:
 - a. Integral with operator. Provide separate remote-mounted control enclosure if specified in Drawings.
 - 1) Where explosionproof construction is specified in Drawings, provide NEMA 7 enclosure.
 - 2) For other locations, provide NEMA 4X enclosure.
 - b. Provide integral LOCAL/OFF/REMOTE selector switch and OPEN/CLOSE/STOP pushbuttons.
 - 1) "LOCAL" position provides operation from push buttons.
 - 2) "REMOTE" position enables control from a remote source.
 - c. Provide OPEN/CLOSE/STOP indicating lights and 0 to 100 percent position indication.
 - d. Provide the following contacts for remote connection:
 - 1) Switch in Remote Position
 - 2) Fully Closed
 - 3) Fully Open
 - 4) Fault
 - 3. Limit switches and associated gearing shall be integral with valve actuator.
 - a. Gearing: Intermittent type; bronze or stainless steel; grease lubricated; totally enclosed.
 - b. Contacts: Heavy duty and silver plated with wiping action.
 - c. Remote Indication Contacts: As specified in Drawings.

- d. Switches: Adjustable; allowing for trip points from fully open to closed positions of valve travel; not subject to breakage or slippage due to overtravel; permits visible verification of switch position without disassembly.
 - 4. Torque Limit Switch:
 - a. Capable of interrupting control circuits in both opening and closing when valve torque overload occurs.
 - b. Silver plated contacts.
 - c. Graduated dials for both open and close directions of travel, each independently adjustable.
 - d. Positive means to limit adjustability to avoid exceeding actuator output torque capability with Belleville activating spring pack.
 - e. Permits visible verification of switch position without disassembly.
- G. Operation:
 - 1. Open-Close Service:
 - a. Operators shall operate automatically by remote signal specified and as specified in Drawings.
 - b. When the selector switch is in the REMOTE position, the self-contained electromechanical reversing starter shall cause valve or gate to open or close on receiving a remote signal.
 - c. When the selector switch is in the ON position, the local control station will control the motorized operator.
 - 2. Modulating Service:
 - a. Actuator Controller:
 - 1) Microprocessor based and using proportional-integral derivative algorithm to calculate actuator response.
 - b. Controller shall compare 4 mA – 20 mA direct-current analog command signal to analog feedback signal and move actuator accordingly.
 - c. A microprocessor-based controller shall control the integrally mounted solid state reversing starter.
 - d. Provide 4 mA – 20 mA direct-current analog output signal for continuous remote monitoring of position.
 - 3. Controller System:
 - a. Rated for continuous duty.
- H. Valve Limit Switches:
 - 1. Mechanical cam gear for remote operation, indication, and other control; compatible with associated operation and suitable for service intended; for valves specified in Drawings; with racks, gears, cam, linkage mountings, and accessories.
 - 2. Contact Ratings: 120 V alternating current, 20 amp at 75% – 100% power factor, and 24 V direct current, 5 amp minimum.
 - 3. Enclosures:
 - a. Watertight and oiltight for normal service.
 - 4. Valve box:
 - a. Large enough to contain and to allow easy adjustment of limit switch without switch's removal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field dimensions are as specified in Shop Drawings.

3.2 SHIPPING, STORAGE, HANDLING, AND PROTECTION

- A. As specified in Section 01 60 00 – Product Requirements.

3.3 INSTALLATION

- A. Complete equipment installation with controls, safety devices and auxiliary support systems necessary to start the equipment and verify that the equipment functions correctly under no load conditions. Turn rotating equipment by hand to check. Complete cleaning and testing of piping systems. Inspect and clean equipment, devices, piping, and structures of debris and foreign material.
- B. Securely mount actuators using brackets or hardware specifically designed for attachment to valves.
- C. Extend chain actuators to 5 1/2 ft above operating floor level.
- D. Install operators as specified in Manufacturer's instructions.
- E. Locate valve boxes where specified in Drawings.
- F. Remove temporary bracing supports and other construction debris that may damage equipment.
- G. Remove protective coatings and oils used for protection during shipment and installation.
- H. Flush, fill, and grease lubricated systems as specified in Manufacturer's instructions.
- I. Install temporary connections and devices required to fill, operate, checkout and drain the system. Provide temporary valves, gauges, piping, test equipment, and other materials and equipment necessary to conduct testing and startup.
- J. Check equipment for correct direction of rotation and freedom of moving parts.
- K. Align equipment to Manufacturer's tolerances. Adjust clearances and torques.
- L. Check installation prior to startup for conformance to Manufacturer's instructions.
- M. Adjust or modify equipment to ensure proper operation.
- N. For pneumatic actuators, furnish and install the required air tubing with fittings, connections, taps, pressure switches, electrical devices, wiring, and terminations necessary for a complete system. Each actuator shall have an isolation safety exhaust valve with locking handle provided at each branch airline to the actuator. Air tubing shall be furnished and installed from the compressor to the actuators. Slope air headers to low points and provide moisture traps with drip legs at the low points. Branch connections off main line shall be made off the top of the main line. Furnish taps, isolation valves, and pressure switches on the air piping as shown on the Plans. The contractor shall coordinate between the actuator supplier and the control system supplier to provide a complete and fully operational actuator system.
- O. Correct any deficiencies or problems noted in Manufacturer's representative's installation reports.

3.4 FIELD QUALITY CONTROL

- A. After installation, inspect for proper supports and interferences.
- B. Repair damaged coatings with material equal to original coating as specified in Section 09 96 00 – High Performance Coatings.

- C. Verify that structures, equipment, pipes, valves, fittings, and other appurtenances are compatible. Coordinate field devices, voltages, signal types, power needed, and programming with valve operator to provide proper functioning system.

3.5 MANUFACTURER'S REPRESENTATIVE

- A. The services of the manufacturer's technical representative shall be provided for pre-startup installation checks, startup assistance, training of Owner's personnel, troubleshooting, acceptance testing, and other services as required within these Contract Documents.
- B. Manufacturer's representative shall:
 - 1. Approve installation in writing to Engineer before operation.
 - 2. Verify conformance to all specified requirements.
 - 3. Fully instruct all designated personnel for the plant on proper care, maintenance, and operation of all equipment and appurtenances.
 - 4. Perform specified acceptance tests and operate system to verify satisfactory operation of all equipment in presence of Owner's personnel and Engineer.
 - 5. Check all equipment for excessive noise or vibration, proper alignment, general operation, etc.
 - 6. Operate the equipment through the design performance range consistent with available flows. Adjust, balance, and calibrate and verify that the equipment, safety devices, controls, and process system operate within the design conditions. Each safety device shall be tested for proper setting and signal. Response shall be checked for each equipment item and alarm. Simulation signals may be used to check equipment and alarm responses.
 - 7. Place each piece of equipment in the system in operation until the entire system is functioning. All components shall continue to operate without alarms or shutdowns, except as intended, for 8 consecutive hours to be considered started up.
 - 8. Submit certified written field reports as required by Section 01 33 00 – Submittal Procedures.
 - 9. Provide a certificate by the valve actuator supplier indicating proper installation and startup procedures have been followed. This certificate shall be required and included as part of the final operation and maintenance manuals to validate the specified 3-year warranty.
 - 10. Revisit job sites as often as necessary beyond minimum services specified to correct deficiencies to satisfaction of Engineer.

3.6 ACTUATOR MOUNTING

- A. Actuator Mounting Responsibility:
 - 1. Valves to be actuated shall be shipped to the manufacturer's approved Valve Automation Fabricator (see AWWA C504-94, Section 1.6, Assembly) for complete assembly, calibration, and testing to validate the warranty. A certification of the calibration, testing, and warranty shall be included in the final O&M manuals.
- B. Retrofit Actuators:
 - 1. Valves to be retrofit with new pneumatic actuators shall remain in place during retrofit process unless otherwise shown on the plans. Each size and model valve shall be field surveyed by the Valve Automation Fabricator. The survey by actuator representative shall include supervising the removal of the existing actuator if necessary in order to measure the top works of the valve. The actuator supplier shall supervise the mounting, installation, and testing of the new retrofit actuators.

3.7 ACCEPTANCE TEST

- A. Upon completion of the installation of each valve actuator, an acceptance test will be conducted to verify the satisfactory operation and performance of each actuator. Each valve shall be opened and closed using the plant control system as applicable (AUTO) and manually. The control valves shall also be tested under power loss to verify proper closure.
- B. The test shall be conducted in a manner approved by and in the presence of the Engineer. The equipment and piping will be completely checked for leakage, general operation, etc.
- C. Each valve actuator must perform in a manner acceptable to the Engineer before the Owner will make final acceptance.

3.8 ATTACHMENTS

A. Power Operated Valve Schedule:

- Note that this list may not be inclusive of all power operated valves on the project. Comply with all requirements of contract drawings and specifications.

POWER OPERATED VALVE SCHEDULE										
TAG NO.	P&ID DRAWING	FLOW STREAM ID	VALVE TYPE	OPERATION (NOTE 1)	BODY SIZE (IN)	LOSS OF SIGNAL FAIL ACTION (NOTE 2)	TYPICAL OPERATING RANGE			
							FLOW		PRESSURE	
							MAX/MIN FLOW	UNITS	MAX/MIN PRESSURE	UNITS
301CV1	08-I103	SHX	V330	OC	1.5	FLP	0/25	GPM	25/25	FT
301CV2	08-I103	SHX	V330	OC	3	FLP	0/25	GPM	25/25	FT
301CV3	08-I103	SHX	V330	OC	1.5	FLP	0/4	GPM	5/1	FT
301CV4	08-I103	SHX	V330	OC	3	FLP	0/4	GPM	5/1	FT
NOTES: 1. MOD – Modulating OC – Open/Close Operation 2. Fail-Action codes below for loss of 4 mA – 20 mA signal to actuator positioner on modulating valves. FO – Fail Open FC – Fail Close FLP – Fail Last Position										

END OF SECTION

SECTION 40 05 63 – BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. V303 – Instrumentation Ball Valves.
 - 2. V330 – PVC/CPVC Ball Valves.
- B. Related Sections:
 - 1. Section 40 05 51 – Common Requirements for Process Valves.
 - 2. Section 40 05 57 – Actuators for Process Valves and Gates.
 - 3. Section 40 23 39.1 – Process Piping Schedule.

1.2 REFERENCES

- A. AWWA (American Water Works Association):
 - 1. C507 – Ball Valves, 6 in. – 60 in. (150 mm – 1,500 mm).
- B. ASME International:
 - 1. B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. B16.5 – Pipe Flanges and Flanged Fittings: NPS 1/2 – NPS 24 Metric/Inch Standard.
 - 3. B16.11 – Forged Fittings, Socket-Welding and Threaded.
 - 4. B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
 - 5. B1.20.1 – Pipe Threads, General Purpose, Inch.
- C. ASTM International:
 - 1. A48 – Standard Specification for Gray Iron Castings.
 - 2. D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 - 3. D3222 – Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
 - 4. D4101 – Standard Specification for Polypropylene Injection and Extrusion Materials.
- D. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP-110 – Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

- A. See Section 01 33 00 – Submittal Procedures for general submittal requirements.
- B. Product Data:
 - 1. Submit manufacturer information for system materials and component equipment.
- C. Shop Drawings:
 - 1. Specify system materials and component equipment.
 - 2. Submit installation and anchoring requirements, fasteners, and other details.
 - 3. Specify valve identification number, location, service, type, size, design pressure, operator details, stem details, and loads.
- D. Manufacturer's Certificate:
 - 1. Certify that products meet or exceed specified requirements.

- E. Delegated Design Submittals:
 - 1. Submit signed and sealed Shop Drawings with design calculations and assumptions for seating and unseating pressure.
- F. Manufacturer Instructions:
 - 1. Submit detailed instructions on installation requirements, including storage and handling procedures.
- G. Source Quality-Control Submittals:
 - 1. Specify results of factory tests and inspections.
- H. Field Quality-Control Submittals:
 - 1. Specify results of Contractor-furnished tests and inspections.
- I. Manufacturer Reports:
 - 1. Certify that equipment has been installed as specified in manufacturer instructions.
 - 2. Specify activities on Site, adverse findings, and recommendations.
- J. Closeout Submittals:
 - 1. See Section 01 77 00 – Closeout Procedures.
 - 2. Project Record Documents:
 - a. Record actual locations of installed valve and components.

1.4 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water:
 - 1. Certified to NSF Standard 61 and NSF Standard 372.

1.5 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this Section with minimum five years of experience.

1.6 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 – Quality Requirements for testing, inspection, and analysis requirements.
- B. Test and install butterfly valves as specified in AWWA C507.

1.7 WARRANTY

- A. Furnish minimum three-year manufacturer's warranty for valves.
- B. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as specified in the performance, functions, features, and materials of construction.

- B. Like items of equipment provided in this section shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.
- C. Design Requirements:
 - 1. Valve class shall meet the connecting line requirements or be as specified in the valve schedule or in Drawings.
 - 2. Bubble-tight at rated pressure, or any pressure lower than rated, applied from either side with the valve mounted in any orientation.
 - 3. Suitable for applications involving frequent throttling and applications requiring valve actuation after long periods of inactivity.
- D. Operator:
 - 1. As specified in valve schedules and Section 40 05 57 – Actuators for Process Valves and Gates.

2.2 TYPE V303: INSTRUMENTATION BALL VALVES

- A. Manufacturers and Products:
 - 1. Swagelok – 40G Series (available in 1/8 in. – 3/4 in.)
 - 2. Parker – B Series (available in 1/16 in. – 1/2 in.)
- B. General:
 - 1. Stainless steel body ball valve, nylon handle.

2.3 TYPE V330: PVC/CPVC BALL VALVES

- A. Manufacturers:
 - 1. Georg Fischer – 546 Pro (available in 3/8 in. – 4 in.)
 - 2. Asahi/America, Inc.
 - 3. NIBCO/Chemtrol –
 - a. PVC – U-45TB-V (available in 1/2 in. – 2 in.)
or
S-45TB-V (available in 3 in. – 6 in.)
 - b. CPVC – U-51TB-V (available in 1/2 in. – 2 in.)
or
S-51TB-V (available in 3 in. – 6 in.)
 - 4. Hayward Flow Control – TBH Series True Union (available in 1/4 in. – 6 in.)
 - 5. Spears – True Union 2000 (available in 1/2 in. – 8 in.)
- B. Typical Service:
 - 1. Water
 - 2. Chemicals
 - 3. Drain
 - 4. Sample locations
- C. General:
 - 1. Type: Nonlubricated and capable of sealing in either flow direction.
 - 2. Working Pressure:
 - a. 1/2 in. – 2 in. – 250 psi.
 - b. 2 1/2 in. – 6 in. – 150 psi.
 - 3. Maximum Process Fluid Temperature: As specified in Section 40 23 39.1 – Process Piping Schedule.
 - 4. Ports: Full size.

5. All ball valves on sodium hypochlorite lines and/or chlorine dioxide lines shall be venting type valves.
6. End Connections:
 - a. True Union:
 - 1) Solvent or heat welded to piping.
 - 2) Defer to manufacturer's recommendation for installation.
- D. Operation:
 1. Operator: Hand lever unless specified otherwise in valve schedule or in Section 40 05 57 – Actuators for Process Valves and Gates.
- E. Materials:
 1. Body and Ball:
 - a. PVC, ASTM D1784 when adjoining to PVC pipe.
 - b. CPVC, ASTM D1784 when adjoining to CPVC pipe.
 2. Seats: PTFE.
 3. O-rings: Viton (FKM)

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements for transporting, handling, storing, and protecting products requirements.
- B. Inspection:
 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials as specified in manufacturer instructions.
- D. Protection:
 1. Protect materials from moisture and dust by storing them in clean, dry location remote from construction operations areas.
 2. Provide additional protection as specified in manufacturer instructions.

3.2 INSTALLATION

- A. Install valves as specified in AWWA C507.

3.3 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.
- C. Count and record number of turns to open and close valve, account for any discrepancies with Manufacturer's data.

3.4 MANUFACTURER'S SERVICES

- A. A Manufacturer's representative for the equipment specified in this section shall be present at the jobsite for the minimum person-days listed for the services below, travel time excluded:
 1. 1 person-day for installation assistance, inspection, and certification of the installation. Provide certificate.

2. 1/2 person-day for functional and performance testing.
3. 1 person-day for pre-startup classroom or jobsite training of Owner's personnel.

B. Training of Owner's personnel shall be at times and locations specified by Owner.

C. See Section 01 75 00 – Startup Testing and Training.

3.5 MANUFACTURER'S CERTIFICATE(S)

A. Provide as specified in Section 01 75 00 – Startup Testing and Training.

END OF SECTION

SECTION 40 05 65.23 – CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Type V633: PVC/CPVC Ball Check Valve, 4 in. and Larger.
- B. Related Sections:
 - 1. Section 40 05 51 – Common Requirements for Process Valves.
 - 2. Section 40 05 57 – Actuators for Process Valves and Gates.

1.2 REFERENCES

- A. AWWA (American Water Works Association):
 - 1. C508 – Swing-Check Valves for Waterworks Service, 2 in. – 24 in. NPS.
 - 2. C510 – Double Check Valve Backflow Prevention Assembly.
- B. ASME International:
 - 1. B1.20.1 – Pipe Threads, General Purpose, Inch.
 - 2. B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 3. B16.11 – Forged Fittings, Socket-Welding and Threaded.
 - 4. B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
- C. ASTM International:
 - 1. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. A536 – Standard Specification for Ductile Iron Castings.
 - 3. B62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
 - 4. B148 – Standard Specification for Aluminum-Bronze Sand Castings.
 - 5. B584 – Standard Specification for Copper Alloy Sand Castings for General Applications.
 - 6. D1784 – Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 - 7. D2000 – Standard Classification System for Rubber Products in Automotive Applications.
- D. NSF International:
 - 1. 61 – Drinking Water System Components – Health Effects.
 - 2. 372 – Drinking Water System Components – Lead Content.
- E. SSPC – The Society for Protective Coatings:
 - 1. SP 6 – Commercial Blast Cleaning.

1.3 SUBMITTALS

- A. See Section 01 33 00 – Submittal Procedures for general submittal requirements.
- B. Product Data:
 - 1. Submit manufacturer information for system materials and component equipment.
- C. Shop Drawings:
 - 1. Specify system materials and component equipment.
 - 2. Submit installation and anchoring requirements, fasteners, and other details.
 - 3. Specify valve identification number, location, service, type, size, design pressure, operator details, stem details, and loads.

- D. Manufacturer's Certificate:
 - 1. Certify that products meet or exceed specified requirements.
- E. Delegated Design Submittals:
 - 1. Submit signed and sealed Shop Drawings with design calculations and assumptions for seating and unseating pressure.
- F. Manufacturer Instructions:
 - 1. Submit detailed instructions on installation requirements, including storage and handling procedures.
- G. Source Quality-Control Submittals:
 - 1. Specify results of factory tests and inspections.
- H. Field Quality-Control Submittals:
 - 1. Specify results of Contractor-furnished tests and inspections.
- I. Manufacturer Reports:
 - 1. Certify that equipment has been installed as specified in manufacturer instructions.
 - 2. Specify activities on Site, adverse findings, and recommendations.
- J. Closeout Submittals:
 - 1. Project Record Documents:
 - a. Record actual locations of installed valve and components.
 - 2. See Section 01 77 00 – Closeout Procedures for additional requirements.

1.4 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water:
 - 1. Certified to NSF Standard 61 and NSF Standard 372.

1.5 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this Section with minimum five years of experience.

1.6 SOURCE QUALITY CONTROL

- A. Requirements for testing, inspection, and analysis as specified in Section 01 40 00 – Quality Requirements.
- B. Hydrostatically test check valves at twice rated pressure as specified in AWWA C508.
- C. Permitted Leakage at Specified Working Pressure:
 - 1. None

1.7 WARRANTY

- A. Furnish one-year manufacturer's warranty for Type V614, V634, V635, V641, V642, and V650 valves.
- B. Furnish two-year manufacturer's warranty for Type V615, V616, V617, V618, V625, V631, V632, V633, and V652 valves.

- C. Furnish three-year manufacturer's warranty for valves V600, V605, V608, V612, and V613 valves.
- D. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified in this section.
- B. Like items of equipment provided in this section shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.
- C. Design Requirements:
 - 1. Valve class shall meet the requirements of the connecting line or as specified in either the valve schedule or in Drawings.
 - 2. Bubble-tight at rated pressure, or any pressure lower than rated.
 - 3. Suitable for applications involving frequent throttling and applications requiring valve operation after long periods of inactivity.
- D. Operator:
 - 1. As specified in valve schedules and Section 40 05 57 – Actuators for Process Valves and Gates.

2.2 TYPE V633: PVC/CPVC BALL CHECK VALVE, 4 IN. AND LARGER:

- A. Manufacturers:
 - 1. Asahi/America, Inc.
 - 2. NIBCO/Chemtrol
 - 3. Spears – True Union 2000 (available in 4 in. – 8 in.)
 - 4. Hayward Flow Control – TC Series (available 4 in. – 6 in.)
- B. General:
 - 1. End Connections:
 - a. True Union Solvent Weld
 - 2. Pressure Rating:
 - a. Rated 150 psi at 70°F, 110 psi at 140°F
- C. Materials:
 - 1. Body and Ball:
 - a. PVC, ASTM D1784 Cell Class 12454 when adjoining to PVC pipe,
 - b. CPVC, ASTM D1784 Cell Class 23447 chlorinated polyvinyl chloride body
 - c. Seats and Seal:
 - 1) Viton (FPM)
 - d. O-rings:
 - 1) Viton (FPM)
- D. Seat and seal:
 - 1. Viton (FPM)

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection:
 - 1. Accept materials onsite in manufacturer's original packaging and inspect for damage.
- C. Store materials as specified in manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection as specified in manufacturer instructions.

3.2 INSTALLATION

- A. As specified in AWWA C508 and manufacturer instructions.
- B. Dielectric Fittings:
 - 1. Provide between dissimilar metals.

3.3 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.

3.4 MANUFACTURER'S SERVICES

- A. A Manufacturer's representative for the equipment specified in this section shall be present at the jobsite for the minimum person-days listed for the services below, travel time excluded:
 - 1. 1 person-day for installation assistance, inspection, and certification of the installation. Provide certificate.
 - 2. 1/2 person-day for functional and performance testing.
 - 3. 1 person-day for pre-startup classroom or jobsite training of Owner's personnel.
- B. Training of Owner's personnel shall be at times and locations specified by Owner.

3.5 MANUFACTURER'S CERTIFICATE(S)

- A. Provide as specified in Section 01 75 00 – Startup Testing and Training.

END OF SECTION

SECTION 40 05 73 – SPECIAL–APPLICATION PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Type V901: Diaphragm Valve, 1/2 in. and Larger.
 - 2. Type V903: Antisiphon/Back Pressure Valves, 4 in. and Smaller.
- B. Related Sections:
 - 1. Section 40 05 51 – Common Requirements for Process Valves.
 - 2. Section 40 05 57 – Actuators for Process Valves and Gates.

1.2 DEFINITIONS

- A. OUTSIDE SCREW AND YOKE (OS&Y) VALVE:
 - 1. A valve in which the operating screw is driven by a threaded nut that is built into the handle.

1.3 REFERENCES

- A. AWWA (American Water Works Association)
- B. ASME International:
 - 1. B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. B16.5 – Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 - 3. B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
 - 4. B1.20.1 – Pipe Threads, General Purpose, Inch.
- C. ASTM International:
 - 1. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. B62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
 - 3. B584 – Standard Specification for Copper Alloy Sand Castings for General Applications.
 - 4. D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- D. MSS (Manufacturers Standardization Society of the Valve and Fittings Industry):
 - 1. SP-70 – Gray Iron Gate Valves, Flanged and Threaded Ends.
 - 2. SP-80 – Bronze Gate, Globe, Angle and Check Valves.

1.4 SUBMITTALS

- A. See Section 01 33 00 – Submittal Procedures for general submittal requirements.
- B. Action Submittals:
 - 1. Product Data:
 - a. Submit manufacturer information for system materials and component equipment.
 - 2. Shop Drawings:
 - a. Indicate system materials and component equipment.
 - b. Submit installation and anchoring requirements, fasteners, and other details.
 - c. Indicate valve identification number, location, service, type, size, design pressure, operator details, stem details, and loads.

- C. Informational Submittal:
 - 1. Manufacturer's Certificate:
 - a. Certify that products meet or exceed specified requirements.
 - 2. Delegated Design Submittals:
 - a. Submit signed and sealed Shop Drawings with design calculations and assumptions for seating and unseating pressure.
 - 3. Manufacturer Instructions:
 - a. Submit detailed instructions on installation requirements, including storage and handling procedures.
 - 4. Source Quality-Control Submittals:
 - a. Indicate results of factory tests and inspections.
 - 5. Field Quality-Control Submittals:
 - a. Indicate results of Contractor-furnished tests and inspections.
 - 6. Manufacturer Reports:
 - a. Certify that equipment has been installed according to manufacturer instructions.
 - b. Indicate activities on Site, adverse findings, and recommendations.
 - 7. Closeout Submittals:
 - a. See Section 01 70 00 – Execution Requirements.
 - b. Project Record Documents:
 - 1) Record actual locations of installed valve and components.

1.5 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water:
 - 1. Certified to NSF Standard 61 and NSF Standard 372.

1.6 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this section with minimum five years of experience.

1.7 SOURCE QUALITY CONTROL

- A. Requirements for testing, inspection, and analysis as specified in Section 01 40 00 – Quality Requirements.
- B. Test and install valves according to AWWA standards.

1.8 WARRANTY

- A. Furnish three-year manufacturer's warranty for valves.
- B. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified in this section.

- B. Like items of equipment provided in this section shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.
- C. Design Requirements:
 - 1. Valve class shall meet the requirements of the connecting line or as indicated in the valve schedule or on the drawings.
 - 2. Bubble-tight at rated pressure, or any pressure lower than rated, applied from either side with the valve mounted in any orientation.
 - 3. Suitable for applications involving frequent throttling and applications requiring valve actuation after long periods of inactivity.
- D. Operator:
 - 1. As specified in valve schedules and Section 40 05 57 – Actuators for Process Valves and Gates.

2.2 TYPE V901: DIAPHRAGM VALVE, 1/2 IN. AND LARGER

- A. Manufacturers:
 - 1. George Fisher.
 - 2. Asahi/America, Inc
- B. General:
 - 1. Weir type.
 - 2. All metallic components shall be isolated for contact with fluid and the surrounding atmosphere
 - 3. Working Pressure: 100 psi at 120°F.
 - 4. Valve must also be suitable for testing at elevated pressure per respective flow stream as indicated in Piping Schedule.
 - 5. End Connections:
 - a. 1/2 in. – 2 in: True union socket ends
 - b. 2 1/2 in. and larger: ANSI Flanges
- C. Operation:
 - 1. Manual operator, with indicating, rising stem and handwheel.
 - 2. Operators as specified in valve schedule or 40 05 57 – Actuators for Process Valves and Gates.
- D. Materials:
 - 1. Body and Bonnet: CPVC
 - 2. Internal metals and hardware: Type 316 Stainless Steel
 - 3. Diaphragm: PTFE or Viton, compatible with process flow as identified in piping Schedule.
- E. Finishes: As indicated in the Pipe Schedule.

2.3 TYPE V903: ANTI-SIPHON/BACK PRESSURE VALVES, 4 IN. AND SMALLER

- A. Manufacturers:
 - 1. Plast-O-Matic Valves, Inc.; Series RVDT/RVDTM (1/4 in. – 2 in.)
 - 2. Griffco; G Series (1/2 in. – 4 in.)
 - 3. Or equal.
- B. General:
 - 1. Spring controlled diaphragm, with a safety vent, to close when upstream pressure reaches a minimum set point and serve as an antisiphon device.

2. Pressure Rating: 150 psi.
 3. Valve material shall be appropriate for chemical service.
 4. 0 – 50 psi set range
- C. Operation:
1. Manual operator
 2. Operators as specified in valve schedule or Section 40 05 57 – Actuators for Process Valves and Gates.
- D. Materials:
1. Body: CPVC
 2. Diaphragm: PTFE

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 – Product Requirements for transporting, handling, storing, and protecting products.
- B. Inspection:
1. Accept materials on site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 2. Provide additional protection according to manufacturer instructions.

3.2 INSTALLATION

- A. According to manufacturer's instructions.

3.3 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.
- C. Count and record number of turns to open and close valve; account for any discrepancies with Manufacturer's data.

3.4 MANUFACTURER'S SERVICES

- A. A Manufacturer's representative for the equipment specified in this section shall be present at the jobsite for the minimum person-days listed for the services below, travel time excluded:
1. 2 person-days for installation assistance, inspection, and certification of the installation.
 - a. Provide certificate.
 2. 2 person-days for functional and performance testing.
 3. 2 person-days for pre-startup classroom or jobsite training of Owner's personnel.
- B. Training of Owner's personnel shall be at times and locations specified by Owner.

3.5 MANUFACTURER'S CERTIFICATE(S)

- A. Provide as specified in Section 01 75 00 – Startup Testing and Training.

END OF SECTION

SECTION 40 23 39 – PROCESS PIPING – GENERAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Basic Process Piping Materials, Methods, and Appurtenances.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete.
 - 2. Section 09 96 00 – High-Performance Coatings.
 - 3. Section 22 05 53 – Mechanical Identification.
 - 4. Section 31 23 23.16 – Trench Backfill.
 - 5. Section 33 13 00 – Disinfection of Water Systems.
 - 6. Section 40 05 00 – Piping Systems Testing.
 - 7. Section 40 05 06 – Process Piping Specialties.
 - 8. Section 40 41 13 – Heat Tracing.
 - 9. Section 40 42 00 – Process Mechanical Insulation.

1.2 REFERENCES

- A. AASHTO (American Association of State Highway and Transportation Officials):
 - 1. Standard Specifications for Highway Bridges.
- B. ANSI (American National Standards Institute):
 - 1. A21.52 – Ductile Iron Pipe, Centrifugally Cast, for Gas.
 - 2. B1.20.1 – Pipe Threads, General Purpose (Inch).
 - 3. B16.1 – Cast Iron Pipe Flanges and Flanged Fittings.
 - 4. B16.3 – Malleable Iron Threaded Fittings.
 - 5. B16.5 – Pipe Flanges and Flanged Fittings.
 - 6. B16.9 – Factory-Made Wrought Steel Butt welding Fittings.
 - 7. B16.11 – Forged Fittings, Socket-Welding and Threaded.
 - 8. B16.15 – Cast Bronze Threaded Fittings, Classes 125 and 250.
 - 9. B16.21 – Nonmetallic Flat Gaskets for Pipe Flanges.
 - 10. B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 11. B16.24 – Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500, and 2500.
 - 12. B16.25 – Butt Welding Ends.
 - 13. B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.
- C. API (American Petroleum Institute):
 - 1. 5L – Specification for Line Pipe.
- D. ASME (American Society of Mechanical Engineers):
 - 1. Boiler and Pressure Vessel Code, Section VITI, Division 1, Pressure Vessels.
 - 2. Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
 - 3. B31.1 – Power Piping.
 - 4. B31.3 – Process Piping.
 - 5. B31.9, –Building Services Piping.
 - 6. B36.10M – Welded and Seamless Wrought Steel Pipe.
- E. ASNT (American Society for Nondestructive Testing):
 - 1. SNT-TC-1A – Recommended Practice for Nondestructive Testing Personnel Qualifications.

- F. ASTM (American Society for Testing and Materials):
1. A47 – Standard Specification for Ferritic Malleable Iron Castings.
 2. A53 Rev A – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 3. A105 – Standard Specification for Carbon Steel Forgings for Piping Applications
 4. A106 – Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.
 5. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 6. A135 – Standard Specification for Electric-Resistance-Welded Steel Pipe.
 7. A139 Rev A – Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and over).
 8. A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 9. A181 Rev A – Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
 10. A182 Rev C – Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 11. A183 – Standard Specification for Carbon Steel Track Bolts and Nuts.
 12. A193 Rev A – Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 13. A194 – Standard Specification for Carbon Steel, Stainless Steel, and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or both.
 14. A197 – Standard Specification for Cupola Malleable Iron.
 15. A216 – Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
 16. A234 – Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Services.
 17. A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 18. A276 – Standard Specification for Stainless Steel Bars and Shapes.
 19. A283 Rev A – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 20. A285 – Standard Specification for Pressure Vessel Plates, Carbon Steel, Low and Intermediate Tensile Strength.
 21. A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
 22. A312 – Standard Specification for Seamless and Welded Austenitic Stainless-Steel Pipes.
 23. A320 – Standard Specification for Alloy Steel and Stainless-Steel Bolting Materials for Low-Temperature Service.
 24. A395 – Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 25. A403 Rev A – Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
 26. A409 – Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
 27. A536 – Standard Specification for Ductile Iron Castings.
 28. A563 – Standard Specification for Carbon and Alloy Steel Nuts.
 29. A587 – Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
 30. A774 – Standard Specification for As-Welded Wrought Austenitic Stainless-Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
 31. A778 Rev A – Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
 32. B32 – Standard Specification for Solder Metal.
 33. B43 – Standard Specification for Seamless Red Brass Pipe, Standard Sizes.

34. B61 – Standard Specification for Steam or Valve Bronzed Casting.
35. B62 – Standard Specification for Composition Bronzed or Ounce Metal Castings.
36. B75 – Standard Specification for Seamless Copper Tube.
37. B88 Rev A – Standard Specification for Seamless Copper Water Tube.
38. B98 – Standard Specification for Copper-Silicone Alloy Rod, Bar, and Shapes.
39. C582 – Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment.
40. D412 – Standard Testing Method for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
41. D413 – Standard Testing Methods for Rubber Property-Adhesion to Flexible Substrate.
42. D1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
43. D1784 – Standard Classification System and Basics for Specifications for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
44. D1785 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
45. D2000 – Standard Classification System for Rubber Products in Automotive Applications.
46. D2310 – Standard Classification for Machine-Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
47. D2464 – Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
48. D2466 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
49. D2467 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
50. D2564 – Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
51. D2665 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe for Drain, Waste, and Vent Pipe and Fittings, Schedule 40.
52. D2996 – Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
53. D3222 Rev A – Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
54. D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
55. D4101 Rev B – Standard Specification for Propylene Plastic Injection and Extrusion Materials.
56. F437 – Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
57. F439 Rev A – Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
58. F441 – Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
59. F491 Rev A – Standard Specification for Poly (Vinylidene Fluoride) (PVDF) Plastic-Lined Ferrous Metal Pipes, and Fittings.
60. F493 Rev A – Standard Specification for Solvent Cements for Chlorinated Poly Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
61. F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) based on outside diameter.

G. AWS (American Welding Society):

1. A5.8 – Specification for Filler Metals for Brazing and Braze Welding.
2. QC 1 – Specification for AWS Certification of Welding Inspectors.

H. AWWA (American Water Works Association):

1. C104/A21.4 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

2. C110/A21.10 – Ductile-Iron and Gray-Iron Fittings, 3 in. – 48 in. for Water and Other Liquids.
3. C111/A21.11 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. C115/A21.15 – Flanged Ductile-Iron Pipe with Threaded Flanges.
5. C151/A21.51 – Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
6. C153/A21.53 – Ductile-Iron Compact Fittings 3 in. – 16 in, for Water and Other Liquids.
7. C200 – Steel Water Pipe – 6 in. and Larger.
8. C205 – Cement-Mortar Protective Lining and Coating for Steel Water Pipe – 4 in. and Larger-Shop Applied.
9. C207 – Steel Pipe Flanges for Water Works Service, Sizes 4 in. – 144 in.
10. C208 – Dimensions for Fabricated Steel Water Pipe Fittings.
11. C213 – Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
12. C606 – Grooved and Shouldered Type Joints.
13. M11 – Steel Pipe – A Guide for Design and Installation.

- I. MSS (Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.):
 1. SP 43 – Wrought Stainless Steel Butt-Welding Fittings Including Reference to Other Corrosion Resistant Materials.
- J. NFPA (National Fire Protection Association):
 1. 24 – Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.3 DEFINITIONS

- A. Submerged or Wetted:
 1. Zone below elevation of:
 - a. Top face of channel walls and cover slabs.
 - b. Top face of basin walkways.
 - c. Top face of clarifier walkways.
 - d. Top face of digester walls, including structure piping penetrations.
 - e. Liquid surface or within 2 feet above top of liquid surface.
 - f. Top of tank wall or under tank cover.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 1. Shop Fabricated Piping:
 - a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
 - b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
 2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
 3. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
 4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
 5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
 6. Gasket material, temperature rating, and pressure rating for each type of pipe and each type of service.
- C. Quality Control Submittals:
 1. Manufacturer's Certification of Compliance.

2. Qualifications:
 - a. Weld Inspection and Testing Agency: Certification and qualifications.
 - b. Welding Inspector:
 - 1) Certification and qualifications.
 - c. Welders:
 - 1) List of qualified welders and welding operators.
 - 2) Current test records for qualified welder(s) and weld type(s) for factory and field welding.
3. Weld Procedures:
 - a. Records as specified in ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
4. Nondestructive inspection and testing procedures.
5. Manufacturer's Certification of Compliance:
 - a. Pipe and fittings.
 - b. Factory applied resins and coatings.
6. Certified weld inspection and test reports.
7. Test logs.

1.5 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water:
 1. Certified to NSF 61 and NSF 372.
- B. Weld Inspection and Testing Laboratory Qualifications:
 1. Retain approved independent testing laboratory that will provide the services of an AWS certified welding inspector qualified as specified in AWS QC1 with prior inspection experience of welds specified herein.
 2. Perform weld examinations with qualified testing personnel who will carry out radiography, ultrasonic, magnetic particle, and other nondestructive testing methods as specified herein.
 3. Welding Inspector:
 - a. Be present when shop or field welding is performed to certify that welding is as specified in specified standards and requirements.
 - b. Duties include, but are not limited to:
 - 1) Job material verification and storage.
 - 2) Qualification of welders.
 - 3) Certify conformance with approved welding procedure specifications.
 - 4) Maintain records and prepare reports in a timely manner.
 - 5) Notify Engineer within 1 hour of discovery of unsatisfactory weld performance and within 24 hours of weld test failure.
 - 6) Supervision of testing personnel.
- C. Welder and Welding Operator Performance:
 1. Qualify welders and welding operators by approved testing laboratory before performing any welding under this section.
 2. Perform welder qualification tests as specified in Section IX, Article III of the ASME Boiler and Pressure Vessel Code.
 3. Qualification tests may be waived if evidence of prior qualification is deemed suitable by the Engineer.
 4. Qualify welders and operators in the performance of making groove welds in each different pipe material, including carbon steel pipe, in Positions 2G and 5G for each welding process to be used.
 5. Qualify welders and welding operators for stainless steel as stated herein on the type of stainless steel being welded with the welding process used.
- D. Certifications:

1. Coal-Tar Epoxy Applicator:
 - a. Certified by Piping Manufacturer to be qualified to apply coal-tar epoxy coating to submerged or embedded ductile iron or cast-iron soil piping.
2. Weld Testing Agency:
 - a. Certified as specified in current American Society for Nondestructive Testing (4153 Arlingate Plaza, Columbus, OH 43228) recommended practice SNT-TC-1A, NDT Level II.

E. Quality Control Submittals:

1. Manufacturer's Certification of Compliance.
2. Laboratory Testing Equipment:
 - a. Certified calibrations, Manufacturer's product data, and test procedures.
3. Certified welding inspection and test results.
4. Qualifications:
 - a. Weld Inspection and Testing Agency:
 - 1) Certification and qualifications.
 - b. Welding Inspector:
 - 1) Certification and qualifications.
 - c. Welders:
 - 1) List of qualified welders and welding operators.
 - 2) Current test records for qualified welder(s) and weld type(s) for factory and field welding.
5. Weld Procedures:
 - a. Records as specified in ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
6. Nondestructive inspection and testing procedures.
7. Manufacturer's Certification of Compliance:
 - a. Pipe and fittings.
 - b. Welding electrodes and filler materials.
 - c. Factory applied resins and coatings.
8. Certified weld inspection and test reports.
9. Pipe coating applicator certification.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 01 60 00 – Product Requirements.
- B. Flanges:
 1. Securely attach metal, hardboard, or wood protectors over entire gasket surface.
- C. Threaded or Socket Welding Ends:
 1. Fit with metal, wood, or plastic plugs or caps.
- D. Linings and Coatings:
 1. Prevent excessive drying.
- E. Cold Weather Storage:
 1. Locate products to prevent coating from freezing to ground.
- F. Handling:
 1. Use heavy canvas or nylon slings to lift pipe and fittings.

1.7 WARRANTIES

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 PIPING

- A. As specified on Piping Data Sheet(s) and section 40 23 39.1 - Process Piping Schedule located at the end of this section as Supplement.
- B. Diameters Shown:
 - 1. Standardized Products: Nominal size.
 - 2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME 836.10M.
 - 3. Cement-Lined Steel Pipe: Lining inside diameter.

2.2 JOINTS

- A. Grooved End System:
 - 1. Rigid, except where joints are used to correct misalignment, to provide flexibility, or where shown, furnish flexible type.
 - 2. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.
- B. Flanged Joints:
 - 1. Flanges for ductile iron pipe shall conform to AWWA C115 at pressure rating meeting requirements of the connecting piping.
 - 2. Flanges for steel pipe shall conform to ANSI/ASME B16.5 at pressure rating meeting requirements of the connecting piping.
 - 3. Higher pressure rated flanges as required, to mate with equipment when equipment flange is of higher-pressure rating than required for piping.
- C. Threaded Joints:
 - 1. NPT taper pipe threads as specified in ANSI B 1.20. 1.
- D. Thrust Tie-Rod Assemblies:
 - 1. NFPA 24; tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.
- E. Mechanical Joint Anchor Gland Follower:
 - 1. Ductile iron anchor type, wedge action, with break off tightening bolts.
 - 2. Manufacturer and Product:
 - a. EBAA Iron Inc. – Megalug (3 in.– 54 in.)
- F. Flexible Mechanical Compression Joint Coupling:
 - 1. Stainless steel, ASTM A276, Type 305 bands.
 - 2. Manufacturers:
 - a. Pipeline Products Corp.
 - b. Fernco Joint Sealer Co.
- G. Mechanical connections of the high-density polyethylene pipe to auxiliary equipment (valves, pumps, tanks, and other piping systems) shall be through flanged connections consisting of:
 - 1. A polyethylene stub end thermally butt-fused to the end of the pipe.
 - 2. ASTM A240, Type 304 stainless steel backing flange, 125 lbs, ANSI B16.1 Standard. Insulating flanges shall be used where shown.
 - 3. Bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to the Manufacturer's standard. Retorque the nuts after 4 hours.
 - 4. Gaskets as specified on Data Sheet.

5. Connection to buried mechanical joint fittings and valves shall be by restrained mechanical joint follower glad designed for HDPE pipe. Provide stainless steel stiffener as required by pipe manufacturer.

2.3 COUPLINGS

- A. Steel Middle Rings and Followers:
 1. Fusion bonded, epoxy-lined, and coated as specified in Section 09 96 00 – High Performance Coatings.
- B. Flexible Couplings:
 1. Manufacturers and Products:
 - a. Steel Pipe:
 - 1) Dresser – Style 38 (1/2 in. & Larger)
 - 2) Smith-Blair – Style 411 (1/2 in. – 60 in.)
 - 3) Romac – 501 (2 in. – 24 in.)
 - b. Ductile Iron Pipe:
 - 1) Dresser – Style 38 (14 in. & Larger)
 - 2) Smith-Blair – Style 411 (1/2 in. – 60 in.)
 - 3) Romac – 501 (2 in. – 24 in.)
- C. Transition Couplings:
 1. Manufacturers and Products:
 - a. Dresser – Style 62 (3 in. – 24 in.)
 - b. Smith-Blair – Style 413 (2 in. – 48 in.)
 - c. Romac – RC501 (3 in. – 24 in.)
- D. Flanged Coupling Adapters:
 1. Manufacturers and Products:
 - a. Steel Pipe:
 - 1) Smith-Blair – Series 913 (3 in. & Larger)
 - 2) Dresser Industries, Inc. – Style 128-W (3 in. – 24 in.)
 - 3) Romac – FC400 (12 in. – 96 in.)
 - b. Ductile Iron Pipe:
 - 1) Smith-Blair – Series 912 (3 in. – 12 in.)
 - 2) Dresser Industries, Inc. – Style 128-W (3 in. – 24 in.)
 - 3) Romac – FCA501 (3 in. – 16 in.)
- E. Dismantling Joints:
 1. Manufacturers and Products:
 - a. Steel or Ductile Iron Pipe:
 - 1) Smith-Blair – Series 975 (3 in. & Larger)
 - 2) Dresser Industries, Inc. – Style 131 (4 in. – 24 in.)
 - 3) Romac – DJ400 (3 in. – 72 in.)

2.4 HARDWARE

- A. All hardware on submerged piping or piping below the top elevation of tanks and directly exposed to water, wastewater and/or wastewater solids, including but not limited to bolts, nuts, washers, and threaded rod shall be stainless steel.

2.5 GASKET LUBRICANT

- A. Lubricant shall be supplied by pipe Manufacturer and no substitute or “or equal” will be allowed.

2.6 DOUBLE WALL CONTAINMENT PIPING SYSTEM

- A. All system components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.7 THRUST RESTRAINT

- A. Buried piping shall be restrained joint piping unless specified otherwise or when connecting to existing pipelines. When connecting to existing pipelines concrete thrust blocking shall be used as specified in Section 03 30 00 – Cast-In-Place Concrete.
- B. All above grade piping shall be adequately restrained and supported.

2.8 VENT AND DRAIN VALVES

- A. Pipeline 2 1/2 in. Diameter and Larger:
 - 1. Vent connections shall be 3/4 in. with V300 ball valve. Drain connection shall be 1 in. with V300 ball valve, unless shown otherwise.
- B. Pipeline 2 in. Diameter and Smaller:
 - 1. Vent connections shall be 1/2 in. with V300 ball valve. Drain connection shall be 1 in. with V300 ball valve, unless shown otherwise.
- C. Provide galvanized steel pipe plug in each ball valve.

2.9 FABRICATION

- A. Mark each pipe length on outside:
 - 1. Size or diameter and class.
 - 2. Manufacturer's identification and pipe serial number.
 - 3. Location number on laying drawing.
 - 4. Date of manufacture.
- B. Code markings as specified in approved Shop Drawings.
- C. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the site with flanges in place and properly faced.
 - 1. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the Manufacturer.

2.10 FINISHES

- A. Factories prepare, prime, and finish coat as specified in Pipe Data Sheet(s), Piping Schedule, and Section 09 96 00 – High Performance Coatings.
- B. Galvanizing:
 - 1. Hot-dip applied, meeting requirements of ASTM A153.
 - 2. Electroplated zinc or cadmium plating is unacceptable.
 - 3. Stainless steel components may be substituted where galvanizing is specified.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.
- B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.
- C. Welding Electrodes:
 - 1. Verify proper grade and type, free of moisture and dampness, and coating is undamaged.

3.2 PREPARATION

- A. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.
- B. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
- C. Damaged Coatings and Linings:
 - 1. Repair using original coating and lining materials as specified in Manufacturer's instructions, except for damaged glass-lined pipe or PVDF-lined pipe that is to be promptly removed from the site.

3.3 WELDING

- A. Perform as specified in Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.1 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting Manufacturer.
- B. Weld Identification:
 - 1. Mark each weld with symbol identifying welder.
- C. Pipe End Preparation:
 - 1. Machine Shaping:
 - a. Preferred.
 - 2. Oxygen or Arc Cutting:
 - a. Smooth to touch, true, and slag removal by chipping or grinding.
 - 3. Beveled Ends for Butt Welding:
 - a. ANSI B16.25.
- D. Surfaces:
 - 1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
 - 2. Clean stainless-steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
 - 3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.
- E. Alignment and Spacing:
 - 1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
 - 2. Root Opening of Joint:
 - a. As stated in qualified welding procedure.
 - 3. Minimum Spacing of Circumferential Butt Welds:

- a. Minimum four times pipe wall thickness or 1 in, whichever is greater.
- F. Climatic Conditions:
 - 1. Do not perform welding if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32°F.
 - 2. Stainless Steel and Alloy Piping:
 - a. If the ambient is below 32°F, local preheating to a temperature warm to the hand is required.
- G. Tack Welds:
 - 1. Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.
- H. Surface Defects:
 - 1. Chip or grind out those affecting soundness of weld.
- I. Weld Passes:
 - 1. As required in welding procedure.
- J. Weld Quality:
 - 1. Free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of limits shown in applicable piping code.
- 3.4 INSTALLATION – GENERAL
 - A. Join pipe and fittings as specified in Manufacturer's instructions, unless otherwise shown or specified.
 - B. Remove foreign objects prior to assembly and installation.
 - C. Flanged Joints:
 - 1. Install perpendicular to pipe centerline.
 - 2. Bolt Holes:
 - a. Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
 - 3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
 - 4. Plastic Flanges:
 - a. Install annular ring filler gasket at joints of raised-face flange.
 - 5. Raised-Face Flanges:
 - a. Use flat-face flange when joining with flat-faced ductile or cast iron flange.
 - D. Threaded and Coupled Joints:
 - 1. Conform to ANSI B1.20.1.
 - 2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
 - 3. Countersink pipe ends, ream and clean chips and burrs after threading.
 - 4. Make connections with not more than three threads exposed.
 - 5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.
 - E. Soldered Joints:
 - 1. Use only solder specified for particular service.

2. Cut pipe ends square and remove fins and burrs.
 3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
 4. Wipe excess solder from exterior of joint before hardened.
 5. Before soldering, remove stems and washers from solder joint valves.
- F. Couplings:
1. General:
 - a. Install as specified in Manufacturer's written instructions.
 - b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
 - c. Remove pipe coating if necessary to present smooth surface.
 2. Application:
 - a. Metallic Piping Systems:
 - 1) Flexible couplings, transition couplings, and flanged coupling adapters.
 - b. Nonmetallic Piping Systems:
 - 1) Teflon bellows connector.
 - c. Concrete Encased Couplings:
 - 1) Sleeve type coupling.
 - d. Corrosive Service Piping:
 - 1) Elastomer bellows connector.
 - e. Grit Slurry Piping:
 - 1) Elastomer bellows connector.
- G. Pipe Connections at Concrete Structures:
1. As specified in Section 40 05 06 – Process Piping Specialties.
- H. Penetrations:
1. Watertight Penetrations:
 - a. Provide wall pipes with thrust collars, as specified in Section 40 05 06 – Process Piping Specialties.
 - b. Provide taps for stud bolts in flanges to be set flush with wall face.
 2. Nonwatertight Penetrations:
 - a. Pipe sleeves with seep ring as specified in Section 40 05 06 – Process Piping Specialties.
 - b. Pipe sleeves with modular mechanical seal may be provided where fabrication of seep ring on pipe sleeve is impractical.
 3. Existing Walls:
 - a. Rotary drilled holes with modular mechanical seal as specified in Section 40 05 06 – Process Piping Specialties.
 4. Fire-Rated or Smoke-Rated Walls, Floor, or Ceilings: Insulated and encased pipe sleeves as specified in Section 40 05 06 – Process Piping Specialties.
- I. PVC and CPVC Piping:
1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
 2. Use strap wrench for tightening threaded plastic joints. Do not over tighten fittings.
 3. Do not thread Schedule 40 pipe.
- J. Ductile Iron, Cement-Lined Ductile Iron, and Glass-Lined Ductile Iron Piping:
1. Cutting Pipe:
 - a. Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter.
 - b. DO NOT flame cut.
 2. Dressing Cut Ends:
 - a. General:
 - 1) As required for the type of joint to be made.
 - b. Rubber Gasketed Joints:

- 1) Remove sharp edges or projections.
- c. Push-On Joints:
 - 1) Bevel, as recommended by pipe Manufacturer.
- d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End
- e. Pipe Couplings:
 - 1) As recommended by the coupling or adapter Manufacturer.

3.5 INSTALLATION–EXPOSED PIPING

- A. Piping Runs:
 - 1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
 - 2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.
- B. Supports:
 - 1. As specified in Section 40 05 07 – Hangers and Supports for Process Piping.
- C. Group piping wherever practical at common elevations; installing to conserve building space and not interfere with use of space and other work.
- D. Unions or Flanges:
 - 1. Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.
- E. Install piping so that no load or movement more than that stipulated by equipment Manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.
- F. Piping clearance, unless otherwise shown:
 - 1. Over Walkway and Stairs:
 - a. Minimum of 7 ft 6 in, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 - 2. Between Equipment or Equipment Piping and Adjacent Piping:
 - a. Minimum 3 ft 0 in, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 - 3. From Adjacent Work:
 - a. Minimum 1 in. from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 - 4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
 - 5. Head room in front of openings, doors, and windows shall not be less than the top of the opening.
 - 6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
 - 7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.6 INSTALLATION–BURIED PIPE

- A. Joints:
 - 1. Dissimilar Buried Pipes:
 - a. Provide flexible mechanical compression joints for pressure pipe.

- b. Provide concrete closure collar for gravity and low pressure (maximum 10 psi) piping or as shown on Drawings.
 - 2. Concrete Encased or Embedded Pipe:
 - a. Do not encase joints in concrete unless specifically shown.

B. Placement:

- 1. Keep trench dry until pipe laying and joining are completed.
- 2. Pipe Base and Pipe Zone:
 - a. As specified in Section 31 23 23.16 – Trench Backfill.
- 3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
- 4. Measure for grade at pipe invert, not at top of pipe.
- 5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
- 6. Prevent foreign material from entering pipe during placement.
- 7. Close and block open end of last pipe section laid when placement operations are not in progress and at close of day's work.
- 8. Lay pipe upgrade with bell ends pointing in the direction the pipe is laying.
- 9. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
- 10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
 - a. Shorter pipe lengths.
 - b. Special mitered joints.
 - c. Standard or special fabricated bends.
- 11. After joint has been made, check pipe alignment and grade.
- 12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
- 13. Prevent uplift and floating of pipe prior to backfilling.

C. PVC and CPVC Pipe Placement:

- 1. Lay pipe snaking from one side of trench to other.
- 2. Offset:
 - a. As recommended by Manufacturer for maximum temperature variation between time of solvent welding and during operation.
- 3. Do not lay pipe when temperature is below 40°F, or above 90°F when exposed to direct sunlight.
- 4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

- 1. Deflection from Horizontal Line, Except PVC, CPVC, or HDPE:
 - a. Maximum 2 in.
- 2. Deflection from Vertical Grade:
 - a. Maximum 1/4 in.
- 3. Joint Deflection:
 - a. Maximum of 75% of Manufacturer's recommendation.
- 4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 ft from position shown.
- 5. Pipe Cover:
 - a. Minimum 5 ft, unless otherwise shown on Drawings.

3.7 THRUST RESTRAINT

A. Location:

- 1. Buried Piping:

- a. At pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.
 - 2. Exposed Piping:
 - a. At all joints in pressure piping.
- B. Thrust Ties:
 - 1. Install as detailed.
 - 2. Anchoring retainer glands or thrust ties with setscrews is unacceptable.
- C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping:
 - 1. Install pipe joint Manufacturer's adapter gland follower and pipe end retainer or thrust tie-rods and socket clamps.
- D. Thrust Blocking:
 - 1. Place between undisturbed ground and fitting to be anchored.
 - 2. Quantity of Concrete:
 - a. Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
 - 3. Place blocking so that pipe and fitting joints will be accessible for repairs.
 - 4. Place concrete as specified in Section 03 30 00 – Cast-In-Place Concrete.

3.8 BRANCH CONNECTIONS

- A. DO NOT install branch connections smaller than 1/2 in. nominal pipe size, including instrument connections, unless shown otherwise.
- B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.
- C. Threaded Pipe Tap Connections:
 - 1. Ductile Iron Piping:
 - a. Connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.
 - 2. Welded Steel or Alloy Piping:
 - a. Connect only with welded thread-o-let or half-coupling as specified on Piping Data Sheet.
 - 3. Limitations:
 - a. Threaded taps in pipe barrel are unacceptable.

3.9 VENTS AND DRAINS

- A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install the vents on high points, and drains on low points of pipelines, whether shown or not.

3.10 CLEANING

- A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.
- B. Blow clean of loose debris in plant process air, natural gas, and instrument air-lines with compressed air at 4,000 fpm; do not flush with water.

- C. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.
- D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.
- E. Remove accumulated debris through drains 2 in. and larger or by removing spools and valves from piping.

3.11 DISINFECTION

- A. Disinfect pipelines intended to carry potable water (W1).
- B. See Section 33 13 00 – Disinfection of Water Systems.

3.12 FIELD FINISHING

- A. Notify Engineer at least 3 days prior to start of any surface preparation or coating application work.
- B. As specified in Section 09 96 00 – High Performance Coatings.

3.13 PIPE IDENTIFICATION

- A. As specified in Section 09 96 00 – High Performance Coatings.
- B. As specified in Section 22 05 53 – Mechanical Identification.

3.14 INSULATION

- A. As specified in Section 40 42 00 – Process Mechanical Insulation.

3.15 HEAT TRACING

- A. As specified in Section 40 41 13 – Heat Tracing.

3.16 FIELD QUALITY CONTROL

- A. Pressure Leakage Testing:
 - 1. As specified in Section 40 05 00 – Piping Systems Testing.
- B. Minimum Duties of Welding Inspector:
 - 1. Job material verification and storage
 - 2. Qualifications of welders.
 - 3. Certify conformance with approved welding procedures.
 - 4. Maintenance of records and preparation of reports in a timely manner.
 - 5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.
- C. Required Weld Examinations:
 - 1. Perform Examinations as specified in Piping Code ASME B31.1.
 - 2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for all piping covered by this section.
 - 3. Examine at least one of each type and position of weld made by each welder or welder operator.

4. For each weld found to be defective under the acceptable standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above 3. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

3.17 SUPPLEMENTS

- A. The supplements listed below are a part of this section.
 1. Section 40 23 39.1 – Process Piping Schedule.
 2. Data Sheets:
 - a. Section 40 23 39.13 – DS – CM Lined DIP and Fittings
 - b. Section 40 23 39.16 – DS – Welded Steel Pipe and Fittings
 - c. Section 40 23 39.32 – DS – Steel Pipe
 - d. Section 40 23 39.36 – DS – SS Pipe and Fittings – General Service
 - e. Section 40 23 39.40 – DS – C900 Polyvinyl Chloride Pipe and Fittings
 - f. Section 40 23 39.43 – DS – Polyvinyl Chloride (PVC) Pipe and Fittings
 - g. Section 40 23 39.46 – DS – Chlorinated Polyvinyl (CPVC) Pipe & Fittings
 - h. Section 40 23 39.56 – DS – High Density Polyethylene Pipe and Fittings
 - i. Section 40 23 39.59 – DS – C906 (HDPE) Pipe and Fittings
 - j. Section 40 23 39.61 – DS – Fiber Reinforced Pipe and Fittings
 - k. Section 40 23 39.72 – DS – Polytetrafluoroethylene (PTFE) Tubing
 - l. Section 40 23 39.73 – DS – Polyethylene (PET) Tubing
 - m. Section 40 23 39.76 – DS – PVC Tubing

END OF SECTION

**SECTION 40 23 39.1
PROCESS PIPING SCHEDULE**

Service	Flow Stream Identifier	Installation (Note 1)	Nominal Diameter (Note 2)	Material (Note 3)	Coating (Note 8)	Spec/Data Sheet No.	Max Operating Temp (°F)	Max Operating Pressure (psig)	Test Pressure (psig) & Method (Note 4)	Pipe Color (Note 5)	Remarks
Aluminum Chlorohydrate	ACH	Exposed	All	PVC		40 23 39.43	Ambient	20	35, HH		
Cationic Polymer	CPO	Exposed	All	PVC and PVC Tubing		40 23 39.43 40 23 39.60	Ambient	20	35, HH		
Hydrofluorosilicic Acid	HFS	Exposed	All	CPVC and PTFE Hose		40 23 39.46 40 23 39.63	Ambient	20	35, HH		
Sodium Hydroxide (Caustic Soda)	SHX	Exposed	All	CPVC and PTFE Hose		40 23 39.46 40 23 39.63	Ambient	30	45, HH		
Utility Water (Non-Potable)	W2	Exposed	All	PVC		40 23 39.43	Ambient	70	105, HH	Blue	

Notes:

1 Encased – Buried piping under concrete slabs, and/or structures shall be concrete encased per standard detail D40/2400-009 unless specified otherwise in Drawings. Exposed – Inside/Outside Submerged – Below Liquid Surface 2 Buried – Directly into Soil > Greater Than < Less Than <= Less Than or Equal To >= Greater Than or Equal To 3 BS – Black Steel CELDI – Ceramic Epoxy Lined Ductile Iron CLDI – Cement Lined Ductile Iron CPVC – Chlorinated Polyvinyl Chloride GLDI – Glass Lined Ductile Iron CU – Copper DWV – Drain Waste Vent HDPE – High Density Polyethylene MDPE – Medium Density Polyethylene STL – Carbon Steel (AWWA C222) SST – Stainless Steel FL PVC – Flanged Polyvinyl Chloride Pipe PO PVC – Push on Joint Polyvinyl Chloride Pipe CLSTL – Cement Lined Welded Steel (AWWA C205) SW PVC – Solvent Weld Polyvinyl Chloride Pipe PTFE – Polytetrafluoroethylene	4 P – Pneumatic Test G – Gravity Piping AM – Air Method HH – High Head LH – Low Head LP – Low-Pressure Pneumatic Test See Section 40 05 00 – Piping Systems Testing for requirements. Pipe testing required as specified above. 5 See Section 09 96 00 for required painting. For buried piping, no color shall be required; coordinate for proper coatings, as necessary. Where no color is specified, color to be selected by Owner. For exposed piping not coated, provide colored banding and identification. 6 General – Deviations from this schedule are specified in Drawing notes. 7 General – The piping material shall be specified by requirements for the service listed being drained or vented. 8 EPP – Epoxy and Polyurethane Coating System HSE – High Solids Epoxy CTP – Coal Tar Pitch HT – High Temperature

Remarks:

- 1 Where buried piping transitions to exposed PVC piping, the buried piping shall be extended at least 6 in. above the floor before transitioning to exposed PVC piping.
- 2 Natural gas piping shall be tested as specified in Section 406 of the International Fuel Gas Code.
- 3 FL PVC, PO PVC, or SW PVC where shown.
- 4 Heat trace and insulate all outside piping as specified in Section 40 41 13 – Heat Tracing.
- 5 Buried is flexible tubing in PVC carrier.
- 6 Provide 316 SS unless connection with existing piping is 304 SS. In the case that the connection with existing piping is 304 SS, provide 304 SS.
- 7 Make sure of chemical compatibility for all CPVC welding agents.

END OF SECTION

**SECTION 40 23 39.43
POLYVINYL CHLORIDE PIPE AND FITTINGS**

Item	Size	Description
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 23447-B as specified in ASTM D1785-05. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule 80 PVC: as specified above and in ASTM D2467.
Joints	All	Solvent socket-weld except where connection to valves and equipment may require future disassembly. Threaded joints shall NOT be used unless specifically approved by Engineer.
Flanges	All	One-piece, molded hub type PVC flat face flange as specified in Fittings above, 125 lb. ANSI B16.1-89 drilling.
Bolting	All	Flat Face Mating Flange or In Corrosive Areas: ASTM A193 Rev A-94 Type 316 stainless steel Grade B8M hex head bolts and ASTM A194-94 Grade 8M hex head nuts. With Raised Face Mating Flange: Carbon steel ASTM A307-94 Grade B square head bolts and ASTM A563-93 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8 in. thick. Raised Face Mating Flange: Flat ring 1/8 in. thick, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Gasket material shall be suitable for each service. Submit recommended gasket material for each service to Engineer.
Solvent Cement	All	As specified by the pipe and fitting manufacturer and in ASTM F493 Rev A. Solvent cement shall be rated for use with each service. Provide manufacturer's certification that the solvent is appropriate for respective service.
Thread Lubricant	All	Teflon Tape

END OF SECTION

**SECTION 40 23 39.46
CHLORINATED POLYVINYL CHLORIDE PIPE AND FITTINGS**

Item	Size	Description
Pipe	All	Schedule 80 CPVC: Type IV, Grade I or Class 23447-B as specified in ASTM D1784 and ASTM DF441. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule 80 CPVC as specified above: As specified in ASTM F439 Rev A for socket-weld type and ASTM F437 for threaded type.
Joints	All	Solvent socket-weld except where connection to valves and equipment may require future disassembly. Threaded joints shall NOT be used unless specifically approved by Engineer.
Flanges	All	One-piece, molded hub type CPVC flat face flange as specified in Fittings above, 125 lb. ANSI B16.1-89 drilling.
Bolting	All	Flat Face Mating Flange or In Corrosive Areas: ASTM A193 Rev A-94 Type 316 stainless steel Grade B8M hex head bolts and ASTM A194-94 Grade 8M hex head nuts. With Raised Face Mating Flange: Carbon steel ASTM A307-94 Grade B square head bolts and ASTM A563-93 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8 in. thick. Raised Face Mating Flange: Flat ring 1/8 in. thick, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Gasket material shall be suitable for each service. Submit recommended gasket material for each service to Engineer.
Solvent Cement	All	As specified by the pipe and fitting manufacturer and in ASTM F493 Rev A. Solvent cement shall be rated for use with each service. Provide manufacturer's certification that the solvent is appropriate for respective service.
Thread Lubricant	All	Teflon Tape

END OF SECTION

**SECTION 40 23 39.60
DATA SHEET REINFORCED PVC TUBING**

Item	Description		
Pipe	PVC tubing with braided polyethylene reinforcement. Tubing shall comply with the regulations of the FDA for materials used with potable water or in contact with food products. Tubing shall have a constant wall thickness with the interior surface glossy smooth.		
Material	Property	Value or Rating	ASTM method
	Minimum Working Pressure	100 psi (@ 70°F) 70 psi (@ 160°F)	
	Minimum Safety Factor	3:1	
	Minimum Burst Pressure	645 psi	
	Max Operating Temperature	165°F	
	Brittle Temperature	(-50)°F	D746-98
	Durometer Hardness (Shore)	80A (±5)	D2240-02
	Tensile Strength	2,500 psi	D412-98
	Ultimate Elongation	320%	D412-98
	Specific Gravity	1.2	D792-98
	Water Adsorption	0.12%	D570-98
Fittings	Barbed PVC with SST hose clamps.		

END OF SECTION

SECTION 40 23 39.63 DATA SHEET POLYTETRAFLUOROETHYLENE HOSE			
Item	Description		
Pipe			
Material	Property	Value or Rating	ASTM method
	Minimum Working Pressure	100 psi (@ 70°F) 70 psi (@ 160°F)	
	Minimum Safety Factor	4:1	
	Working Pressure	50 psi (@75 deg F)	
	Max Operating Temperature	130°F	
Fittings	Contractor shall provide manufacturer's recommended fittings based on fluid and service conditions. Fittings to be supplied by manufacturer of hose. Acceptable fittings include compression fittings or push-to-connect fittings.		

END OF SECTION

SECTION 40 61 13 – PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work to furnish all materials, labor, equipment, tools, supplies, and incidentals necessary for the installation and testing of all process control systems.
- B. Related Sections:
 - 1. Section 40 67 23 – Control Panels
 - 2. Section 40 68 63 – DCS and OWS Programming
 - 3. Section 40 70 00 – Instrumentation for Process Systems

1.2 DEFINITIONS:

- A. OWS:
 - 1. Operator Workstation (Operator Monitor and Control Process through Graphical Displays)
- B. OIT:
 - 1. Operator Interface Terminal
- C. DCS:
 - 1. Distributed Control System
- D. I/O:
 - 1. Input/Output
- E. INFI-NET (Plant Loop):
 - 1. Bailey/Harmony redundant token-passing control network interconnecting controllers, I/O, and gateways.
- F. VFD:
 - 1. Variable Frequency Drive
- G. SSRVS:
 - 1. Solid State Reduced Voltage Starter ("Soft Starter")
- H. RTU:
 - 1. Remote Telemetry Unit
- I. MTU:
 - 1. Master Telemetry Unit
- J. MCC:
 - 1. Motor Control Center
- K. Operating Program:
 - 1. Operating system, Operator Workstation, or other core software.
- L. Integrated Operating Platform:
 - 1. System of installed, connected, and configured hardware, operating programs, and networking equipment.

- M. DCS and OWS Programming:
 - 1. Software configuration of operating programs to implement process control strategies.
 - N. Control System Specialist:
 - 1. A company specializing in process control hardware and software, including instrumentation, DCS, networking, installation, and configuration.
 - O. Controlway:
 - 1. Backplane bus within Harmony/INFI 90 I/O racks
 - P. Composer for Harmony (Programming Tool):
 - 1. ABB engineering/configuration environment for Harmony/INFI 90.
 - Q. OPC Gateway:
 - 1. ABB Harmony/INFI 90 OPC (DA/UA) server or S+ Operations interface for HMI/SCADA connectivity.
 - R. Harmony Controller:
 - 1. Primary controller class used in INFI 90 systems.
- 1.3 SUBMITTALS
- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
 - B. Product Data:
 - 1. Instrument Installation Details.
 - 2. Certified Calibration Sheets.
 - 3. Complete and detailed instruction manuals on each item furnished including but not limited to all devices and instruments. Information to be contained in the instruction manuals shall include but not be limited to drawings, dimensions, manufacturer's recommendations, ratings, performance charts, power requirements, schematics, maintenance requirements and procedures, calibration recommendations and procedures, repair instructions, complete and recommended spare parts lists and related information.
 - 4. Proposed tagging and attachment materials and methods.
 - 5. INFI-NET topology (redundancy, drops, media, and node addresses).
 - 6. Rack and module BOMs
 - 7. OPC/OWS interface details
 - C. Shop Drawings:
 - 1. Shall be submitted for approval by the Engineer.
 - 2. The Contractor shall submit to the Engineer, for approval, Shop Drawings of the equipment to be installed to meet the sections. The Drawings shall be supported by notes or written directions as required to fully define the installation. The submission shall be made as soon as feasible after award of the Contract and, in any event, shall be submitted and approval obtained before installation of the equipment.
 - 3. The information required on the Shop Drawings shall include, but is not necessarily limited to:
 - a. Full and complete specifications covering the equipment proposed to be furnished.
 - b. Detail Drawings showing plan, network connections and elevation dimensions of the equipment proposed to be furnished.
 - c. Guarantees of performance of the equipment proposed to be furnished.
 - d. Nearest location of factory maintenance and service facilities that will be available to service the equipment offered.

- e. To scale plans, sections and elevations detailing entire installation. Include mounting hardware, brackets, assemblies, and other devices as required for a complete installation.
 - f. INFI-NET network drawings
 - g. Harmony rack elevations
 - h. Marshalling details
 - 4. Control panels:
 - a. Panel and subpanel layout
 - b. Point-to-Point Wiring and Interconnection Diagrams
 - c. System hardware
- D. Contract Closeout Submittals:
 - 1. Project Record Documents
 - 2. Operating and Maintenance Data
 - 3. Warranty
 - a. See Section 01 78 36 – Warranties and Bonds for additional requirements.
 - 4. Final as-built copies of documented DCS and OWS programs for vendor supplied equipment packages, on electronic media, suitable for future troubleshooting or modifications by others.
 - 5. Deliver composer project, exported tag list, OPC address map, and controller images/backups.
 - 6. OWS handoff, if OWS is 800xA or a 3rd-party OWS, include connection guide and tested node list.
 - 7. Firmware/versions matrix for all new equipment including but not limited to:
 - a. Controllers
 - b. I/O modules
 - c. Gateways
 - d. OPC server
- E. Instrumentation and control testing documents shall be submitted for approval by the Engineer:
 - 1. Credentials of technicians doing the inspection and testing.
 - 2. Written certification as detailed under testing requirements in this section.

1.4 QUALITY ASSURANCE

- A. The Contractor shall designate in writing the qualified Control System Specialist, including a detailed listing of the firm, resumes and work history of each person working on the project, and project specific references. The qualifications of the Control System Specialist shall be subject to approval of the Owner and the Engineer.
- B. The minimum qualifications for the Control System Specialist shall include:
 - 1. An established firm in operation as a control and automation company for a minimum of 5 years, with demonstrated water and wastewater industry experience.
 - 2. Staffed with experienced personnel capable of executing the required aspects of the project.
 - 3. Documented ABB Harmony/INFI-90 commissioning experience in water/wastewater industry and Composer proficiency.
 - 4. ABB-approved/authorized integrator for Harmony work.

1.5 SCOPE OF WORK

- A. The Contractor shall engage the services of a Control System Specialist, who shall furnish all materials, equipment, labor, and services to achieve a fully functional process control system for this project, except for those services specifically excluded herein to be provided by an Application Engineer.
 - 1. The Control System Specialist shall be ABB Group.

- B. The Control System Specialist shall be responsible for providing and installing all instrumentation, DCS controllers, computer equipment, networking equipment, and other control system hardware as specified for a complete process control system installation.
- C. In general, the Control System Specialist shall:
1. Provide Composer Harmony configuration, function-code logic, controller loading, OPC/S+ interface, and OWS screen development to implement process control of equipment described within Section 40 61 96 - Process Control Descriptions.
 2. Furnish, install, configure, and calibrate instrumentation as detailed on the drawings and in the sections.
 3. Fabricate and install all control panels as specified in Drawings, except for those provided as part of a vendor supplied equipment package. Terminate all field control wiring inside control panels.
 - a. Where existing control panels are being replaced with new, field investigate and develop as-builts of the existing instrumentation and control installation to identify and label all I/O and communication wiring entering the existing panels. The contractor shall be responsible for properly identifying and labelling all existing wiring and reconnecting to the new control panel. Perform point-to-point wiring checks and startup testing for reconnected existing components and wiring following the same requirements as new equipment.
 4. Provide all hardware required to properly communicate between all control panels and remote sites, whether or not explicitly identified in the drawings or sections.
 5. Install networking equipment and communication cables between control devices as specified in Drawings and sections. Provide configuration of equipment, including network switches and firewalls, to ensure proper communication between all devices associated with the integrated operating platform.
 6. Provide all instrumentation and control device relocation work associated with the relocation of equipment, including disconnecting all existing wiring and conduit and terminating, calibrating, and replacing service to relocated equipment.
 7. Modification to existing instrumentation and control systems as required to new and existing equipment to maintain process operations.
 8. Provide overall coordination, installation, supervision, and installation of control panels, instrumentation, computer hardware, networking systems, and other miscellaneous control system components as specified.
 9. Provide coordination with the Contractor and participate in all meetings as directed by the sections or Contractor.
 10. Execute the testing procedures outlined in this document.
- D. Vendor system packages may be provided under other sections of this contract that may interface with the process control system via communications protocol and/or hardwired I/O. Refer to the associated sections and the contract drawings for additional details. The Control System Specialist shall be responsible for coordination, furnishing, installing, and configuring any communication devices or drivers necessary to ensure proper communication with each of the vendor-furnished systems.
- E. Vendor system packages may include instrumentation or control panels that shall be installed and configured by the Control System Specialist as specified in vendor instructions. Upon satisfactory installation, configuration, and calibration, the Control System Specialist shall coordinate with each vendor to inspect finished work. The Control System Specialist shall submit documentation indicating that the vendor has inspected and approved the installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection:

1. Delivery, storage, and handling shall be as specified in Manufacturer's recommendation and the requirements of other sections herein.

1.7 PROJECT AND SITE CONDITIONS

A. Environmental Requirements:

1. Instrumentation and control elements may be installed outdoors exposed to sun, rain and excessive humidity and shall be capable of continuous operation without significant reduction of their operating life under the ambient conditions below:
 - a. Temperature:
 - 1) (-25)°C – 80°C
 - b. Pressure:
 - 1) 650 mm Hg – 800 mm Hg
 - c. Relative Humidity:
 - 1) 20% – 100% condensing
 - d. Vibration Frequency:
 - 1) 10 Hz – 2000 Hz
 - e. Vibration Position:
 - 1) 1.5 mm peak-to-peak
 - f. Vibration Acceleration:
 - 1) 10 G.

- B. Where the ratings of individual components cannot meet the requirements, provide suitable means of physical protection. Suitable physical protection shall consist of an assembly which meets the requirements listed, while limiting the ambient conditions at the non-conforming component to 90% of the component's rating (Example: A component rated for vibration at only 5 G. acceleration would be required to be combined with vibration isolation to limit the acceleration of the component to 4.5 G. when subjected to ambient acceleration of 10 G. from 10 Hz – 2000 Hz.).

C. Operating Environmental Conditions:

1. All instruments and control devices provided shall be rated for continuous operation in their installed operating environment and shall be capable of continuous operation at the operating conditions without significant reduction of their operating life.

- D. All controlling devices shall be NEMA or IEC rated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. All meters, instruments, control units, and other components shall be the most recent field proven models marketed by their respective manufacturers at the time of the submittal of the shop drawings unless otherwise specified to match existing equipment.
- B. Analog measurements and control signals shall be electrical and shall vary in direct linear proportion to the variable being measured. All analog signals whether inputs or outputs shall be 4 mA – 20 mA DC unless otherwise noted. The analog input signals shall maintain loop integrity with the installation of properly sized resistors across the input terminals. Provide surge protection for all analog signal terminations.
- C. All of the elements, instruments, accessories, and assemblies shall be installed as specified in the manufacturer's installation instructions, and as detailed on the Drawings. Shielded

instrumentation cables shall be used for all analog signals from the instruments to the DCS panels. Separate conduits shall be used for instrument power, instrument signals, and fiber optic cables.

- D. All instruments installed outdoors subject to direct sunlight shall include a stainless-steel sunshade.
- E. All digital outputs shall be isolated from the field equipment through an interposing relay. The relays shall be mounted inside the DCS cabinets.
- F. The Contractor shall make the necessary power connections and signal connections from the field devices (i.e., instruments, control valves, etc.) to the DCS cabinet.
- G. The Contractor shall configure and verify proper operation of the Integrated Operating Platform, included but not limited to:
 - 1. The computers, OITs, networking hardware, surge protection devices, uninterruptible power supplies, and other incidental equipment shall be configured and installed as shown on the Drawings and as specified herein.
 - 2. All networked devices shall be configured for proper communication via the topology and protocol shown on the Drawings or specified herein.
 - 3. Verify that all system devices power up, function, and properly communicate prior to commencing any startup or testing procedures as described herein.

3.2 SYSTEM WIRING COORDINATION

- A. The Control System Specialist shall develop complete point-to-point interconnection wiring termination sheets for all control connections to be provided for the project. The sheets shall identify all external interconnecting wiring associated with all new control panels or existing control panels.
 - 1. Develop point-to-point interconnection wiring termination sheets for performance of the Work and to document terminations.
 - 2. Use information from shop drawings, record drawings, plan drawings, and field inspections to develop sheets. Contractor shall field investigate the existing installation to determine the connections for equipment that is to remain and reconnected.
 - 3. The interconnection wiring termination sheets shall include:
 - a. External wiring for each piece of equipment, panel, instrument, local control stations, and other field devices with an electrical connection.
 - b. Numbered terminal block identification for each wire termination.
 - c. Identification of the assigned wire numbers for all interconnections.
 - d. Conduit tags, terminal numbers, and pull box identifications through which wiring is routed between end points.
 - e. Identification equipment documents from which the wire numbering and termination information was obtained.
 - 4. Conduct point-to-point wiring checks to determine that wiring and terminations are installed in compliance with the point-to-point interconnection diagrams. The Control System Specialist shall document all wiring checks and signoff on completed wiring termination sheets. Submit signed documentation to Owner and Engineer.

3.3 TESTING AND INSTALLATION REQUIREMENTS

- A. Testing and Installation Requirements:
 - 1. The Contractor shall be required to coordinate the following services during construction related to the testing and installation of the process control system. The complete system testing shall include all DCS panels, computer systems, network devices, interconnecting cables, and other peripheral devices required for a complete and functional system. The testing of the system shall occur in stages as defined below. The Contractor shall

develop and submit proposed testing procedures and documentation for each test. Testing documentation shall include signature lines for representatives of the Control Systems Specialist, Engineer, and Owner. Signatures shall be provided for each portion of the test, including a final signoff indicating satisfactory completion of the entire test. Any deviations from the test procedure or corrections made during test must be recorded on the documentation and initialed by individual making the record. Testing documentation submittals must be approved by the Engineer prior to the scheduling of any actual tests.

B. Factory Readiness Test:

1. A Factory Readiness Test shall be performed for each control panel fabricated and provided by the Control System Specialist. The test will be witnessed by, at minimum, representatives of both the Engineer and Owner. Additional witnesses may be present at the Engineer or Owner's discretion. The Control System Specialist shall provide notice to the Engineer a minimum of thirty (30) days in advance of the test.
2. The purpose of the Factory Readiness Test is to verify that all hardware and wiring within the control panel has been properly constructed and ready for shipment to the project site, and to test the automatic and manual process control strategies through DCS and OWS programming. This control strategy portion of the testing will be primarily performed by the Application Engineer, with support from the Control System Specialist as needed.
3. The Control System Specialist shall assemble all hardware components within the specified enclosure, including the instruments, controllers, network components and other required items. This assembly shall be complete and considered suitable for field installation.
4. For the Factory Readiness Test, the Control System Specialist shall demonstrate that the control panel is suitable for field installation by powering up each item and testing for proper network connections. In addition, the Control System Specialist shall test each input and output for proper operation from each field connection point within the control panel. The Control System Specialist shall be responsible for all measurement and testing components required to complete the Factory Readiness Test.
5. The Control System Specialist shall be responsible for connecting test instruments to the DCS and verifying proper operation of each input and output. All wire and terminal numbers shall be checked for conformance with the submittal drawings during this Readiness Test.
6. Each analog I/O point shall be checked for proper operation from each field connection point in the control enclosure. The Control System Specialist shall simulate inputs and outputs in order to fully confirm the proper operation of each analog I/O. The loop tuning shall be performed on the controller using Composer, all final P/I/D values and anti-reset windup and bumpless transfer behavior shall be documented.
7. The Control System Specialist may load a test program in the DCS in order to facilitate the Factory Readiness Test.
8. Upon satisfactory completion of the control panel hardware and wiring portion of the test, the Application Engineer will load the DCS and OWS programming to begin functional testing of control strategies.
9. Each analog and discrete I/O signal will be checked through the DCS to the OWS screens to verify proper mapping of tags.
10. Functionality of the system will be checked to ensure conformance with process control strategies.
11. Process conditions and field equipment feedback will be simulated or forced in order to prove proper DCS response and logic functionality.
12. If during the Factory Readiness Test the Application Engineer, Engineer, or Owner finds that process control is not achievable due to errors in the control panel wiring or construction, the functional testing shall stop, and the Control System Specialist shall correct the work and repeat the Factory Readiness Test at no additional cost to the Owner.

13. The Control System Specialist shall submit completed testing documentation as record to the Engineer upon satisfactory completion of the Factory Readiness Test prior to shipment of the control panels to the project site.

C. Site Readiness Test:

1. A Site Readiness Test shall be performed after the installation of all control system components including DCS control panels, communications, control wiring, device configurations, instrument calibrations, motor controllers, and variable frequency controllers as specified in the Contract Documents. The test will be witnessed by, at minimum, representatives of both the Engineer and Owner. Additional witnesses may be present at the Engineer or Owner's discretion. The Control System Specialist shall provide notice to the Engineer a minimum of thirty (30) days in advance of the test.
2. The purpose of this test is for the Control System Specialist to verify:
 - a. All instruments have been properly configured and calibrated.
 - b. All field control wiring has been properly installed and terminated.
 - c. All DCS control panel hardware is operating and communicating properly.
 - d. The installation is ready for the Application Engineer to load DCS and OWS programming and begin functional process control testing.
3. Site Readiness Test shall include energization and testing for correct hardware integration of all system components, including DCS remote I/O assemblies, and reliable communications between components with correct protocols.
4. Provide point-to-point wiring checks for continuity between field devices to final DCS I/O terminations.
5. To the greatest extent possible, the Control System Specialist shall check I/O under process conditions to the end elements. For example, I/O for valve limit switches shall be checked by operating the valve to fully open and closed positions, rather than using jumpers or other means to simulate valve operation. Any testing performed that could upset or affect any live process shall be coordinated with the Owner.
6. Provide verification and documentation of normally closed or normally open contacts for discrete I/O signals.
7. Discrete inputs shall be tested by operating the end device to force a signal change. Observe results on all indicators such as DCS register, panel light, etc.
8. Discrete output signals shall be tested by forcing a value in the DCS register. Observe that the connected equipment properly responds.
9. Analog inputs shall be verified at 0%, 25%, 50%, 75%, and 100% of span. Observe results on all indicators such as DCS register, digital panel meters, etc.
10. Analog outputs shall be tested by entering values in the DCS register to force the outputs at 0%, 25%, 50%, 75%, and 100% of span. Observe that the connected equipment properly responds.
11. Personnel performing the test shall have International Society of Automation (ISA) Certified Control Systems Technicians (CCST) or equivalent credentials as approved by the Engineer or Owner.
12. The Control System Specialist shall submit completed testing documentation as record to the Engineer upon satisfactory completion of the Site Readiness Test.

D. Functional System Test:

1. Upon the Engineer's approval of the Site Readiness Test, the Application Engineer will load the DCS and OWS programming to begin functional testing of control strategies.
2. The test will be witnessed by, at minimum, representatives of both the Engineer and Owner. Additional witnesses may be present at the Engineer or Owner's discretion. Although the Control System Specialist must provide notice to the Engineer a minimum of thirty (30) days in advance of the test, the Functional System Test may be performed consecutively with the Site Readiness Test if approved by the Engineer and Owner ahead of time.

3. The purpose of the functional system testing is to implement and test the automatic and manual process control strategies through DCS and OWS programming. This testing will be primarily performed by the Control System Specialist.
4. For this test, all equipment shall be installed, calibrated, and functioning as required in the contract documents.
5. Each analog and discrete I/O signal will be checked through the DCS to the OWS screens to verify proper mapping of tags.
6. Functionality of the system will be checked to ensure conformance with process control strategies.
7. DCS control loops will be tuned to achieve stable process control.
8. If during the Functional System Test the Engineer, or Owner finds that process control is not achievable due to errors in the installation, the functional testing shall stop, and the Control System Specialist shall correct the installation and repeat the Site Readiness Test at no additional cost to the Owner.

E. Final Acceptance Test:

1. After the system has been started up and running in automatic control to the greatest extent possible as determined by the Engineer/Owner, the Control System Specialist shall conduct a Final Acceptance test of the completed installation. The test shall start after satisfactory completion of all previous tests, the Engineer has received marked record (as-built) drawings from the Contractor, and when directed by the Owner/Engineer.
2. During this test, the Owner and Engineer shall have full use of the system. The duration of the test shall be 30 days.
3. Control System Specialist personnel shall be readily available to address issues onsite during the acceptance test.
4. The system shall operate with 100% reliability during the test period. Failure shall be defined as the inability to control or indicate status of specified inputs or outputs or any specified function of the control systems as described herein caused by defective hardware or software furnished in this project. Failure of hardware or software shall require repair or remedy of the defect to the satisfaction of the Engineer/Owner within 2 days. If the problem cannot be repaired in this time, the test shall be aborted and restarted after the problem is corrected and when directed by the Owner/Engineer. Restarting and satisfactory completion of the test shall be conducted at no additional cost to the Owner.
5. Throughout the duration of the test, no modifications shall be made to the system without prior approval from the Engineer or Owner.

3.4 TRAINING, STARTUP ASSISTANCE, & WARRANTY

A. Training:

1. The Contractor shall provide training for the purpose of familiarizing Owner's personnel with the process control system. All training shall be as scheduled by the Owner. The training shall be scheduled a minimum of thirty (30) days in advance of when it is to be given. Proposed training materials, including a detailed training agenda itemizing relative emphasis on various topics of each course, shall be submitted to the Owner and Engineer at least fourteen (14) days in advance of when the training is to begin. The course content shall include, but not be limited to, a description of system philosophy, all major hardware components utilized in the system and hardware maintenance practices.

B. Startup Assistance:

1. The Contractor shall be responsible for furnishing a qualified technical representative who shall supervise the installation of equipment and/or install equipment, and who shall test, adjust, field calibrate, and fully commission all flow metering equipment, instrumentation equipment, control equipment, and accessories specified herein and required as integral components of the complete systems. The commissioning will be

deemed to be complete only after all systems are found to be performing satisfactorily following the final balancing of plant operation. The guarantee period, during which all defective materials shall be replaced, and all faulty workmanship will be corrected at no cost to the Owner, shall begin with the date on which the commissioning is judged to be complete.

C. Service:

1. Manufacturers shall provide as part of the equipment cost sufficient days of service by a factory-trained service engineer specifically trained on the type of equipment herein specified to assist the Contractor during installation and startup. The service time shall be sufficient to place the units in satisfactory service and instruct the Owner's personnel in proper operation and maintenance of the equipment.
2. A minimum of three (3) days service Engineer time shall be provided.

D. Maintenance Instruction:

1. Operating and maintenance instructions, along with a separate parts list, shall be furnished in three (3) copies to the Owner. Operating instructions shall also incorporate a functional description of the system, including the system schematics which reflect "as-built" modifications. Maintenance requirements particular to the system shall be clearly defined, along with calibration and test procedures.

E. Warranty:

1. All equipment and workmanship furnished under this contract shall be guaranteed to be free of defects in materials and workmanship for a period of one (1) year from and after the date of final acceptance of the work by the Owner, and any such defects which appear within the stipulated guaranty period shall be repaired, replaced, or made good without charge. This guarantee shall include the capacity and integrated performance of the component's parts.

END OF SECTION

SECTION 40 61 96 – PROCESS CONTROL DESCRIPTIONS – GENERAL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Descriptions of process control strategies and intended functionality of new system equipment and processes. These descriptions shall serve as the starting point for process control and are expected to be continually refined throughout the execution of the project. The descriptions are not intended to identify every status or alarm indication required as part of the plant process control system. Refer to contract drawings and related specifications sections for additional process control information.
- B. This Section Does/May Not Include:
 - 1. Process control strategies for equipment furnished as part of a vendor supplied control package. These systems will be programmed and implemented by the vendor. Refer to equipment specifications for process control requirements of vendor supplied systems.
- C. Related Sections:
 - 1. Section 40 61 13 – Process Control System General Provisions.
 - 2. Section 40 68 63 – DCS and OWS Programming

1.2 DEFINITIONS

- A. Integrated Operating Platform:
 - 1. System of installed, connected, and configured hardware, operating programs, and networking equipment.
- B. DCS and Operator Interface Programming:
 - 1. Software configuration of operating programs to implement process control strategies.
- C. Control System Specialist:
 - 1. A company specializing in process control hardware and software, including instrumentation, DCS, networking, installation, and configuration.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COMMON CONTROL STRATEGIES

- A. This section provides an overview of common control strategies and alarms for equipment and instruments. Unless stated otherwise for specific equipment in subsequent control description documents, these strategies and alarms should be considered universal. Some of these strategies describe three position selector control switches which may be LOCAL-OFF-REMOTE, HAND-OFF-AUTO, ON-OFF-AUTO, or some other variation in the field. See contract P&ID's and control schematic drawings for specific switch details.
- B. Constant Speed Motors/Pumps
 - 1. The motor will be capable of LOCAL MANUAL control from the motor control panel or MCC. REMOTE MANUAL and REMOTE AUTO control will be provided by the DCS program and operator workstation (OWS).
 - 2. Local control will be provided by a ON-OFF-AUTO selector switch at the motor control panel or MCC.

- a. LOCAL-OFF-REMOTE Operation:
 - 1) In OFF mode, the motor is stopped and cannot be started.
 - 2) If hard interlocks are satisfied:
 - a) In LOCAL mode, the motor is started and stopped locally.
 - b) In REMOTE mode, the motor is started and stopped from OWS.
 3. Remote control will be provided by a virtual ON-OFF-AUTO selector on the OWS.
 - a. ON-OFF-AUTO Operation:
 - 1) In OFF mode, the motor is stopped.
 - 2) If the motor is ready for remote control and interlocks are satisfied:
 - a) In ON mode, the motor starts.
 - b) In AUTO mode, the DCS program will control motor operations based on the automatic control strategy described herein.
- C. Adjustable Speed Motors/Pumps
 1. The motor will be capable of LOCAL MANUAL control from the motor control panel or VFDs. REMOTE MANUAL and REMOTE AUTO control will be provided by the DCS program and OWS.
 2. Local control will be provided by a LOCAL-OFF-REMOTE selector switch at the motor VFDs or MCC.
 - a. LOCAL-OFF-REMOTE Operation:
 - 1) In OFF mode, the motor is stopped and cannot be started.
 - 2) If hard interlocks are satisfied:
 - a) In LOCAL mode, the motor is started locally, and motor speed is controlled from the local speed potentiometer or VFD keypad.
 - b) In REMOTE mode, motor start, stop, and speed control is from OWS.
 3. Remote control will be provided by a virtual ON-OFF-AUTO selector and MANUAL SPEED SETPOINT on the OWS.
 - a. ON-OFF-AUTO Operation:
 - 1) In OFF mode, the motor is stopped.
 - 2) If the motor is ready for remote control and interlocks are satisfied:
 - a) In ON mode, the motor starts, and motor speed is set by the virtual MANUAL SPEED SETPOINT in terms of percent on the OWS. Allowable percentage range shall be coordinated with the process equipment to ensure operation is not allowed in ranges that would result in damage to the equipment or undesirable process outcomes.
 - b) In AUTO mode, the DCS program will control motor operations based on the automatic control strategy described herein.
- D. Discrete Valve Actuators
 1. Local control will be provided by a LOCAL-OFF-REMOTE selector switch at the valve actuator.
 - a. LOCAL-OFF-REMOTE Operation:
 - 1) In OFF mode, the actuator is off and cannot be controlled.
 - 2) In LOCAL mode, the valve can be opened, closed, and stopped in transition from the actuator.
 - 3) In REMOTE mode, the valve open and close commands come from OWS. Certain actuators may also include a remote STOP command to stop the actuator mid-transition. Refer to contract drawings for details.
 2. Remote control will be provided by a virtual MANUAL-AUTO selector on the OWS.
 - a. MANUAL-AUTO Operation:
 - 1) If the valve is ready for remote control:
 - a) In MANUAL mode, the operator can manually open and close the valve.
 - b) In AUTO mode, the DCS program will control valve operations based on the automatic control strategy described herein.

- E. Modulated Valve Actuators
1. Local control will be provided by a LOCAL-OFF-REMOTE selector switch at the valve actuator.
 - a. LOCAL-OFF-REMOTE Operation:
 - 1) In OFF mode, the actuator is off and cannot be controlled.
 - 2) In LOCAL mode, the valve can be opened, closed, and stopped in transition from the actuator.
 - 3) In REMOTE mode, the valve position is modulated by the DCS.
 2. Remote control will be provided by a virtual MANUAL-AUTO selector on the OWS.
 - a. MANUAL-AUTO Operation:
 - 1) If the valve is ready for remote control:
 - a) In MANUAL mode, the operator can manually enter a valve position setpoint 0% – 100%.
 - b) In AUTO mode, the DCS program will control valve operations based on the automatic control strategy described herein.
- F. DCS Calculated Alarms:
1. Analog Signal Diagnostic Alarms:
 - a. These DCS calculated alarms will be generated for all analog input signals.
 - b. High Alarm:
 - 1) DCS generated alarm if the value exceeds operator high value alarm setpoint.
 - c. Low Alarm:
 - 1) DCS generated alarm if the value falls below operator low value alarm range setpoint.
 - d. Out of Range:
 - 1) DCS generated alarm if measurement is out of range, indicating an instrument fault. DCS shall hold last good value while measurement is out of range.
 - e. Broken Loop:
 - 1) DCS generated alarm if signal broken loop is detected. DCS shall hold last good value while broken loop is active.
 2. Equipment Alarms:
 - a. These DCS calculated alarms will be generated for all equipment with DCS control. All alarm delay timers and deadbands shall be operator-adjustable. These alarms only apply to remote OWS control and will not be generated when equipment is in a LOCAL control state.
 - b. Pumps/Motors:
 - 1) Command Fail:
 - a) DCS generated alarm if setpoint is not achieved within a deadband before a set time-delay once a command is given.
 - 2) Fail to Start:
 - a) DCS generated alarm if running feedback is not received before a set time-delay after run command is given.
 - 3) Fail to Stop:
 - a) DCS generated alarm if running feedback is not lost before a set time-delay after run command has been removed.
 - 4) Uncommanded Change Alarm:
 - a) DCS generated deviation alarm if equipment changes states (running, speed) without being given a command.
 - c. Gates/Valves:
 - 1) Command Fail:
 - a) DCS generated alarm if position setpoint is not achieved within deadband before a set time-delay after a position command is given (modulated only).
 - 2) Fail to Open:

- a) DCS generated alarm if open feedback not received before a set time-delay after open command is given.
 - 3) Fail to Close:
 - a) DCS generated alarm if closed feedback not received before a set time-delay after close command is given.
 - 4) Uncommanded Change Alarm:
 - a) DCS generated deviation alarm if equipment changes states (open/close status, position) without being given a command.
- 3. DCS Diagnostic Alarms:
 - a. These DCS calculated alarms will be generated for all new DCSs provided as part of the project.
 - b. DCS Card Fault:
 - 1) The DCS shall generate an alarm for any I/O card faults as available from the platform.
 - c. DCS Heartbeat:
 - 1) The DCS shall have an alternating "heartbeat" bit for use in communications diagnostics.
 - d. DCS Communications Fault:
 - 1) A DCS that receives peer-to-peer data from another controller over the network must monitor the heartbeat of the supplying controller. If the heartbeat bit remains unchanged for a specified period, a communications fault alarm will be triggered. The alarm delay should be set appropriately to accommodate anticipated communication delays or poll rates, including any delays associated with radio communications. This alarm should serve as a failure condition for any control strategies that depend on receiving the data.

3.2 OVERALL PROCESS FLOW DESCRIPTION

- A. Liquid Train:
 - 1. Facility 103 – Sodium Hydroxide Feed System

END OF SECTION

SECTION 40 61 96.103 – PROCESS CONTROL DESCRIPTIONS – SODIUM HYDROXIDE FEED SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
1. Control strategies and expected functionality for a specific process area or facility in the project. It provides detailed descriptions to understand and configure the control systems concerning a specific process. These descriptions complement the Process Control Descriptions - General specification, which covers universal control descriptions and serves as a foundation for the detailed facility strategies. Refer to the General PCD for typical equipment and instrument control strategies.
- B. Related Section:
1. Section 40 61 13 – Process Control System General Provisions
 2. Section 40 61 96 – Process Control Descriptions – General
 3. Section 40 68 63 – DCS and OWS Programming

1.2 REFERENCES

- A. Drawing Number 08-I103 – Sodium Hydroxide Process and Instrumentation Diagram.

1.3 EQUIPMENT AND INSTRUMENTATION

- A. Motors and Pumps:

Equipment Tag	Name	Existing/ Proposed	Type	Driver	Operation
XPMP01	SHX Transfer Pump 1	Proposed	C	F	On/Off
XPMP02	SHX Transfer Pump 2	Proposed	C	F	On/Off
C = Centrifugal PD = Positive-Displacement EM = Electric Motor PO = Pneumatic-Operated V = Variable-Speed F = Fixed-Speed					

- B. Valves and Gates:

Equipment Tag	Name	Existing/ Proposed	Operator	Remote Operation
CV01	TNK01 Inlet Valve	Proposed	MO	OC
CV02	TNK01 Outlet Valve	Proposed	MO	OC
CV03	TNK02 Inlet Valve	Proposed	MO	OC
CV04	TNK02 Outlet Valve	Proposed	MO	OC
MAN = Manual MO = Electric Motor-Operated PO = Pneumatic-Operated HO=Hydraulic-Operated OC = Open/Close OSC = Open/Stop/Close MOD = Modulating				

- C. Instruments:
- Discrete Instruments:

Equipment Tag	Name	Existing/Proposed	Setpoint
LSH01	TNK01 High Level Switch	Proposed	5.5ft
LSH02	TNK02 High Level Switch	Proposed	5.5ft

- Analog Instruments:

Equipment Tag	Name	Existing/Proposed	Nominal Range
WE01	TNK01 Scale	Proposed	0 - 6000lb
WE02	TNK02 Scale	Proposed	0 - 6000lb

- D. Control Panels and Local Control Stations:

Equipment Tag	Name	Existing/Proposed
CP01	SHX Day Tank Control Panel	Proposed
LCP01	SHX Day Tank Control Valve Local Control Panel 1	Proposed
LCP02	SHX Day Tank Control Valve Local Control Panel 2	Proposed
LCP03	SHX Day Tank Control Valve Local Control Panel 3	Proposed
LCP04	SHX Day Tank Control Valve Local Control Panel 4	Proposed

- E. Controllers:

Equipment Tag	Name
	Need to be updated to Local, not shown on P&ID

1.4 PROCESS DESCRIPTION

- A. The Sodium Hydroxide Day Tank Storage System includes two day tanks, each equipped with four motorized control valves and two centrifugal transfer pumps. The chemical volume in each tank is monitored using a scale that measures the tank's weight. Each tank is configured with both high and low level setpoints.

When the duty tank chemical level drops to the low setpoint, the tank will enter a fill cycle and the standby, full tank, will be switched to the duty tank. For the fill cycle, the outlet valve closes, and the inlet valve opens, allowing one of the transfer pumps to refill the tank. Once the chemical in the tank reaches the high setpoint the transfer pump will shut off and the inlet valve will close. The full tank, standby, will be identified as the duty tank. Once identified as the duty tank the outlet valve will open to supply chemical to the metering pumps.

- B. Automatic Mode:

- The Sodium Hydroxide Feed System will operate based on the high and low weight setpoint of the day tanks. The pumps will operate in a duty/standby capacity. When placed into automatic mode, the controller will control the day tank level as follows:
 - The standby pump will turn on and the inlet motorized valve (CV01 or CV03) will open.
 - If the measured tank weight is at a high setpoint plus the deadband, a delay timer will begin to count down. Once the timer elapses, the full tank will be identified as the duty tank. The inlet valve will close for the corresponding tank, shut off the

transfer pump and the full tank's outlet valve (CV02 or CV04) will open for the metering pumps.

- c. If a day tank reaches the low weight setpoint plus the deadband, a delay timer will begin to countdown. Once the timer elapses, the low-level tank will be identified as the standby tank. The outlet valve will close for the corresponding tank, turn on the transfer pump and that tank's inlet valve will open.
- d. If both tanks are below the low setpoint, then the lowest point between the two tanks will be identified as the standby tank.
- e. If both tanks are at the high setpoint, then the highest point between the two tanks will be identified as the duty tank.
- f. Day tanks will be filled and supply feed pumps one at a time.

2. While pumps can be manually assigned duty/standby assignments, an automatic pump rotation strategy shall also be provided. When Auto Rotation is selected, the controller shall continuously compare runtimes of available pumps (available = in remote, not in fault, etc.). The pump with the lowest runtime will be assigned the duty status, with the other pump being assigned as standby. Either pump determined to be "not available" will be assigned as standby. Any pump in standby will not be called by any auto control strategy and will not be assigned as duty. Pumps shall not change duty/standby status while running. The controller shall track runtimes of each pump for this purpose. Each runtime value will be adjustable by an operator of appropriate security/access level (specifics to be coordinated with the owner).

C. Manual Mode:

1. Under manual mode, the operator will choose which tanks to fill, pump to run and outlet valve to open for the metering pumps.

1.5 OPERATOR WORKSTATION CONTROLS

A. Control Setpoints:

1. The following table lists the expected new adjustable control setpoints that will be added to the operator workstation graphics. The table should be utilized for initial system set up. Some control variables may require historical data logging for populating trends and reports.

Control Setpoint	Entry Range	Default	Description
Day Tank Weight High Setpoint	0 - 6000lb	TBD	Weight to supply feed pumps
Day Tank Weight Low Setpoint	0 - 6000lb	TBD	Weight to fill day tanks
Pump Start Timer Setpoint	0 - 600sec	TBD	Delay timer for starting transfer pump
Pump Stop Timer Setpoint	0 - 600sec	TBD	Delay timer for stopping transfer pump

B. Process Variables

1. The following table lists the expected new process variables related to the control strategy that will be added to the operator workstation graphics. Not all variables (such as motor speeds, pump run statuses, valve open/closed statuses, etc.) are listed. Variables may require event change data logging by the alarm server or historical data logging by the historian for populating trends and reports.

Process Variable	Units	Trend Default Range
Sodium Hydroxide Day Tank Level	Feet	0 - 6ft

C. Alarms

- The following table lists the expected alarms that will be added to the operator workstation graphics. Alarm priority shall be determined through coordination with the Owner during project startup. Alarms described under the Common Control Strategies portion of this specification are not listed in this table but shall be provided as applicable.

Alarms	Description
TNK0X High Level Alarm	Alarm when chemical level reaches the high level in the tank
Pump Starter Fault	Fault generated by the pump starter controller

1.6 INTERLOCKS

A. Hard Interlocks

- The following table lists hard-wired interlock conditions that must be satisfied for equipment operation in either Local or Auto/Remote modes.

Interlock	Description
LSH0X	Day Tank overfill cutoff switch. Hard-wired to pump starter
TNK0X High Level Switch Local Pump Stop Button	High Level Setpoint Maintained stop pushbutton. Hard-wired to pump VFD.
LCP01/03	Inlet Control Valve 1 and 3. Hard-wired to pump VFD

1.7 FAILURE MODES

- A. The following table lists potential failures and the expected process control system response.

Failure	Process Control System Response
Day Tank Scale Fail	Switch corresponding pump to manual mode and generate alarm to operator workstation graphics.
Fail to Open/Close Control Valve	Shutoff corresponding pump and generate alarm to operator workstation graphics. Reference specifications 40 61 96.

END OF SECTION

SECTION 40 67 23 – CONTROL PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. All control panels provided as part of the project, including those provided as part of a manufacturer supplied system specified in other Divisions.
 - 2. The Work to furnish and install functional control panels to operate control systems manually or automatically as specified in this and related sections.
- B. Related Sections:
 - 1. Section 40 61 13 – Process Control System General Provisions

1.2 REFERENCES

- A. NEMA
 - 1. Standard ICS 2 – 2000 Industrial Control and Systems
- B. NFPA
 - 1. 70 – National Electrical Code (NEC)
 - 2. 70E – Standard for Electrical Safety in the Workplace
 - 3. 79 – Electrical Standard for Industrial Machinery
- C. UL
 - 1. 508/508A – Industrial Control Enclosures
- D. All equipment components and completed assemblies specified in this Section shall bear the appropriate label of Underwriters Laboratories.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Action Submittals:
 - 1. Shop Drawings and Product Data:
 - a. Custom unit elementary drawings. Drawings shall include all schematics for control logic as described in the Process Equipment Specifications, and any associated control schematics shown on the Engineer's Drawings for this project. Show interconnections between components and to remotely mounted devices. Include and identify all connecting equipment and remote devices on the schematics. The notation "Remote Device" will not be acceptable. Show wire and terminal numbers. Specify special identifications for devices as required by the mechanical equipment manufacturer or as may be specified in Drawings.
 - b. Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, weight, shipping splits, conduit entrances and anchor bolt pattern. Specify all options, special features, ratings, and deviations from this Section.
 - c. Power and control schematics including external connections. Show wire and terminal numbers and color-coding.
 - d. Instruction and replacement parts books, including manufacturer's part numbers and selections of component ratings.
 - e. As-built final drawings.
 - f. Documentation that the panel assembly facility is a UL-508 certified facility.

- g. Furnish complete Bill of Materials specifying manufacturer's name and part numbers.
 - h. Manufacturer's cut sheets for every component used in the panel assembly adequately marked to show the items being included. The manufacturer's name shall be clearly visible on each cut sheet submitted.
 - i. Assembly Ratings:
 - 1) Short-circuit rating.
 - 2) Voltage
 - 3) Continuous current
 - j. Major Component Ratings:
 - 1) Voltage
 - 2) Continuous current
 - 3) Interrupting ratings
 - k. Cable terminal sizes.
 - l. Instruction and renewal parts books.
- C. Informational Submittals:
- 1. Factory Tests:
 - a. Submittals shall be made for factory tests specified herein.
 - 2. Field Test Reports:
 - a. Submittals shall be made for field tests specified herein.
 - 3. Operation and Maintenance Manuals:
 - a. Include Manufacturer's contact address and telephone number for parts and service.
 - b. Include Instruction books and/or leaflets.
 - c. Include Recommended renewal parts list.
 - d. Include Record Documents for the information required by the Submittals paragraph above.

1.4 QUALITY ASSURANCE

- A. Submittals shall contain information on related equipment to be furnished under this section but described in the related sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will also be returned unreviewed.
- B. All submittals for control panels provided as part of an equipment vendor's scope shall be submitted as a part of the Process Equipment manufacturer's submittal.
- C. All submittals for control panels provided by the Control System Specialist shall be submitted as a part of the Control System Specialist's submittals.
- D. The equipment manufacturer shall create all equipment shop drawings, including all wiring diagrams, in the manufacturer's Engineering department. All equipment shop drawings shall bear the mechanical equipment manufacturer's logo, drawing file numbers, and shall be maintained on file in the mechanical equipment manufacturer's archive file system.
- E. The manufacturer shall submit for approval, a training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual.
- F. The manufacturer of the control panels shall have produced similar equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

- G. The control panels shall be assembled in a UL-508 certified facility. A submittal of documentation certifying that the panel fabrication facility is a UL-508 certified facility, is required. A UL label shall be affixed to the inside of the external door by the panel fabrication assembly.
- H. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.
- I. Control panels submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.
- J. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.5 JOBSITE DELIVERY, STORAGE AND HANDLING

- A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.
- B. Equipment shall be handled and stored as specified in manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment and shall be made available to the Contractor and Owner/Engineer.
- C. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.
- D. Where space heaters are provided in equipment, provide temporary electrical power, and operate space heaters during storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.6 WARRANTY

- A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for the same length of time as the associated mechanical equipment, but not less than 1 year from the date of final acceptance of the equipment by the Owner and Engineer. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work, requiring shipping or transporting of the equipment, shall be performed by the Manufacturer, at no expense to the Owner.
- B. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 RATINGS

- A. The service voltage shall be as specified and as shown on the Drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be not less than 22,000 amperes RMS symmetrical for panels operating at 480/277 V, and equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the Control Panel. This includes all circuit breakers and combination motor starters. Systems of motor controllers employing series connected ratings for main and feeder devices shall not be used. Motor starter units shall be tested and UL 508A labeled for the specified short

circuit duty in combination with the motor branch circuit protective device. The overall short circuit rating of the panel shall be not less than 10,000 amps RMS symmetrical for panels operating at 120 VAC.

- B. There shall be selective device coordination between the Main Breaker, Feeder Breakers, and control circuit protective devices. When using a circuit breaker or fuses as a main protective device, the instantaneous trip levels of the main protective device shall be higher than the available fault current to the control panel. If fuses are utilized in the control panel design, the protective devices for 3 phase loads shall contain single phase protection of such equipment. If a fault occurs in the circuit of one load of a design with a backup load, the feeder protective device shall not remove both loads from the control system.
- C. The complete control panel assembly shall be UL certified and carry a UL listing for "Industrial Control Panels".
- D. The control panel shall meet all applicable requirements of the NEC.
- E. The control panel enclosure shall be NEMA rated as specified in this section.
- F. Motor controllers, including associated devices, shall be designed for continuous operation at rated current in a 50°C ambient temperature.
- G. For additional ratings and construction notes, refer to the mechanical equipment specifications and the Drawings.

2.2 CONSTRUCTION

- A. General:
 - 1. Submit actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components, and assemblies; and other required details. NEMA ratings of all devices shall meet or exceed the rating of each panel.
 - 2. Control units shall be arranged as shown on the Drawings.
 - 3. Nameplates:
 - a. Exterior:
 - 1) Nameplates shall be engraved, laminated impact acrylic. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips. Prior to installing the adhesive nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues have been removed. Epoxy adhesive or foam tape is not acceptable.
 - 2) There shall be a master nameplate that specifies supply voltage equipment ratings, short circuit current rating, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.
 - 3) Provide permanent warning signs:
 - 4) "DANGER – HIGH VOLTAGE – KEEP OUT" on all doors.
 - 5) "WARNING – HAZARD OF ELECTRIC SHOCK – DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT" on Main Power Disconnect or Disconnects.
 - b. Internal:
 - 1) Provide the panel with a UL 508A label.
 - 2) Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for

identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

4. Control Devices and Indicators:
 - a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30mm, NEMA 4X/13 for outdoor panels, NEMA 4/13 for indoor panels, anodized aluminum or reinforced plastic. Booted control devices are not acceptable. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
 - b. Indicator lamps shall be LED type. For all control applications, indicator lamps shall incorporate a push-to-test feature.
 - c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc.) shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.
 - d. Panel meters for digital display of analog signal values shall be provided where specified. Panel meters shall be 4mA – 20mA loop powered, 1/8 DIN LCD displays, Precision Digital Model PD 6600 series or equal.
 - e. Panel Interface Connector (PIC): The DCS cabinets shall include a PIC mounted on the outside of the enclosure for providing an Ethernet connection to internal devices. The PIC shall include a 120 VAC single phase duplex receptacle with 3 Ampere externally resettable circuit breaker and an RJ45 pass-through connector.
 - f. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.
 - g. The manufacturer shall not remove, reuse, alter, or replace original equipment nameplates or equipment tags associated with equipment or components supplied by the manufacturer's suppliers and sub-suppliers.
5. Control Relays:
 - a. Provide relays as required to implement specified control functions. General purpose, alternating and time delay relays may be used within their ratings for logic, timing and sequencing but shall not be used to drive loads in excess of 80% of their contact "make" or "break" ratings. Provide interposing power relays to drive loads such as starters larger than NEMA size 1 and all other utilization equipment with loads greater than specified for general purpose and time delay relays. Provide relays rated to drive the load as required. Relays shall be provided with an LED status indicator.
 - b. Discrete Input and Output Relays: Terminal block style interposing relays shall be used for all controller inputs and outputs. Devices shall be compatible with the Bailey INFI 90 system. Provide pullup or pulldown resistors on all digital outputs as required for the application.
6. Control and Instrument Power Transformers:
 - a. Control power transformers shall be provided. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity, and shall be not less than 100VA.
 - b. Control power transformers shall be 120 V grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded, and the other leg shall be fused.
 - c. Control power transformers shall be installed inside the control panel that they serve. They shall not be mounted exterior to the panel.
7. Power Supplies:
 - a. When required, the control panel shall be furnished with a separate DC power supply to provide DC power for control panel components and the loop power for 2-wire instruments. The power supplies shall be DIN rail mounted, 120VAC input, 24VDC output, with output load rated as required for the connected loads. Power supplies shall be provided by Phoenix Contact, Allen-Bradley, or Sola.

8. Surge Protection:
 - a. Provide a surge protection device installed on the incoming power source to protect control panel components from electrical surge damage. Surge device shall be rated for the voltage and phase of the incoming power source.
 9. Phase Monitor:
 - a. For control panels powering three phase motors with across-the-line or reduced voltage starters, provide a phase monitoring relay wired into the motor start circuits to stop motors during a loss of phase condition. Motor Saver Model 460 or equivalent.
 10. Motor Control Reset:
 - a. For panels controlling motors:
 - 1) Provide a physical reset button on the face of the panel that resets all controllers, overloads, and interlock circuits.
 - 2) Provide an automatic reset feature whereby any electronic motor controller or fail-safe interlock circuit is automatically reset when power is lost and subsequently restored to the panel.
- B. Enclosures:
1. General:
 - a. Each enclosure shall incorporate a removable back panel, and side panels, on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs for wall mounted enclosures, and 316 SS hardware for free standing enclosures.
 - b. All freestanding enclosures shall be provided with feet of the same construction as the enclosure.
 - c. Back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.
 - d. All enclosure doors shall have bonding studs. The enclosure interior shall have a bonding stud.
 - e. Each enclosure shall be provided with a documentation pocket on the inner door.
 - f. Enclosures shall not have holes or knockouts.
 - g. Provide manufacturer's window kits where shown on the Drawings.
 - h. All enclosures shall be able to be padlocked.
 2. NEMA 4X:
 - a. NEMA 4X panels shall be provided for all outdoor locations, or indoor locations where directly exposed to process or wash-down water.
 - b. NEMA 4X 316 Stainless Steel
 - c. Type 316 stainless steel, body, and door
 - d. Stainless steel continuous hinge
 - e. Foam gasket
 - f. Single point quarter turn latches (20 in. by 24 in. and below). All others 3-point latch.
 - g. Manufacturers
 - 1) Hoffman Comline Series
 - 2) EMF Company
 - 3) NEMA Enclosures Company
 - 4) Hammond Company
 - 5) Approved Equal
 3. NEMA 12:
 - a. NEMA 12 panels shall be provided for clean and dry indoor locations.
 - b. NEMA 12 Painted Steel.
 - c. Painted steel, body, and door
 - d. Continuous hinge
 - e. Foam gasket
 - f. Single point quarter turn latches (20 in. by 24 in. and below). All others 3-point latch.

- g. Manufacturers
 - 1) Hoffman Comline Series
 - 2) EMF Company
 - 3) NEMA Enclosures Company
 - 4) Hammond Company
 - 5) Approved Equal

C. Environmental Conditioning:

- 1. Air Conditioning
 - a. A panel air conditioner shall be provided where panels include variable frequency drives and are installed outdoors or unconditioned indoor spaces.
 - b. The air conditioner shall be powered from the panel. A separate power source shall not be required.
 - c. The enclosure cooling system shall not compromise the enclosure's NEMA rating and shall be sized for the environment in which the control panel will be installed.
 - d. The air conditioner shall be sized to provide cooling to maintain the interior temperature of the panel to meet VFD manufacturer recommendations for maximum ambient temperature.
- 2. Ventilation:
 - a. Where air conditioning is not required, panel fans and louvers shall be provided where panels are installed in unconditioned indoor spaces.
 - b. Panel ventilation shall also be provided in indoor conditioned spaces where the panel manufacturer has determined it necessary to maintain the interior temperature of the panel within manufacturer recommended limits.
 - c. The fans shall be powered from the panel. A separate power source shall not be required.
 - d. The enclosure ventilation system shall not compromise the enclosure's NEMA rating and shall be sized for the environment in which the control panel will be installed.
 - e. The ventilation shall be sized to maintain the interior temperature of the panel to meet manufacturer recommendations for maximum ambient temperature of all electronic components.
- 3. Condensation Control:
 - a. A self-contained enclosure condensation heater with thermostat and fan shall be mounted inside control panels if panel is mounted outdoors or in a non-airconditioned space.
 - 1) Enclosure heaters shall be energized from 120 V, single-phase power supply and sized to prevent condensation within the enclosure.
 - 2) Locate enclosure heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.
 - 3) Enclosure heaters shall have an internal fan for heat distribution and shall be controlled with adjustable thermostats. The thermostat shall have an adjustment range of 40°F – 90°F. Provide a circuit breaker or fused disconnect switch within the enclosure.
 - 4) Enclosure heaters shall be Hoffman type DAH or equal.
 - b. Strip heaters may be provided if they are 240 V rated, powered at 120 V AC, and do not have a surface temperature higher than 60°C. Strip heaters and thermostats shall be as manufactured by Chromalox or equal.
 - c. Each panel shall have a 1/2 in. stainless steel condensate drain.

D. Internal Wiring:

- 1. Power and control wiring shall be tinned stranded copper, minimum size No. 16 AWG, with 600 V, 90°C, flame retardant, Type MTW thermoplastic insulation. Line side power wiring shall be sized for the full rating or frame size of the connected device.
- 2. Analog signal wires shall be 600 V Class, insulated stranded tinned copper, twisted shielded #18 AWG pair.

3. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. Field wiring shall not be terminated directly on any panel-mounted device.
 4. All wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal.
 5. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. Plan wire routing such that no low twisted shielded pair cable conducting analog 4mA – 20 mA signals or low voltage analog signals are routed in the same wire trough as power conductors carrying greater than 120V.
 6. All control panel wiring shall use color coding:
 - a. Black: AC power at line voltage
 - b. Red: switched AC power
 - c. Orange: May be energized while the main disconnect is in the off position
 - d. White: AC neutral
 - e. Orange/white stripe or white/orange stripe: separate derived neutral
 - f. Red/white stripe or white/red stripe: switched neutral.
 - g. Green or green w/ yellow tracer: ground/earth ground
 - h. Blue: Ungrounded DC power
 - i. Blue/white stripe or white/blue stripe: DC grounded common
 - j. Brown: 480V AC 3 phase – phase A
 - k. Orange: 480V AC 3 phase – phase B
 - l. Yellow: 480V AC 3 Phase – phase C
 - m. Purple: common for analog signal wiring
 - n. Brown: positive leg of an analog signal
- E. Field Installed Internal Wiring:
1. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
 2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type like Raychem TMS-SCE, or equal.
 - a. Where existing field wiring is being used to connect to a new panel, provide new labels. Where an existing wiring identifier is present that differs from the wiring identifier documented on the panel drawings, provide label for both identification numbers.
 3. In general, all conduit entering or leaving outdoor panels shall be stubbed up into the bottom of the enclosure to the greatest extent possible.
- F. Terminal Blocks:
1. Terminal blocks shall be DIN-rail-mounted one-piece molded plastic blocks with tubular-clamp-screw type and end barriers. Terminal blocks shall be rated for 600 V except for control and instrumentation circuits, or 4 mA – 20 mA analog signal conductors.
 2. Provide 600 V rated terminal blocks for any conductor carrying any voltage over 120 V to ground.
 3. Provide 600 V rated strap screw terminal blocks for any power conductors carrying over 20 amps, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.
 4. Power conductors carrying over 20 amps, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap-screw terminal point.

5. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20% spare terminals, but not less than two spare terminals.
6. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.
7. Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.
8. Control circuits, 120 V and below, and 4 mA – 20 mA analog signal conductors shall be terminated with manufacturer's recommended insulated connectors.
9. Current Loop Surge Protection Devices: The 4 mA – 20 mA signal loop channels on analog inputs and outputs shall be protected against static discharge, lightning, and faulty wiring with three stage surge protection terminal block devices. Devices shall be pluggable with indication status lights. Devices shall be PLUGTRAB series as manufactured by Phoenix Contact or equal.
10. All wiring to hazardous locations shall terminate in intrinsically safe barrier devices.
11. Provide an AC ground bar bonded to the panel enclosure (if metal) with 20 percent spare terminals.
12. Provided ground terminal blocks for each twisted-shielded pair drain wire.

2.3 MAIN CIRCUIT PROTECTIVE DEVICE

- A. For panels operating at 480VAC, unless otherwise shown on the Drawings, the main circuit protective device shall be a molded case (MCCB), 3 Pole, 600 V, fixed type, manually operated with stored energy closing mechanism. For MCCBs 200A and larger, trip device shall be solid state with adjustable long time pickup, and delay; adjustable short time pickup and delay; and short time i²t switch. Provide ground fault pickups where specified in Drawings.
 1. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position. Where panels are shown or specified with inner and outer doors, disconnecting handles and controls shall be located on the inner door.

2.4 ACROSS THE LINE MOTOR CONTROLLERS

- A. General:
 1. Provide the NEMA size starter, circuit breaker trip ratings, control power transformers and thermal overload heater element ratings matched to the motors and control equipment actually supplied, in compliance with the NEC and the manufacturer's heater selection tables. All variations necessary to accommodate the motors and controls as actually furnished shall be made without extra cost to the Owner.
 2. Furnish lugs for incoming wiring. Allow adequate clearance for bending and terminating of cable size and type specified.
 3. A NEMA rated magnetic motor starter shall be furnished for each motor. Each motor starter shall be provided with a motor circuit protector, or circuit breaker, and equipped to provide undervoltage release and overload protection on all three phases. The short circuit protective device shall have an adjustable magnetic trip range up to 1400% of rated continuous current and a trip test feature. MCPs shall be labeled as specified in UL489. NEMA starter sizes and breaker trip ratings shall be as required for the horsepower specified but shall be in no case less than NEMA Size 1. If the manufacturer of the equipment utilizing the motor, supplies a motor horsepower larger than that shown on the Drawings, the Contractor shall supply a motor starter sufficient in size to control the motor supplied.
 4. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to each motor. Disconnects mechanisms shall be located inside the

enclosure such that the main circuit breaker handle is the only device interlocked with the panel door.

5. Each motor starter shall have a 120 V operating coil unless otherwise noted.
6. Overload relays shall be electronic type with adjustable features and remote reset. A normally closed contact shall be directly used in the start circuit and a normally open contact shall be wired to a terminal board for overload alarm.
7. All interfaces between control panel and remote devices shall be isolated via an interposing relay. Interposing relays shall have contacts rated for 250 VAC and 10 Amps continuous. Relays shall be Control Relays as specified herein.

B. Magnetic Motor Starters

1. Motor starters shall be 2 or 3 pole, single or 3 phase as required, 60 Hertz, 600 V, magnetically operated, full voltage non reversing. NEMA sizes shall be as required for the horsepower shown on the Drawings.
2. Each motor starter shall have a 120 V operating coil, and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the Drawings. A minimum of one N.O. and one N.C. auxiliary contacts shall be provided in addition to the contacts required.
3. Overload relays shall be electronic, adjustable, with remote and local reset.
4. Built in control stations and indicating lights shall be furnished where shown on the Drawings.
5. All wires shall be terminated on terminal blocks and shall be tagged.
6. Provide as built wiring diagram and post it in a protective cover inside the cell.

C. Contactors

1. Contactors shall be a circuit breaker and contactor, 600 V, 3 Pole, 60 Hz, magnetically operated. NEMA size shall be as required for the kilowatt ratings required for the equipment provided but shall be not less than NEMA size 1.
2. Contactors shall have a 120 V operating coil and control power transformer. Furnish the control power transformer with extra capacity for the unit heater fan.

D. Control Relays

1. Control relays shall be 300 V, industrial rated, plugin socket type, housed in a transparent polycarbonate dust cover, designed as specified in UL Standard 508 for motor controller duty. Continuous contact rating shall be 10 amps resistive, 1/4 HP at 120 VAC, operating temperature (-10)°C – 55°C. Provide spare N.O. & N.C. contacts. Relays shall be Potter & Brumfield KRP Series or equal with neon coil indicator light. Timing relays shall be 300 V, solid state type, with rotary switch to select the timing range.

E. Elapsed Time Meter

1. A six-digit, non-resettable elapsed time meter shall be installed on the face of each motor starter.

2.5 VARIABLE FREQUENCY DRIVE MOTOR CONTROLLERS

- A. As specified in Division 26 – Electrical for variable frequency drives (VFDs), where VFDs are provided for motor starting and control.

2.6 INSTRUMENTATION DEVICES

- A. Where instrumentation devices are specified in Drawings, see Instrumentation sections of Division 40 – Process Integration.

2.7 REMOTE MONITORING AND CONTROL INTERFACE

- A. General:
 - 1. All control and interconnection points from the equipment to the plant control and monitoring system shall be brought to dedicated terminal blocks. No field connections shall be made directly to the equipment control devices. Functions to be brought out shall be as specified in related specification sections and the contract drawings.
- B. Discrete control or status functions shall be from C relays with contacts rated at 120 V AC. Analog signals shall be isolated from each other.

2.8 FACTORY TESTING

- A. The entire control panel shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to ensure the workability and reliable operation of the equipment.
- B. Factory test equipment and test methods shall conform with the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.
- C. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.
- D. Factory test equipment and test methods shall be subject to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and to the Owner/Engineer's approval.

PART 3 - EXECUTION

3.1 INSTALLER'S QUALIFICATIONS

- A. Installer shall be specialized in installing this type of equipment, with minimum 5 years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.2 EXAMINATION

- A. Examine installation area to assure there is enough clearance to install the equipment.
- B. Housekeeping pads shall be included for the floor mounted motor controllers as detailed on the Drawings with the exception of motor controllers which are to be installed adjacent to an existing unit. Housekeeping pads for these (if used) should match the existing installation.
- C. Check concrete pads and baseplates for uniformity and level surface.
- D. Verify that the equipment is ready to install.
- E. Verify field measurements are as instructed by manufacturer.

3.3 INSTALLATION

- A. The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.
- B. Install required safety labels.

- C. All wiring shall be neatly installed, and wire ways shall be used wherever possible. All wiring shall be identified at all terminating locations by Tag ID as specified in Drawings.

3.4 FIELD QUALITY CONTROL

- A. Inspect installed equipment for anchoring, alignment, grounding, and physical damage.
- B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.
- C. Provide one set of as-built panel drawings laminated, in each panel pocket.

3.5 FIELD ADJUSTING

- A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.

3.6 FIELD TESTING

- A. Perform all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.
- B. Megger and record phase to phase and phase to ground insulation resistance. Megger, for 1 minute, at minimum voltage of 1000 VDC. Measured Insulation resistance shall be at least 100 megohms. In no case shall the manufacturer's maximum test voltages be exceeded.
- C. Test each key interlock system for proper functioning.
- D. Test all control logic before energizing the motor or equipment.

3.7 CLEANING

- A. Remove all rubbish and debris from inside and around the motor controllers. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.8 EQUIPMENT PROTECTION AND RESTORATION

- A. Touchup and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

END OF SECTION

SECTION 40 68 63 – DCS AND OWS PROGRAMMING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The DCS and OWS programming work to be performed by the Control System Specialist, consisting of labor, licensing, software, and incidentals for the programming of DCS, OITs, OWS servers and workstations, and other hardware that make up the process control system. The work shall include every item of programming and configuration necessary for a complete and functioning installation.
- B. Related Sections:
 - 1. 40 61 96 – Process Control Descriptions

1.2 REFERENCES

- A. ANSI/ISA:
 - 1. 18.2-2016 – Management of Alarm Systems for the Process Industries.

1.3 DEFINITIONS

- A. OWS:
 - 1. Operator Workstation (Operator Monitor and Control Process through Graphical Displays)
- B. OIT:
 - 1. Operator Interface Terminal
- C. DCS:
 - 1. Distributed Control System
- D. EWS:
 - 1. Engineering Workstation
- E. I/O:
 - 1. Input/Output
- F. VFD:
 - 1. Variable Frequency Drive
- G. SSRVS:
 - 1. Solid State Reduced Voltage Starter ("Soft Starter")
- H. RTU:
 - 1. Remote Telemetry Unit
- I. MTU:
 - 1. Master Telemetry Unit
- J. MCC:
 - 1. Motor Control Center
- K. ETM:

1. Elapsed Time Meter
- L. IOP:
 1. Integrated Operating Platform – System of installed, connected, and configured hardware, operating programs, and networking equipment.
- M. DCS and OWS Programming:
 1. Software configuration of operating programs to implement plant control strategies.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCOPE

- A. The Control System Specialist shall be responsible for design of the DCS and OWS programs to achieve process control as specified in Drawings and sections. The Control System Specialist shall fully coordinate all components and details of the control system with all other equipment on the project.
- B. The Control System Specialist shall coordinate all DCS and OWS programming, testing, and startup activities throughout the duration of the project.
- C. Before final acceptance, the Control System Specialist shall configure all control loops to achieve stable process control in all conditions and perform a thorough test of all system functions.
- D. The system shall include custom DCS programming and process screen displays developed by the Control System Specialist. The screens will provide the major vehicle for operators to monitor and interact with the treatment process. These displays shall enable speedy access and provide the capability to manipulate process control variables along with performing standard operator tasks such as ramping values and responding to alarms. User defined graphics displays shall depict specific views of the process operations and control. They shall be created and configured for monitoring and managing the process through the software.
- E. Prior to finalizing graphic screens, the Control System Specialist shall submit screen captures of the proposed OWS screens to the Engineer and Owner for review. The submitted screen captures shall be sufficient to display the contents of the system, and to determine visual conformance with the Owner's standards. The Control System Specialist shall modify the screen contents based on the Owner and Engineer review prior to functional system testing. Review of the screens at this stage is preliminary and is not a final approval of all OWS content and functionality as required by the contract documents.

3.2 GENERAL

- A. All server and workstation programs required for the IOP shall be automatically started during the boot sequence.
- B. All calculations shall be performed in the DCS, including but not limited to analog control point values, unit conversions, timers, and numeric manipulations.
- C. All set points shall test for minimum and maximum values and shall be operator adjustable via the operator interface software.

- D. The DCS shall be configured to provide the system a heartbeat function that will enable the system to periodically check for proper communications. The OWS application shall issue an alarm if communication fails. A DCS monitoring screen shall be configured to indicate the alarm conditions and log any occurrence of an alarm with a date/time stamp and description.
- E. Inputs/Outputs:
1. P&ID and I/O list sheets in Drawings show the expected I/O points. Some I/O points on the input/output list may exist and therefore not specified in the P&IDs.
 2. All analog I/O shall be trended on the associated OWS.
 3. Analog Inputs: Analog inputs shall be scaled, summed, logged, provided with high and low alarming with adjustable dead-bands, and integrated against time for totalization as required.
 4. Analog Outputs: Analog outputs shall be scaled as required.
 5. Digital Inputs: Digital inputs shall be configured as status indicators or as alarms as required. As an alarm indicator, the digital indicator shall record a descriptive alarm message with the date and time of the occurrence.
 6. Digital Outputs: Digital outputs shall be configured as either normally open or normally closed contacts with maintained or momentary action as may be required.
- F. OWS Graphic Displays:
1. Layout:
 - a. Header or sidebar display containing city logo, alarm indicator, and non-process related navigation objects.
 - b. Main process overview screens will display major equipment statuses, analog values, and alarms in a graphical P&ID format.
 - c. Equipment popups will allow the operator to drill down to specific motors, valves, and instruments, displaying detailed information and allowing for equipment and device control.
 - d. A trending screen will display up to four trend charts for analog process values.
 - e. An alarming screen will display an alarm log history with description, date and timestamp, and acknowledgement status of alarm.
 - f. An event log screen will display system event history such as user logins with date and timestamps.
 - g. A DCS diagnostic screen will display DCS module statuses, as well as any communication alarms. This screen will also depict the local control panel network and any connected devices (OIT, Ethernet Switches, etc.)
 2. Navigation tools will be intuitive and consist of a navigation ribbon, as well as process links to adjacent displays and complexes.
- G. Package Systems:
1. Control and status data transmitted to and/or received from peer devices via a communications network must be performed using peer-to-peer messaging or similar method requiring only the peer devices. Peer-to-peer control data shall not be conveyed to a peer device via OWSs, OIT, servers, or workstations.
 2. Coordinate control and status data interface between IOP and packaged systems with manufacturer.
- H. The Control System Specialist shall furnish the Owner final as-built copies of documented DCS and OIT programs, on electronic media, suitable for future troubleshooting or modifications by others.

3.3 SECURITY

- A. OIT applications shall employ security configurations to prevent unauthorized changes to control and alarm parameters.

- B. At minimum, the security configuration shall consist of four access levels (Coordinate additional access levels and restrictions with Owner):
 - 1. Engineer:
 - a. Unrestricted access to all system features and parameters.
 - 2. Maintenance:
 - a. Start and stop servers, workstations, and programs.
 - b. Control loop tuning
 - c. Run diagnostic programs.
 - d. Process troubleshooting and repair.
 - e. IOP troubleshooting and repair.
 - f. Adjust process parameters.
 - g. Bypass interlocks and permissives configured with bypass option.
 - h. Enable and disable equipment control from DCS.
 - 3. Operator:
 - a. Start and stop OWS applications.
 - b. Adjust process parameters.
 - 4. View:
 - a. OWS navigation privileges only.
- C. User management shall utilize a User Configuration popup display with features to support adding, modifying, and deleting users. User management displays and features shall be restricted to users with Engineer privileges.
- D. Password management shall utilize a popup display to allow users to manage their respective passwords.
- E. A user shall be automatically logged out after periods of inactivity. Coordinate the time span a user must be inactive with the owner.

3.4 ALARM MANAGEMENT

- A. At a minimum, each alarm in the DCS shall have the following attributes.
 - 1. Alarm description.
 - 2. Alarm setpoint or logical condition.
 - 3. Alarm priority.
 - 4. Deadband (analog alarms).
 - 5. On delay.
 - 6. Off delay.
 - 7. Area or group .
 - 8. Alarm message. Alarm messages shall be consistent in wording.
 - 9. Alarm shelving by operator.
 - 10. Alarm suppression by program.
- B. Disabled, suppressed by design, or shelved alarms shall not impact other logic functions, such as interlock actions.
- C. At a minimum, each alarm record will include the following attributes.
 - 1. Alarm source tag name.
 - 2. Alarm description.
 - 3. Alarm state.
 - 4. Alarm Priority.
 - 5. Alarm group.
 - 6. Process value at time of occurrence.
 - 7. Time and date of alarm occurrence change of state.
- D. Alarm states will be used when displaying alarms on the OWS:

1. Normal: No indication.
 2. Unacknowledged Alarm: Audible and visual indication of alarm condition. Indication will be easily distinguishable from other alarm states.
 3. Acknowledged Alarm: Visual indication of alarm condition. Indication will be easily distinguishable from other alarm states.
 4. Return-to-Normal Unacknowledged Alarm: Visual indication of alarm condition. Indication will be easily distinguishable from other alarm states.
- E. All alarm configurations, controls, and states will be handled in the DCS. Alarm setpoints and limits may be viewable or, if authorized, adjustable from the OWS; however, alarm configurations shall be managed and maintained through the EWS.
- F. Coordinate self-healing and reset required alarms with Owner. All alarms shall be acknowledged via the OWS.
- G. Preconfigure analog device feedback high-high, high, low, low-low, rate-of-change, and out-of-range alarms.
- H. Other specific alarms are designated in the control loop descriptions.

3.5 PROCESS EQUIPMENT AND DEVICES

- A. OWS graphic objects shall use color and text to indicate remote control mode, software mode, and operating states.
1. Remote control modes will include Remote and Not in Remote.
 2. Software modes shall include Manual/Off/Auto modes.
 - a. Manual: Operator is control owner. If equipment and/or device is in remote control, ready for operation in any mode, and interlocks are satisfied the equipment operation shall follow operator commands.
 - b. Off: Equipment and/or device operation from IOP is disabled.
 - c. Auto: Program is control owner. If equipment and/or device are in remote control, ready for automatic operation, interlocks are satisfied, and permissives are satisfied, the equipment operation shall follow program commands.
 3. States:
 - a. Machine, pump, and blower operating states shall include stopped, stopping, starting, running.
 - b. Valve and gate operating states shall include closing, closed, opening, and opened.
 - c. Unique colors shall be used for stopped/closed, running/closed, starting/opening, and stopping/closing states. Coordinate colors with the Owner.
 4. Variable speed and variable position devices shall include actual speed and/or position as applicable.
 5. Alarm indications for process objects will include an alarm border and alarm priority symbol in the color of the highest priority active, unacknowledged alarm. Additionally, the alarm symbol shall include the priority value for said alarm.
- B. Popup faceplate displays will be included for monitoring, controlling, and configuring equipment and/or devices capable of control from the OWS. Faceplates shall be accessed by a click event on the graphic object. At a minimum, faceplates shall include the following features and configured with the applicable access levels.
1. Operator:
 - a. General display with:
 - 1) mode selector.
 - 2) manual speed (position) setpoint (if applicable).
 - 3) cumulative interlocks, permissives, unit ready for automatic control status, actual state, and actual speed (if applicable).

- b. Diagnostics displays with status indications for each interlock trip, permissive trip, unit not ready trip, and fault trip.
 - c. Operating statistics, such as elapsed time meters and operation cycle counts. This display shall also include a reset button to reset total values.
 - 2. Maintenance:
 - a. Include diagnostic features including the ability to disable operation separate from any operator-adjustable features.
 - b. Provide a means to bypass interlocks and permissives that are configured with a bypass feature.
 - 3. Engineer:
 - a. Include all configuration settings required to fully control unit, including but not limited to default modes, bump-less transfer, operating range, individual interlock, and permissive bypassing.
 - C. All actuated or driven units shall include DCS logic and OWS features to calculate and display operating statistics, such as cycle counts and ETMs.
 - 1. ETMs and cycle counters shall totalize the time and the number of times a unit is in the operating state, such as running or opened.
 - 2. ETMs and cycle counters shall capture starts per hour, daily totals, monthly totals, and running totals for display on OIT. Running totals shall maintain values until reset via an operator-selectable reset button on the respective faceplate. Daily totals are reset at engineer-adjustable time-of-day.
 - 3. Each ETM and cycle counter shall include provisions for users with Maintenance permissions to restore or set totalized values to a new value.
 - D. Equipment and/or devices with state feedback and remote control from the DCS, such as machines, valves and pumps, shall include a timeout alarm to indicate the commanded state was not achieved. Alarms for this type of failure must be reset by initiating an alarm reset from the OWS, achieving commanded state, local mode change, or software mode change.
 - E. Equipment and/or devices with remote control feedback to the OWS shall include an alarm to indicate when the field mode selector is not set for remote control.
- ### 3.6 PROCESS MONITORING AND CONTROL
- A. Each process shall include Manual/Off/Auto modes for automatic control, overriding automatic control, and disabling OWS control.
 - B. Each process shall have an associated popup display that uses symbols, text, and color to indicate the actual process state. The following states shall be included. In some cases, not all states are required, and may be omitted as needed.
 - 1. Resetting, Idle, Starting, Executing, Completing, Complete
 - 2. Holding, Held, and Un-holding
 - 3. Suspending, Suspended, and Unsuspending
 - 4. Stopping and Stopped
 - 5. Aborting, Aborted, and Clearing
 - C. A PID popup display shall be provided for configuring, adjusting, and monitoring closed-loop process controls. At a minimum, PID displays shall include maintenance adjustable PID loop parameters, operator-adjustable setpoint, and real time trend with setpoint, process variable and control variable pens.
 - D. Provide alarms as required to indicate when a closed-loop process is out of control.

■ - CLOSED/OFF
■ - OPENED/ON/AUTO

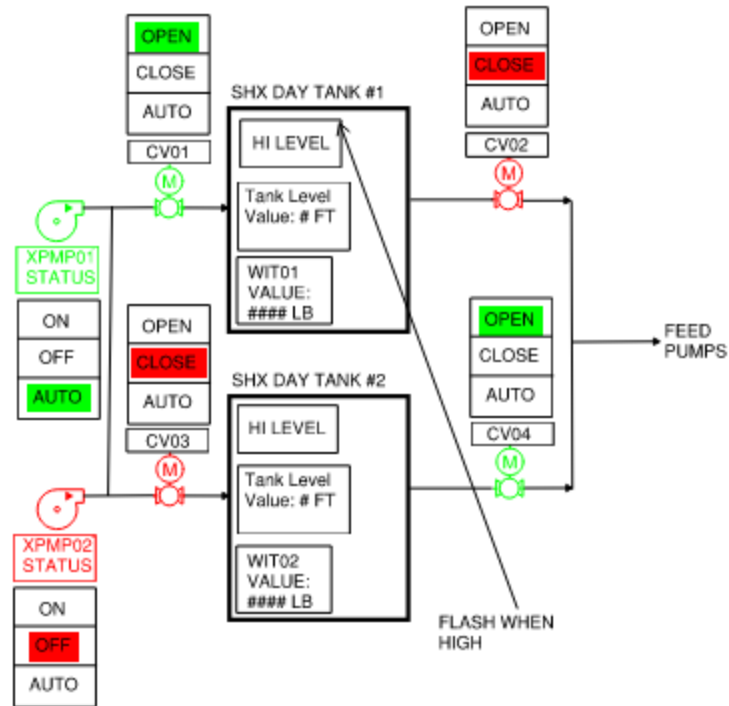


Figure 3-2: Proposed Day Tanks OWS Graphic Display

END OF SECTION

SECTION 40 70 00 – INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work for furnishing all materials, labor, equipment, tools, supplies, and incidentals for installation of all instrumentation equipment. The work shall include every item of construction necessary for a complete and acceptable installation.
- B. Related Sections:
 - 1. Section 40 61 13 – Process Control System General Provisions.
 - 2. Division 40 – Process Integration Instrumentation Sections.

1.2 REFERENCES

- A. ISA:
 - 1. S20 – Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves
 - 2. S50.1 – Compatibility of Analog Signals for Electronic Industrial Process Instruments
 - 3. S51.1 – Process Instrumentation Terminology
 - 4. S51.1 – Sec. 5 – Test Procedures
- B. NSF International:
 - 1. NSF 61 – Drinking Water System Components – Health Effects.
 - 2. NSF 372 – Drinking Water System Components – Lead Content.

1.3 COORDINATION

- A. Section 01 30 00 – Administrative Requirements.
- B. Coordinate Work of this Section with piping Work.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit manufacturer information for system materials and component equipment, including connection requirements.
- C. Shop Drawings:
 - 1. Specify system materials and component equipment.
 - 2. Submit installation requirements and other details.
- D. Manufacturer's Certificate:
 - 1. Certify that products meet or exceed specified requirements.
- E. Source Quality-Control Submittals:
 - 1. Specify results of factory tests and inspections.
- F. Field Quality-Control Submittals:
 - 1. Specify results of Contractor-furnished tests and inspections.

- G. Manufacturer Reports:
 - 1. Certify that equipment has been installed as specified in manufacturer instructions.
- H. Qualifications Statement:
 - 1. Submit qualifications for manufacturer.
- I. Closeout Submittals
 - 1. See Section 01 77 00 – Closeout Procedures for requirements.
 - 2. Project Record Documents:
 - a. Record actual locations and final orientation of equipment and accessories.

1.5 QUALITY ASSURANCE

- A. Make sure that materials of construction of wetted parts are compatible with process liquid.
- B. Materials in Contact with Potable Water:
 - 1. Certified to NSF 61 and NSF 372.

1.6 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified with minimum three years of documented experience.

1.7 SOURCE QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements for testing, inspection, and analysis.
- B. Certificate of Compliance:
 - 1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance specifying that Work performed at manufacturer's facility conforms to Contract Documents.
- C. Similar instruments shall be by the same Manufacturer to the extent practical.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection:
 - 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store equipment as specified in manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection as specified in manufacturer instructions.

1.9 WARRANTY

- A. See Section 01 78 36 – Warranty and Bonds, and individual instrument sections for additional or longer warranty requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Furnish instruments as specified in the individual instrument specifications. Instruments for services not listed shall be equal in quality, performance, and environmental and functional characteristics as instruments listed and shall be approved in writing by the Owner.

2.2 INSTRUMENT ACCESSORIES

- A. Instrument and Control Device Tags:
 - 1. Each field mounted instrument or control device shall be identified by its unique tag number as it appears in the contract documents. The tag number shall be stamped on a 1 in. by 2 in. stainless steel tag permanently attached to the instrument by braided stainless steel wire which has been sealed by an approved method such that the wire must be cut, or the seal broken to remove the tag. The tag number shall not be stamped on the nameplate of the instrument. This requirement shall be documented on the Instrumentation Section Sheet.
- B. Sunshades:
 - 1. Furnish stainless steel sunshades for all outdoor instruments not shaded by adjacent or integral equipment.
- C. Process Tubing:
 - 1. Stainless Steel, ASTM A 269, TP316, seamless, annealed, 1/2 in. by 0.065 in. W.T. minimum.
- D. Pneumatic Supply Tubing:
 - 1. Stainless Steel, ASTM A 269, TP316, seamless, annealed, 1/2 in. by 0.065 in. W.T., 3/8 in. by 0.049 in. W.T. and 1/4 in. by 0.035 in. W.T. minimum.
- E. Fittings:
 - 1. 316 Stainless Steel ferrule type, Swagelok or equal.
- F. Pipe Stand Type Supports for Instrumentation:
 - 1. Pipe stands shall be stainless steel using welded fabrications with 2 in. schedule 40 pipe, 2 in. square tube by 0.188 in. thick, 3/8 zinc/cadmium plated hardware, 1/2 in. expansion anchors, 12 gauge mounting channel and 1/4 in. thick stainless-steel plate as a minimum. Supply U-bolts or cable mounts, as necessary. Acceptable alternatives include engineered pipe stand systems such as O'Brien Saddlepak.
- G. Enclosures for outdoor locations:
 - 1. Furnish and install NEMA 4X enclosures. All outdoor enclosures with instrumentation accessible in enclosure door shall have a stainless steel sunshade.

2.3 INSTRUMENTATION CABLING

- A. Instrumentation signal wiring shall meet the following requirements:
 - 1. 18AWG minimum stranded tinned copper twisted pairs and triads as applicable for the application.
 - 2. Color code shall be black/red pair (black/red/white triad).
 - 3. Individually shielded with shield drain wires.
 - 4. Insulation to be polyethylene PE or PVC.
 - 5. Outer jacket to be black polyvinyl chloride PVC.

2.4 CALIBRATION

- A. Order instruments factory calibrated to the range specified in calibration sheets indicating certification of traceability to National Institute of Standards and Technology (NIST). Instruments shall be ranged as specified in the specification or as directed by Engineer.

2.5 FABRICATION

- A. Materials of Construction:
 - 1. Provide 316 Stainless Steel for wetted and other parts unless otherwise specified.

2.6 DIAPHRAGM PRESSURE SEALS

- A. Provide diaphragm type pressure seals with all pressure instrumentation including gauges, switches, and transmitters, for all process applications other than filtered water (unless specified to be provided with an annular style seal).
- B. Seals shall be 316L stainless steel housing and include a flushing port in the lower housing.
- C. Manufacturers and Products:
 - 1. Ashcroft Model 201 or equal

2.7 ANNULAR PRESSURE SEALS

- A. Where specified in Drawings, provide annular style isolation ring pressure seals installed in-line with process piping for pressure instrumentation connection.
- B. See Section 40 05 06 – Process Piping Specialties for requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 77 00 – Closeout Procedures for installation and examination requirements.
- B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION

- A. Coordinate location and orientation of instrumentation with final equipment installations.
- B. Ensure that instruments are located to be easily accessible for maintenance.
- C. Install sensing elements at the point of measurement and route sensing line or cable to the transmitter. Cables from sensors to transmitters shall be installed in conduit where subject to physical damage, and exposed cabling shall be limited to no more than 6 feet. Provide conduit cord connector fitting when transitioning from conduit to exposed cable. Provide strain relief grips where required for vertical cable support. Factory cords shall be trimmed to length to avoid excessive cable loops.
- D. Install transmitters 4 ft 6 in. above grade or platform in an easily accessible location adjacent to the sensor location. Mount on pipe stanchion or support designed for the purpose individually or grouped with other transmitters.
- E. Surge Protection

1. 2-wire Loop Powered Instruments: Furnish and install surge protector, Emerson EDCO SS65 or equal, in each 4 mA – 20 mA current loop, adjacent to each respective instrument.
 2. 4-wire Separately Powered Instruments: Furnish and install 120VAC/24VDC combination surge protector, EDCO SLAC-12036 or equal, adjacent to each respective instrument.
- F. Steel supports shall be as specified in this Section and all other sections.
- G. Process connections for instrumentation shall be as specified in piping sections and other section requirements.
- H. Provide block valves at taps for pressure or sampling sensor lines. Provide plugged tees at taps suitable for rodding or blowing out taps. Make pipe taps with weld-o-let type fittings or equal. Install block valves suitable for the service and rated as the pipe at each tap, generally use NPT threaded ball valves. Use materials rated for the service and transition to tubing for sensor runs. Use 1/2 in. OD 316 SS tubing or as specified in Drawing details.
- I. Tubing and Fittings:
1. Install tubing and fittings in a neat, orderly, and functional manner; level and plumb except as required, noted on approved drawings, or specified. Make offsets required for fittings or equipment level in the horizontal plane to prevent high or low spots.
- J. Conduit and fittings:
1. Install conduit as required. Provide a cast body tee fitting at the instrument connections at the low point of all conduit runs below the instrument with a drain fitting for condensate. Make connections from instrument to tee with liquid-tight flexible conduit and use sealing compound inside the conduit and shrink-fit tubing over the outside of the connection to prevent entry of water into the instrument. Heat trace and insulate all liquid filled lines and the sensing body of all instruments connected to liquid service in exterior locations.
- K. Calibration:
1. Calibrate each and every instrument connected to the work of this contract in its range, whether furnished under this contract, Owner-furnished, or existing, and fill out a signed and dated five point calibration sheet and install an initialed and dated calibration sticker. Notify the Owner in writing immediately of any instrument which will not calibrate. Instruments that do not calibrate will require the onsite services of a factory authorized representative at no cost to the Owner.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements for inspecting and testing.
- B. Testing:
1. Test and calibrate instruments to demonstrate that they meet specified accuracy requirements.
- C. Manufacturer Services:
1. Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 1 days on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.
- D. Equipment Acceptance:
1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

2. Make final adjustments to equipment under direction of manufacturer's representative.

E. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 75 00 – Startup Testing and Training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION

SECTION 40 72 23 – RADAR LEVEL METERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Continuous noncontact radar level measurement devices, including those for flume or weir flow measurement applications.
 - 2. Transmitters.
- B. Related Sections:
 - 1. Section 40 70 00 – Instrumentation for Process Systems

1.2 COORDINATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. See Section 40 70 00 – Instrumentation for Process Systems for requirements.
- C. Closeout Submittals
 - 1. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

1.5 WARRANTIES

- A. See Section 01 78 36 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Furnish level meters and accessories as required for application.

2.2 RADAR LEVEL MEASUREMENT DEVICES

- A. Manufacturers:
 - 1. Endress+Hauser
 - 2. Siemens Automation Technology
 - 3. Rosemount
 - 4. Vega
- B. Description:
 - 1. Radar device using microwave signals and time of flight technology, with separate radar sensor and transmitter, for continuous level measurement applications.
- C. Measuring Range:
 - 1. As specified in schedule.

- D. Radar Sensor:
 - 1. Material: Chemically resistant PVDF.
 - 2. IP68 submersible rated.
 - 3. Process Temperature Range: (-5)°F – 140°F.
- E. Accessories:
 - 1. Providing mounting hardware accessories as required for mounting application.
- F. Transmitter:
 - 1. Selected by sensor manufacturer to match sensor.
 - 2. Level transmitters for open channel flow applications shall be provided with preconfigured settings for converting level measurement to flow measurement.
 - 3. Visual Display: LCD Four digit minimum.
 - 4. Output Signal: Minimum of two 4 mA DC – 20 mA DC.
 - 5. Location: As specified in Drawings.
 - 6. Control Power: 120 VAC, single phase, 60 Hz.
 - 7. Housing Material: NEMA 4X, IP66/67.
 - 8. Furnish cable, field preamplifiers, and signal conditioners as required to maintain accuracy from sensor to terminal device.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

3.2 INSTALLATION

- A. Mount meters as specified in manufacturer's instructions.
- B. Blocking Distance:
 - 1. Contractor shall coordinate the sensor blocking distance with the level measurement requirements and mounting location of the sensor to ensure proper operation for each application.
- C. Beam Width:
 - 1. Contractor shall coordinate the sensor beam width with the level measurement requirements and mounting location of the sensor to ensure proper operation for each application.
- D. See Section 40 70 00 – Instrumentation for Process Systems for additional requirements.

3.3 FIELD QUALITY CONTROL

- A. Testing:
 - 1. Test and calibrate meters to demonstrate that it meets manufacturer's specified accuracy.
- B. See Section 40 70 00 – Instrumentation for Process Systems for additional requirements.

3.4 DEMONSTRATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

3.5 ATTACHMENTS

A. Level Meter Schedule:

Instrument Tag	Application	Measurement Range
MHK_CHM_ACH_LVL01	Liquid ACH Tank #1 Level	0 - 17ft
MHK_CHM_ACH_LVL02	Liquid ACH Tank #2 Level	0 - 17ft
MHK_CHM_ACH_LVL03	Liquid ACH Tank #3 Level	0 - 17ft
MHK_CHM_HF_LVL01	Hydrofluorosilicic Acid Tank Level	0 - 15ft
MHK_CHM_POLYC_LVL01	Cationic Polymer Tank Level	0 - 15ft
MHK_CHM_NAOH_LVL01	Sodium Hydroxide Tank #1 Level	0 - 17ft
MHK_CHM_NAOH_LVL02	Sodium Hydroxide Tank #2 Level	0 - 17ft
MHK_CHM_NAOH_LVL03	Sodium Hydroxide Tank #3 Level	0 - 17ft

END OF SECTION

SECTION 40 72 76 – LEVEL SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Tilting Float Level Switches.
- B. Related Section:
 - 1. Section 40 70 00 – Instrumentation for Process Systems

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

1.3 COORDINATION

- A. See Section 40 70 00– Instrumentation for Process Systems for requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

1.5 WARRANTY

- A. Furnish one-year manufacturer's warranty for tilting float switches.
- B. Provide ten-year manufacturer's warranty for conductivity level switches.
- C. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 TILTING FLOAT SWITCHES

- A. Manufacturers:
 - 1. Siemens
 - 2. Anchor Scientific
 - 3. Madison
 - 4. Or equal.
- B. Type:
 - 1. Direct acting tilt float switch.
- C. Materials:
 - 1. Rigid, Teflon coated.
 - 2. Mercury free.
- D. Electrical Contacts:
 - 1. One normally open or normally closed contact, as specified in Drawings.
 - 2. Rated 1A, 120 VAC minimum.

- E. Furnished with required length of cable and weight kit for cable suspension, as required.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

3.2 INSTALLATION

- A. Hang level switch cords with strain relief devices to prevent cord damage.
- B. See Section 40 70 00 – Instrumentation for Process Systems for additional requirements.

3.3 FIELD QUALITY CONTROL

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

3.4 DEMONSTRATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

3.5 ATTACHMENTS

- A. Float Switch Schedule:

Instrument Tag	Application	Mounting Height
MHK_CHM_NAOH_LSH01	Day Tank #1 Overflow Switch	
MHK_CHM_NAOH_LSH02	Day Tank #2 Tank Overflow Switch	6ft

END OF SECTION

SECTION 40 73 45 – WEIGHT SCALES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Scales for chemical day tanks, drums, and IBC totes.
 - 2. Transmitters.
- B. Related Sections:
 - 1. Section 40 70 00 – Instrumentation for Process Systems

1.2 COORDINATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

1.3 SUBMITTALS

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Furnish scales, transmitters, interconnecting cables, and accessories as required for application.

2.2 PLATFORM WEIGHT SCALES FOR LIQUID TANKS, DRUMS, AND TOTES

- A. Manufacturers:
 - 1. Scaletron
 - 2. Force Flow
- B. Description:
 - 1. Digital tank scale with electronic load cells for weight detection of tanks, drums, and IBC totes for pump in and pump out applications. Exact model provided shall match the tank application.
- C. Features:
 - 1. Fabricated with rugged steel frame that has a coating system resistant to moisture, chemical being weighed, abrasion, impact, and UV light.
- D. For day tank applications, scale shall have adjustable hold down lugs to secure the vessel to the platform.
- E. Provide scale with built-in containment feature for full volume of tank, drum, or tote where specified in documents.
- F. Measuring Range:
 - 1. As specified in schedule.

- G. Accuracy:
 - 1. Plus or minus 0.25%.
- H. Size:
 - 1. As specified in Drawings – suitable for size of tank, drum, or IBC tote.
- I. Accessories:
 - 1. Furnish cable between scale and transmitter, length as required for the application.

2.3 TRANSMITTERS (CONTROLLERS)

- A. Models
 - 1. Scaletron AccuPro 5000 PB
 - 2. Force Flow Solo G2
- B. Features:
 - 1. Keypad LCD display.
 - 2. Dual channel 4 mA – 20 mA output.
 - 3. Two (2) adjustable low level relay outputs.
 - 4. Control Power: 120 VAC, single phase, 60 Hz.
 - 5. Housing Material: NEMA 4X.
- C. Location:
 - 1. As specified in Drawings.
- D. Furnish quantity of transmitters needed based on quantity of scales required.
- E. Furnish cable, field preamplifiers, and signal conditioners as required to maintain accuracy from sensor to terminal device.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

3.2 INSTALLATION

- A. Install scales and transmitters as specified in manufacturer's instructions. Transmitters shall be positioned such that the display can be easily accessed.
- B. See Section 40 70 00 – Instrumentation for Process Systems for additional requirements.

3.3 FIELD QUALITY CONTROL

- A. Testing:
 - 1. Test and calibrate scales to display desired weight or volume units and demonstrate that it meets specified accuracy.
- B. See Section 40 70 00 – Instrumentation for Process Systems for additional requirements.

3.4 DEMONSTRATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

3.5 ATTACHMENTS

A. Weight Scale Schedule:

Instrument Tag	Application	Measurement Range
MHK_CHM_NAOH_WIT01	Sodium Hydroxide Day Tank #1 Weight	0 - 6000lb
MHK_CHM_NAOH_WIT02	Sodium Hydroxide Day Tank #2 Weight	0 - 6000lb

END OF SECTION

SECTION 40 92 13 – MOTORIZED OPERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Motorized gate and valve operators and mechanical, gear type limit switches.
- B. Related Sections:
 - 1. Section 01 33 00 – Submittal Procedures
 - 2. Section 01 40 00 – Quality Requirements.
 - 3. Section 01 60 00 – Product Requirements
 - 4. Section 40 23 43 – Process Valves

1.2 GENERAL

- A. Certain operators are specified in Division 44 to be furnished by equipment Manufacturer as part of their equipment package and/or system. These operators are to be installed by the Contractor as specified herein. In addition to installation, the Contractor shall be responsible for test, inspection, and assisting the equipment suppliers in startup services as required to the place the operators into continuous, reliable operation.

1.3 SCHEDULES

- A. Operator schedules are contained within the Process Valve Schedules in Section 40 23 43, PROCESS VALVES.

1.4 REFERENCES

- A. AWWA (American Water Works Association).
- B. NEMA (National Electrical Manufacturer's Association)

1.5 SUBMITTALS

- A. Submittals shall be made as required in Section 01 33 00, SUBMITTAL PROCEDURES. The following specific information shall be provided:
 - 1. Design Data:
 - a. Product data sheets for make and model.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Operating torque calculations for each valve size and class.
 - d. Maximum starting and normal operating torques for the operators supplied. Size operator for maximum starting torque.
 - 2. Quality requirements Submittals:
 - a. Tests and inspection data.
 - b. Manufacturer's Certificate of Proper Installation.
 - c. Manufacturer's printed installation instructions.
 - d. Special shipping, storage and protection, and handling instructions.
 - e. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
 - f. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

1.6 QUALITY ASSURANCE

- A. Ascertain that the valve Manufacturer provides limit switches with the valves.
- B. Actuator/operator Manufacturer shall coordinate with the valve Manufacturer and submit calculations showing the maximum and normal operating torques for the valves and operators supplied.

PART 2 - PRODUCTS

2.1 MOTORIZED OPERATOR

- A. Manufacturers:
 - 1. Motorized operators for gates and valves shall be the product of a single supplier for each type of valve. Products shall be furnished by one of the following, or Engineer approved equal:
 - a. Asahi Series 19 SMART ON/OFF
 - b. Or Engineer Pre-Approved Equal
- B. Design:
 - 1. Type: Open-Close
 - 2. Cycle time: Maximum of 30 seconds for a 90-degree rotation
 - 3. Duty Cycle: 70%
 - 4. Enclosure: Aluminum alloy, polyester painted, stainless-steel fasteners.
 - 5. Enclosure Protection: Type 4X (IP67) weatherproof.
 - 6. Manual Operation: Provide gear operated hand wheel (100/200 Nm sizes) for 5618 series actuator.
 - 7. Provide square adapter if necessary to adapt to valve.
 - 8. Visual position indicator.
- C. Actuator Gearing:
 - 1. Valve Actuator Gearing: Multiple reduction type with hardened alloy steel spur or helical gears and self-locking, alloy bronze worm gear set in drive train to maintain valve position.
 - 2. Power Gearing: Hardened alloy steel; accurately cut to assure minimum backlash; anti-friction bearing with caged balls or rollers throughout.
- D. Motors:
 - 1. Type: Specifically designed for valve actuator service with high starting torque, totally enclosed non-ventilated construction.
 - 2. Motor Insulation: Minimum NEMA Class F, with a maximum continuous temperature rating of 155 degrees Centigrade, rise plus ambient.
 - 3. Motor Windings: Epoxy treated.
 - 4. Size: Sufficient to open and close valves at maximum stated torque.
 - 5. Voltage Tolerance: Capable of operating at within 10 percent of specified voltage.
 - 6. Motor Duty Ratings: 70% of duty rating for open and close service.
 - 7. Accessories: Internal thermal contacts, 4-watt anti-condensation heater, thermal overload protection, and ground lug.
 - 8. Power Supply: As scheduled or as indicated on the Drawings.
 - 9. Enclosures for Motors, Switches, and Other Electrical Compartments:
 - a. Where explosion-proof construction is indicated on the Drawings, provide NEMA 7 enclosures.
 - b. Other Locations: Provide NEMA 4X (IP67) enclosures.
- E. Controls:

1. Voltage Transformer: As required to step down power supply to control voltage.
 2. Control Station:
 - a. Integral with operator or mounted in separate enclosure.
 - 1) Where explosion-proof construction is indicated on the Drawings, provide NEMA 7 enclosure.
 - 2) For other locations, provide NEMA 4X (IP67) enclosure.
 - b. Provide with additional contacts for remote indication of hand switch position where indicated on the Drawings.
 - c. Provide with the following devices:
 - 1) Lock-out ON-OFF-REMOTE selector switch.
 - 2) OPEN, STOP, CLOSE pushbuttons.
 - 3) OPEN and CLOSE indicating lights.
 3. Limit switches and associated gearing shall be integral with valve actuator.
 - a. Gearing: Intermittent type; bronze or stainless steel; grease lubricated; totally enclosed.
 - b. Contacts: Heavy duty and silver plated with wiping action.
 - c. Remote Indication Contacts: As indicated on the Drawings.
 - d. Switches: Adjustable; allowing for trip points from fully open to closed positions of valve travel; NOT subject to breakage or slippage due to over-travel; permits visible verification of switch position without disassembly.
- F. Operation:
1. Open-Close Service:
 - a. Operators shall operate automatically by remote signal specified and as indicated on the Drawings.
 - b. Manual operation of the valve is through the manual override. To operate manually power is removed from the actuator and then the manual override is used to open and close the valve.
 2. Where indicated on the Drawings, provide 4 to 20 milliampere direct-current analog output signal for continuous remote monitoring of position.
 3. Where indicated on the Drawings, provide a discrete signal to provide an alarm output.
 4. Controller System: Rated for continuous duty.
- G. Valve Limit Switches:
1. Type: Mechanical cam gear for remote operation, indication, and other control; compatible with associated operation and suitable for service intended; for valves specified and indicated on the Drawings; with racks, gears, cam, linkage mountings, and accessories.
 2. Mechanical Limit Switches: 2-pole, 3-pole, or 4-pole; gang-mounted in required multiples, and with necessary mechanical linkage.
 3. Contact Ratings: 120 volt alternating current, 20 amperes at 75 to 100 percent power factor, and 24-volt direct current, 5 amperes minimum.
 4. Enclosures: Watertight and oiltight for normal service.
 5. Valve box: Large enough to contain and to allow easy adjustment of limit switch without switch's removal.

PART 3 - EXECUTION

3.1 SHIPPING, STORAGE, HANDLING, AND PROTECTION

- A. As specified in Section 01 60 00, PRODUCT REQUIREMENTS.

3.2 INSTALLATION

- A. Install operators in accordance with Manufacturer's instructions.

B. Locate valve boxes where indicated on the Drawings.

END OF SECTION

DIVISION 43

PROCESS GAS AND LIQUID HANDLING,
PURIFICATION AND STORAGE EQUIPMENT

SECTION 43 41 43 – POLYETHYLENE UPRIGHT STORAGE TANK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Work necessary to completely furnish and install an upright, flat bottom high density cross-linked polyethylene (XLPE) storage tank, including all related equipment, material, and appurtenances.
- B. Related sections:
 - 1. Section 01 33 00 – Submittal Procedures
 - 2. Section 01 78 23 – Operation and Maintenance Data
 - 3. Section 05 50 00 – Metal Fabrications
 - 4. Section 09 96 00 – Painting and Protective Coatings
 - 5. Division 26 – Electrical Sections
- C. The Contractor shall provide high-density cross-linked polyethylene tanks and accessories per section 2.05, complete and in place, in accordance with the Contract Documents.
- D. Unit Responsibility:
 - 1. The Contractor shall be responsible for furnishing the high density cross-linked tank(s) and its accessories for chemical storage as indicated.

1.2 GENERAL

- A. Equipment Numbers:
 - 1. 50% Sodium Hydroxide (Caustic Soda) Day Tank: 7-T-30, 7-T-31.
- B. Like items of equipment provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, spare parts and manufacturer's services.
- C. Unit Responsibility: The Work requires that the XLPE storage tank, instruments, and components complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment. The supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.
- D. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.
- E. The equipment specified herein is included in the MANUFACTURER/ SUBCONTRACTOR Form. Refer to the Bid Form and the Instructions to Bidders for additional requirements.

1.3 SUBMITTALS

- A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00.

- B. In addition to the requirements of Section 01 33 00, submit the following additional specific information:
1. Shop Drawings:
 - a. Complete Manufacturer's descriptive information and shop drawings for all equipment, material, complete resin system information, and detailed fabrication drawings for Engineer Approval.
 - b. Manufacturer's catalog information and cut sheets for all manufactured items.
 - c. Tank data indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, and wall thickness.
 - d. Complete listing of sizes and descriptions of the fittings and accessories specified for each tank.
 - e. Layouts and assembly schedules for each tank identifying the location and elevation from the bottom of the tank for all fittings and other integrally molded connections and appurtenances.
 - f. A copy of the resin data sheet from the resin manufacturer for the tank is to be supplied and the tank manufacturer is to certify that it will be the resin used in the manufacture of the tank.
 - g. Supporting documentation of Manufacturer's certification to NSF/ANSI Standard 61.
 - h. Supporting information on fittings and accessories to be supplied; heat system, insulation, mastic coating, etc.
 - i. Tank capacity chart indicating gallons for each inch of depth and cumulative total from the bottom.
 - j. Provide tank restraint calculations signed and sealed by professional engineer licensed in the State of the work. Provide tank design certification signed and sealed by a professional engineer licensed in the state of the work. Design according to Section 01 81 02 and Section 01 81 04 as applicable.
 - k. Prior to the manufacture of the tank the designed wall thickness audit is to be supplied based upon 600 psi hoop stress (ASTM D 1998) at 100 degrees F.
 2. Quality Control Submittals:
 - a. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
 - b. Special shipping, storage and protection, and handling instructions.
 - c. Test procedures.
 - d. Factory Test results, reports, and certifications for each tank supplied.
 - 1) Verification of wall thickness
 - 2) Impact test
 - 3) Gel test
 - 4) Hydrostatic test
 - 5) Visual inspection
 - 6) Verification of fitting placement
 - e. Manufacturer's Certificate of Proper Installation.
 - f. Operation and maintenance manual.
 3. Contract Closeout Submittals: Service records for maintenance performed during construction.

1.4 QUALITY ASSURANCE

- A. Tanks furnished under this section shall be supplied by a manufacturer who has been regularly engaged in the design and manufacture of polyethylene storage tanks (based on ASTM D 1998) for over 10 years.
- B. Tanks shall be manufactured from materials certified to NSF/ANSI Standard 61.
- C. References, Codes, and Standards:
1. ASTM
 - a. D638 – Tensile Properties of Plastics

- b. D883 – Definitions of Terms Relating to Plastics
- c. D1505 – Density of Plastics by the Density Gradient Technique
- d. D1525 – Test Method for Vicat Softening Temperature of Plastics
- e. D1693 – Test Method for Environmental Stress-Cracking of Ethylene Plastics
- f. D-1998 – Standard Specification for Polyethylene Upright Storage Tanks
- g. F412 – Definitions and Terms Relating to Plastic Piping Systems
- 2. ARM Standards: Low Temperature Impact Resistance
- 3. NSF/ANSI Standard 61

1.5 OPERATION AND MAINTENANCE DATA

- A. O&M Manuals: Content, format and schedule for providing as specified in Section 01 78 23.
- B. Maintenance Summary Forms: As specified in Section 01 78 23.

1.6 WARRANTY

- A. Provide warranty for a period of 36 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.
- B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided and modified as required to conform to the performance, functions, features, and materials of construction as specified herein.
- B. Materials, equipment, components, and accessories specified in this section shall be, products of:
 - 1. PolyProcessing
 - 2. Assmann Corporation
 - 3. Snyder Industries

2.2 GENERAL REQUIREMENTS

- A. Flanges and Pipe Threads: Comply with ANSI B 16.1, Class 125; or B 16.5, Class 150, unless otherwise indicated. Threaded flanges and fittings shall have standard taper pipe threads complying with ANSI/ASME B 1.20.1.
- B. Anchor bolts shall be specified in Section 05 50 00. Number and size as recommended by manufacturer.
- C. Stainless Steel: Stainless steel components shall be 304 stainless steel, or higher, as specified.
- D. Nameplates: Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in accessible locations with stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, and characteristics.

- E. Tanks shall be rotationally-molded, vertical polyethylene, one-piece seamless construction, cylindrical cross section and vertical with flat bottom.
- F. Where double wall tanks are required on the supplemental data sheets, the containment tank shall be designed to hold a minimum of 115% of the normal fill capacity of the primary tank.

2.3 SUPPLEMENTS

- A. See supplements to this section for additional tank and accessory information.

2.4 TANK MATERIALS AND FABRICATION

A. Resin Classification

1. Tanks are classified according to type as follows:
 - a. Type I – Tanks molded from cross-linkable polyethylene resin.
 - b. Type II - Tanks molded from linear polyethylene resin (not cross-linkable resin).
2. The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. Type I tanks shall be made from cross-linked polyethylene (XLPE) resin as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties. Type II tanks shall be made from high density linear polyethylene (HDLPE) resin as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties.
3. All polyethylene resin material shall contain a minimum of a U.V. 8 stabilizer as compounded by the resin manufacturer.
4. Properties of XLPE (Type I) tank material:

Property	ASTM	Value
Density (Resin)	D1505	0.938 - 0.946 g/cc
Tensile (Yield Stress 2"/min)	D638	2,800 – 3,000 psi
Elongation at Break (2"/min)	D638	700 – 800%
ESCR (100% Igepal, Cond. A, F50)	D1693	>1000 hours
ESCR (10% Igepal, Cond. A, F50)	D1693	>1000 hours
Vicat Softening Degrees F. Temp	D1525	250
Flexural Modulus	D790	87,000 – 110,000 psi

5. Properties of HDPE (Type II) tank material:

Property	ASTM	Value
Density (Resin)	D4883	0.941 - 0.948 g/cc
Tensile (Yield Stress 2"/min)	D638	3,000 psi
Elongation at Break (2"/min)	D638	>100%
ESCR (100% Igepal, Cond. A, F50)	D1693	550 hours
ESCR (10% Igepal, Cond. A, F50)	D1693	50 hours
Vicat Softening Degrees F. Temp	D1525	235
Flexural Modulus	D790	130,000 psi

- B. Wall thickness for a given hoop stress is to be calculated in accordance with ASTM D 1998. Tanks shall be designed using a hoop stress no greater than 600 psi. In no case shall the tank thickness be less than design requirements per ASTM D 1998.
 1. The wall thickness of any cylindrical portion at any fluid level shall be determined by the following equation:

$$T = P \times OD / 2SD$$

Where: T = wall thickness, in
P = pressure, psi

OD = outside diameter, ft
SD = hydrostatic design stress, 600 psi

- C. On closed top tanks (as shown on data sheet) the top head shall be integrally molded with the cylindrical wall. Its minimum thickness shall be equal to the thickness of the top of the straight sidewall. Flat areas shall be provided for attachment of large fittings on the dome of the tank.
- D. Open top tanks (as shown on data sheet) shall have an integral top tank flange to provide optimal rigidity and strength.
- E. Open top tanks (as shown on data sheet) shall have molded-in gallon and liter markers to provide permanent gallonage indication for the life of the tank.
- F. Tanks with 2,000-gallon capacity or larger shall be provided with a minimum of 3 lifting lugs. Lugs shall be designed for lifting the tank when empty.
- G. Tank restraint system shall be designed and provided in accordance with Section 1.3.B.1.j.

2.5 TANK ACCESSORIES

- A. Fittings
 - 1. Tank fittings shall be in accordance with supplemental data sheets provided for each tank.
 - 2. Threaded fittings shall use American Standard Pipe Threads.
 - 3. Bolted flange fittings shall be constructed of one 150 lb. flange with ANSI bolt pattern, one flange gasket and stud bolts with gaskets. Stud bolts to have chemical resistant polyethylene injection molded heads and gaskets to provide a sealing surface between the bolt head and the interior tank wall. Stud bolt heads are to be color coded for visual ease of identifying the bolt material by onsite operators. Green- 316 Stainless Steel, Black- Titanium, Red- Alloy C-276, Blue- Monel. All materials shall be compatible with chemical service and as indicated in the fitting schedule above. For NSF/ANSI 61 certification, EPDM or Viton GF gaskets shall be supplied.
- B. Vents
 - 1. Each tank must be properly vented for the type of material and flow rates expected. Vents must comply with OSHA 1910.106 (f) (2) (iii) or other accepted standard. All tanks must be vented for atmospheric pressure as well as any pressure created by filling and emptying the tank.
 - 2. All u-vents shall be constructed of PVC or other specified materials.
 - 3. Install non-metallic vent caps with 24-mesh, non-corrodible insect screen on each vent pipe.
- C. Overflows
 - 1. Provide 24-mesh non-corrodible insect screen at the end of each overflow or combined overflow/drainpipe.
- D. Flexible Connections
 - 1. All tank fitting attachments shall be provided with flexible couplers. Tank piping flexible couplers shall be designed to allow 4% design movement. Movement shall be considered to occur both outward in tank radius and downward in fitting elevation from the neutral tank fitting placement.
 - 2. The flexible connection shall be manufactured of the same material as the tank or a compatible material approved by the Engineer. The flexible connection is to be attached as close as possible to the tank to reduce stress.
- E. Level Gauge

1. Refer to individual tank data sheet for type of float gauge if one is required.
- F. Down Pipes and Fill Pipes
1. Down pipes and fill pipes shall be prepared per the customer approved drawings and specifications. All down pipes and fill pipes shall be supported using a non-invasive free standing internal pipe support
 2. All down pipes and fill pipes shall be constructed of PVC or material compatible with the material stored. Pipes to have anti-siphon fittings.
- G. Ladders (if applicable)
1. Ladders shall be constructed of FRP and shall be provided with tanks as indicated on supplemental data sheets.
 2. Ladders must be secured to the tank and secured to the concrete to allow for tank expansion/contraction due to temperature and loading changes.
- H. Insulation (if applicable)
1. Insulation used shall be polyurethane foam with a density of 2.5 lb/ft³ with a minimum an "R" value of 6.3/in. The foam shall be applied with a nominal thickness of 2" to the external tank surfaces except the tank bottom.
 2. Upon completion of application and curing of the insulation, 2 full coverage coats of latex mastic coating shall be applied to the surface of the insulation in such manner as to seal the insulation from the outside environment.
- I. Tank Heating Systems (if applicable)
1. Heating systems for use with polyethylene tanks shall be designed to meet specific requirements such as tank material type, tank size, low ambient temperature, and desired maintenance temperature.
 2. All control components of the heating system shall be mounted in water tight, high impact plastic box(es) with a gasketed cover.
 3. All heating system components shall be NEMA 4 rated and factory pre-wired for 110 VAC. All connections shall be labeled to prevent errors in field installation.
 4. Each control box shall contain two temperature controls. One control shall regulate the maintenance temperature setting and the other control shall regulate the high temperature setting. The maintenance temperature setting should be set at the desired maintenance temperature. The high temperature setting shall be adjusted to 10 degrees above the desired maintenance temperature to a maximum of 130 degrees Fahrenheit. All control systems must be designed with a power off failure mode.
 5. The heating panels shall be designed to wrap around and lie flat against the surface of the tanks. The heating panels shall have a maximum heating density of 0.022 watts per square centimeter. All heating panels and sensor bulbs shall be attached to the tank with 2" wide duct tape. Under no circumstances shall cable type heaters be used with polyethylene tanks.
 6. Insulation used shall be polyurethane foam with a density of 2.0 - 3.0 lb./ft³ with a nominal "R" value of 8.33/in. The foam shall be applied with a nominal thickness of 2" to all external tank surfaces except the tank bottom shell.
 7. Upon completion of application and curing of the insulation, two full coverage coats of latex mastic coating shall be applied to the surface of the insulation in such manner as to seal the insulation from the outside environment.

PART 3 - EXECUTION

3.1 GENERAL

- A. The equipment specified herein shall be located as shown on the Drawings and installed in conformance with the Manufacturer's suggested method as approved. The tanks shall be adequately protected as work is accomplished around the tanks.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.
- B. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

3.3 FIELD QUALITY CONTROL

- A. Functional Testing:
 - 1. Conduct of each tank
 - 2. Hydrostatic leak test with the tank full of clean water. Allow water to stand for 24-hours to verify no leakage.

3.4 INSTALLATION

- A. As shown on the Drawings and in strict accordance with manufacturers recommended procedures.

3.5 MANUFACTURER'S SERVICES

- A. A manufacturer's representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services hereinunder, travel time excluded:
 - 1. Installation, Startup, and Testing Services:
 - a. 1 person-day for installation assistance, inspection, and Certificate of Proper Installation.
 - b. 1 person-day for functional and performance testing.
 - c. Provide Qualifications of Manufacturer's Representative.
 - 2. Training Services:
 - a. 1 person-day of prestart classroom or jobsite training of Owner's personnel.
 - b. Training of Owner's personnel shall be at such times and at such locations as required and approved by the Owner.

3.6 ATTACHMENTS

- A. The attachments listed below and following end of section are part of this Specification:
 - 1. 50% Sodium Hydroxide (Caustic Soda) Single Walled Day Storage Tank Data Sheet

END OF SECTION

GARVER TANK DATA SHEET

APPLICABLE TO:

- ☒ PROPOSAL
☐ PURCHASE
☐ RECORD

Tank Equipment No. FTK30, FTK31

Information not specified to be supplied by vendor as applicable

GENERAL INFORMATION

Chemical: 50% Sodium Hydroxide (Caustic Soda)

Working Capacity: 500 GAL

Location: INDOORS

Design Code: ASTM / ASME

Roof: DOMED

Material: XLPE

Shell: VERT CYL

Ambient Temp: 20 - 90 °F

Bottom: SLOPED TO OUTLET

COATING

EXTERNAL

INTERNAL

Surface Prep

Primer

Finish Coat

Insulation Thk

Material (Resin) XLPE

XLPE

Cladding

NOZZLE SCHEDULE

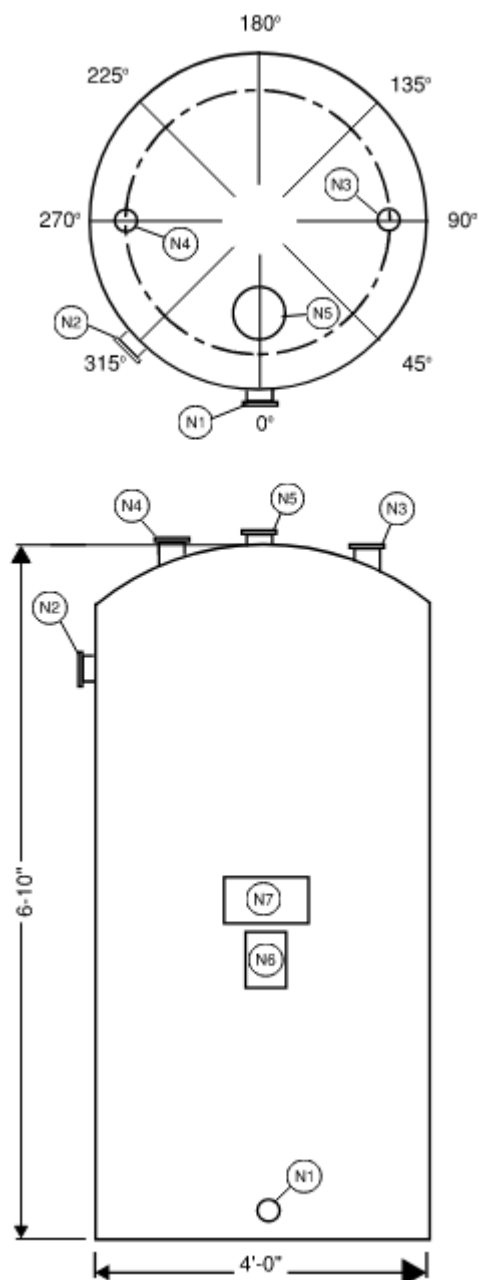
MK	Size/Type	Service	Projection	Radial CL
N1	3" FLG	OUTLET (NOTE 3)	6"	SIDE
N2	3" FLG	OVERFLOW (NOTE 2)	6"	SIDE
N3	3" FLG	FILL	6"	SIDE
N4	4" FLG	VENT	6"	TOP/CENTER
N5	16"	MANWAY	6"	SIDE
N6		MANUFACTURER NAME PLATE		SIDE
N7		CHEMICAL LABEL		SIDE

ACCESSORIES

Level Indicator Molded in Wall	☒	Exterior Pigmented Gel Coat	
Ladder	☐ Int ☐ Ext	Inlet Baffle	
Stairs		Lifting Lugs	☒
Walkway		Thief Hatch	
Platform	Clips ☐	Access Manways	☒
Volume Level Tape	☒	Anchor Lugs	☒
Down Corner	☐ Int ☐ Ext	Syphon Drain	
Insulate		Visual Liquid Level Gauge	
Heat Trace			

Design Maintain (Min) Temp:

High Limit (Cut-Off) Temp:



NOTES:

- SEE SPECIFICATIONS FOR ADDITIONAL INFO.
- EXTEND FILL LINE (N3) AND OVERFLOW (N2) TO 12" FROM TANK BOTTOM, ANTISIPHON. PROVIDE LATERAL SUPPORTS.
- OUTLET (N1) SHALL BE LOCATED AT INVERT OF TANK.
- ALL NOZZLES SHALL BE CONICAL GUSSET NOZZLE LOCATION IN THE ELEVATION
- VIEW MAY BE ROTATED FOR CLARITY AND DIMENSIONING
- REFERENCE DRAWINGS FOR TRUE TANK AND FITTING ORIENTATION

END OF SECTION

SECTION 43 41 45 - FIBERGLASS REINFORCED PLASTIC TANKS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This section includes the Work necessary to furnish and install complete, the Filament-Wound Fiberglass Reinforced Plastic (FRP) tanks including all related equipment, material, and appurtenances.

1.2 GENERAL

- A. Equipment Numbers: See Tank Data Sheets at the end of the section.
- B. Like items of equipment provided hereinafter shall be the end products of one Manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and Manufacturer's services.
- C. Unit Responsibility: The Work requires that the FRP tanks, complete with all accessories and appurtenances, be the end product of one responsible Manufacturer. The Manufacturer shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features and functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the systems as specified herein.
- D. The equipment specified herein is included in the MANUFACTURER/ SUBCONTRACTOR Form. Refer to the Bid Form and the Instructions to Bidders for additional requirements.

1.3 REFERENCES

- A. Refer to the following:
 - 1. ASTM D-3299 Filament Wound Glass Fiber Reinforced Polyester Chemical Resistant Tanks.
 - 2. ASTM D-4097 Standard Specification for Contact-Molded Glass Fiber Reinforced Thermoset Resin Corrosion-Resistant Tanks
 - 3. ASTM D-883 Definitions of Terms Relating to Plastics.
 - 4. ASTM D-2583 Test for Indentation Hardness of Rigid Plastics by Means of Barcol Impressere.
 - 5. ASTM D-2563 Recommended Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts.
 - 6. ASME RTP-1 Reinforced Thermoset Plastic Corrosion Resistant Equipment.
 - 7. American National Standards Institute (ANSI): B16.5, Pipe Flanges and Flanged Fittings.
 - 8. American Society for Testing and Materials (ASTM):
 - a. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment.
 - 9. D2584, Standard Test Method for Ignition Loss of Cured Reinforced Resins.

1.4 DEFINITIONS

- A. FRP: Fiberglass Reinforced Plastic.

1.5 DESIGN REQUIREMENTS

- A. Design the tanks according to Article REFERENCES of this Section.

- B. Design tank, including resin selection, wall thickness, methods and location of support, and stiffener requirements. Design shall be prepared and sealed by designer meeting requirements of Article QUALITY ASSURANCE of this Section.
- C. All tanks are to have a domed roof finished with a non-slip surface created by a heavy sprinkling of sand into the surface of the final surface resin coating.

1.6 SUBMITTALS

- A. The following specific information shall be provided:
 - 1. Shop Drawings:
 - a. Complete Manufacturer's descriptive information and shop drawings for all equipment, material, complete resin system information, and detailed fabrication drawings, and devices furnished.
 - b. Catalog information and cuts for all manufactured items, highlighted to show actual items proposed to be provided.
 - c. Tank data indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, corrosion barrier thickness, and details of nozzle designs.
 - d. All dimensions and locations of all major elements of the FRP tanks and their accessories, critical clearance requirements, and support dimension requirements.
 - e. Shop drawings or equipment drawings, including the location of connections to other work, material list, and empty and operating weights of the tanks.
 - f. Installation or placing drawings for equipment, and installation requirements including location of anchors, and piping connections.
 - g. Submit results of tests specified in Article FACTORY TESTING in this Section.
 - h. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
 - i. Fabricator's detailed requirements for anchor bolts.
 - j. Recommended bolt torques for all bolted FRP connections.
 - 2. Quality Control Submittals:
 - a. Fabricator's Certificate of Compliance with fabrication requirements.
 - b. Resin Manufacturer's Certification of resin for intended service.
 - c. Qualifications of fabricator's Quality Assurance Supervisor.
 - d. Copy of the fabricator's Quality Assurance Program.
 - e. Quality Assurance Inspection:
 - f. Qualifications of independent FRP Quality Assurance Inspector.
 - g. Initial QA Inspection Report.
 - h. Certification of Factory Testing.
 - i. Special shipping, storage and protection, and handling instructions.
 - j. Fabricator's printed installation and tank support instructions.
 - k. Manufacturer's Certificate of Proper Installation.
 - l. Drawings and other information required in Article DESIGN REQUIREMENTS of this Section.
 - m. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
 - n. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

1.7 OPERATION AND MAINTENANCE DATA

- A. Operation and Maintenance
 - 1. The equipment system manufacturer shall be responsible for supplying written instructions, which shall be sufficiently comprehensive to enable the operator to operate and maintain all equipment supplied by the manufacturer. Instructions shall assume the operator is

- familiar with pumping equipment, but he/she has not previously operated and/or maintained the exact equipment supplied.
2. The instruction shall be prepared as a system manual applicable solely to the equipment supplied by the manufacturer and shall include those devices and equipment supplied by him.
 3. Operation and maintenance instructions shall be specific to the equipment supplied in accordance with these specifications.

1.8 QUALITY ASSURANCE

- A. Fabricator's Qualifications: Provide an independent certified Quality Assurance Supervisor of minimum 10 years of experience in the design and manufacture of similar tanks.
 1. Provide a certificate of experience.
 2. Provide 5 project names – including owner, address, contact person, telephone number – for tanks designed and manufactured by fabricators that have been in service for more than 5 years.
- B. Fabricator's Quality Assurance Supervisor:
 1. Minimum 5 years' experience as an FRP inspector.
- C. Designer: Registered Professional Engineer.

1.9 WARRANTY

- A. Provide warranty for a period of 12 months after the final acceptance of the equipment by the Owner and Engineer, but no later than 18 months after delivery. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.
- B. Spare parts identified within this specification shall not be used to address warranty repairs.

1.10 SEQUENCING AND SCHEDULING

- A. Tanks/Vessels shall not be shipped from the factory until the Engineer's review of Certification of Factory Testing is completed.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Some specific requirements relative to this section are attached as supplements at the end of the section.

2.2 MANUFACTURERS

- A. Manufacturers:
 1. Diamond Fiberglass
 2. Tanksystems LLC.
 3. EcoVerde
 4. Or Equal.

Where Manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided as modified to conform to the performance, functions, features, and materials of construction as specified herein.

2.3 SERVICE CONDITIONS

- A. Risk Category III. Seismic Design Category B. SDS=0.142, SD1=0.116
- B. Normal Operating Pressure: Atmospheric.
- C. Instantaneous Pressure:
 - 1. Pressure: 3 psig.
 - 2. Vacuum: -1 psig.
- D. See Tank Data Sheets for additional information.

2.4 MATERIALS

- A. Filaments-Wound: According to ASTM D-3299-88, Grade 1.
- B. Closed Top: Head knuckle radius minimum 1.5"
- C. Flat Bottom:
 - 1. Bottom Knuckle Radius: Minimum 1.5".
 - 2. Extend reinforcement of the knuckle-radius area up the vertical wall a minimum of 8" on tanks to 4' diameter and 12" for tanks over 4' in diameter.
- D. Resin:
 - 1. Suitable for the intended service.
 - 2. Liner Resin: Premium grade vinyl ester resin, Dow Chemical Co. - Derakane 411, Ashland Chemical Co. - Hetron 922, or approved equal.
 - 3. Use the same resin throughout the tank shell. Dual resin systems shall not be acceptable.
 - 4. No dyes, pigments, or colorants except as follows:
 - a. Ultraviolet absorbers shall be added to the exterior surface of all tanks.
 - b. A pigmented exterior gel coat shall be provided when required on the Tank Data Sheets.
 - 5. The resin shall not contain fillers or thixotropic agents.
 - 6. Curing System:
 - a. As recommended by resin Manufacturer.
 - b. Cure all products to a minimum of 90% of the minimum Barcol hardness specified by resin Manufacturer.
 - c. Measure Barcol hardness according to ASTM D-2583-87.
 - 7. Tanks shall be post-cured. Post-cure the tank and appurtenances in accordance with resin Manufacturer's recommendation for time and temperature. Post-curing shall be completed with warm-to-hot dry air, free of combustion products. Hot spots shall be avoided.
- E. Reinforcement:
 - 1. Veil: Synthetic surface veil (Nexus - Burlington Industries, or approved equal), with finish and a binder compatible with the lay-up resin.
 - 2. Interior Layer: A resin-rich interior surface of 100 to 120 mils using chopped strand mat backing the veil. Use no additive in the corrosion barrier.
 - 3. Chopped Strand Mat: Type E glass, minimum 1-1/2 ounces per square foot, with silane finish and styrene soluble binder.
 - 4. Continuous roving used in chopper gun for spray-up: Type E glass.

5. Woven Roving: Type E glass, nominal 24 ounces per square yard, 4 by 5 weave, with silane type finish.
6. Continuous roving used for filament winding: Type E glass with a silane type finish, with a nominal yield of at least 250 strand yards per pound.

2.5 FABRICATION REQUIREMENTS

A. General

1. Tanks shall be chop-hoop filament wound fabrication. Filament wound shall confirm to ASTM Specification D3299-95a, "Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks".

B. Closed Top:

1. Head Knuckle Radius: Minimum 1.5 inch
2. All tanks shall have a domed roof finished with a non-slip surface created by a heavy sprinkling of sand into the surface of the final surface resin coating.

C. Flat Bottom:

1. Bottom Knuckle Radius: Minimum 1.5 inch
2. Extend reinforcement of the knuckle-radius area up the vertical wall a minimum of 8 inches on tanks to 4 feet diameter and 12 inches for tanks over 4 feet in diameter.

D. Laminate:

1. Laminate consists of inner surface and interior layer (together constitute the corrosion barrier), exterior layer (structural layer), and outside surface.
2. Meet the requirements of the mechanical properties and visual acceptance criteria in accordance with ASTM D-2563-87, Level II on tank interior and Level III for outside surfaces.
3. Inner Surface: Reinforce inner surface with a resin-rich surfacing veil of at least 20 mils thick. The inner surface shall have a minimum of 2 plies of veil. The resin content of the inner surface shall be a minimum of 85% by weight.
4. Interior Layer: Construct the interior layer of resin reinforced with a minimum of 2 plies of chopped strand mat. The thickness of the interior layer shall not be less than 100 mils thick.
5. Corrosion Barrier: Glass content of combined inner surface and interior layer shall be 27% $\pm$ 5%. The corrosion barrier shall be considered non-structural for all design aspects.
6. Exterior or structural layer:
 - a. Hand Lay-up (heads, joints, fittings): Alternating layers of chopped strand E-glass or equivalent chopped glass and woven roving. Glass content for hand lay-up layers shall be 30% to 45%.
 - b. Filament Wound: Chop-hoop filament winding with continuous strand roving to provide a glass content of 50% to 80%.
7. Marking:
 - a. Each tank shall be identified with:
 - b. Equipment Identification (TAG) number.
 - c. Resin.
 - d. Chemical to be Stored Including:
 - e. Concentration.
 - f. Specific gravity.
 - g. pH.
 - h. Design pressure/vacuum.
 - i. Tank wall and head minimum thickness.
 - j. Tank capacity, total and usable.
 - k. Tank design temperature.
 - l. Date of manufacture.
 - m. Manufacturer name and addresses.

- n. Provide permanent, visible marking. Seal decals, labels, etc, into the laminate exterior with clear resin.

E. Nozzles:

1. All flanged nozzles shall be hand lay-up construction with the pipe stub molded integrally with the pipe flange. Compression molded or cemented on flanges are prohibited. The resin used for the inner surface and interior layer of flanged stubs shall have the same resin cure system as the tank.
2. Nozzles shall be gusseted with conical or plate type gussets. Plate gussets shall be suitably laminated to the flange back side, hub, pipe neck, and tank wall
3. Nozzles shall be finished flush with the inside surface of the tank, unless indicated otherwise.
4. Provide two gaskets for each nozzle. Gaskets shall be 1/8" thick full-face elastomeric material having a hardness of Shore A60 $\pm$ 5. Gasket material shall be suitable for the intended service.
5. All flanged nozzles shall be rated at 100 psi with dimensions and bolting corresponding to ANSI B16.3-88 for 150 lb. steel flanges.
6. The back face of all flanges shall be spot-faced, flat and parallel to the flange face of sufficient diameter to accept an SAE metal washer under the bolt head or nut.
7. Nozzles shall have a 6" projection as measured from the face of the flange to the tank exterior surface, to allow insertion of flange bolts pointed away from the tank.

F. Manways: Flanged manways shall be provided as indicated on the Tank Data Sheets.

1. Flanged manways shall be provided with full-face Garlock or Gore-Tex Expanded PTFE gaskets, 40 to 60 Durometer and 1/4-inch minimum thickness.
2. Flange dimensions, including bolting pattern, shall be as required for design pressures stated hereinbefore. In addition, minimum thickness for all man-way flanges shall meet or exceed requirements of ASTM D-3299 for side entry man-ways.
3. Manway bolts and hardware shall be FRP or 316 Stainless-steel.
4. The area directly surrounding man-way nozzles shall have a double, reinforcing plate installed.

2.6 APPURTENANCES

A. Supports:

1. Pipe Supports:
 - a. Provide for all tank overflow pipes and loading pipes, as required.
 - b. Spacing of supports shall be as recommended by the fabricator but shall not be greater than 4' center to center and shall allow removal of the pipe.
 - c. Provide FRP supports complete with necessary bolts, nuts, and washers.
2. Provide lifting lugs suitably attached for all tanks weighing over 100 pounds.
3. Anchor Bolts: Type 316, stainless steel bolts, sized by fabricator and at least 1/2" in diameter, or as shown and as specified in Section 05 50 00, METAL FABRICATIONS.
4. Anchor Bolt Clips: Provide minimum of four equally spaced anchor bolt clips on each tank. The anchor bolt clips to be fabricated from FRP or TYPE 316 stainless steel.
5. Safety Devices: The completed work shall include all necessary permanent safety devices, required by OSHA, and other Federal, State, and local health and safety regulations.

2.7 SOURCE QUALITY CONTROL

A. Provide services of an independent FRP testing inspector to be present at the point of manufacture at the time fabrication is started, to perform the following:

1. Observe manufacturing methods, machinery, and techniques to assure compliance with industry standards and these specifications.
2. Observe initial fabrication to verify compliance with these specifications.
3. Observe quality control methods for mixing resins and testing of completed equipment.

4. Generally observe quality of other, ongoing fabrication.
 5. Prepare an Initial QA Inspection Report.
- B. Upon completion of fabrication and prior to shipment, the independent FRP testing inspector shall perform or witness the following:
1. Visual inspection to the requirements of ASTM D-2563-87.
 2. Barcol Hardness measurements per ASTM D-2583-87.
 3. Acetone sensitivity test for all internal secondary bonds.
 4. Glass content by ignition loss on three cutouts per ASTM D-2584.
 5. Hydrostatic Leak Test:
 - a. Perform on all tanks.
 - b. Fill to top nozzle; allow it to stand for 2 hours with no visible leakage.
 6. Repairs deemed acceptable by the independent FRP testing inspector must be approved by Engineer. Provide service records for repairs performed during construction.
 7. Identify and retain all cutouts. The engineer may select certain cutouts for testing for physical properties of the laminate.
 8. Factory Test Reports: Certify and sign the results of the following:

Inspections.
 9. Results of hydrostatic testing.
 10. Test Reports of physical properties of standard laminates.

PART 3 - EXECUTION

3.1 GENERAL

- A. The equipment specified herein shall be located as shown on the Drawings and installed in conformance with the Manufacturer's suggested method as approved. The tanks shall be adequately protected as work is accomplished around the tanks.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Section 01 60 00, PRODUCT REQUIREMENTS. In addition, prepare and protect the tank for shipment as follows:
1. Mount tanks on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
 2. Protect all flanged nozzles with wooden blinds bolted to the flange and having a diameter of 2" greater than the outside diameter of the flange.
 3. Provide either rigid plugs inside the ends to prevent deflection or wooden boxes for all un-flanged components. Brace the open ends of tanks with a suitable stiffening member to prevent deflection.
 4. Do not ship components or other pieces loose inside the tanks.
 5. Load tanks with at least 2" clearance between the tank (including fittings) and the bulk heads or bed of the vehicle.
 6. Regardless of the mode of transportation, firmly fasten and pad all components to prevent shifting of the load or flexing of components while in transit.
 7. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

3.3 INSTALLATION

- A. The intent of this Section is to advise the installing Contractor of certain mandatory requirements which must be accomplished during installation of Fiberglass Reinforced Plastic (FRP) tanks. It is not intended to be used as a sole specification governing the installations, but only to communicate certain assumptions used in the design of the vessels.

- B. In accordance with the Manufacturer's written instructions.
- C. Accurately place anchor bolts using templates furnished by the Manufacturer.
- D. The vessel foundation must provide full non-elastic support to the flat bottom preferably through the use of wet grout, which will allow continuous support even though surfaces may not be flat.
- E. Prior to tightening anchor bolts, hard shims must be installed under all anchor lugs, completely filling the void between the lug and foundation.
- F. Unless otherwise agreed, all piping and ducting shall be independently supported, so as not to apply loads to the vessel nozzles. Potential loads due to thermal expansion of piping should also be isolated from the vessel. During installation, do not force piping into alignment; this can create excessive stresses in the tank.
- G. Do not mate raised face flanges or ring gaskets to full faced FRP nozzles.
- H. Where tank foundations are cutout to accommodate full bottom drains, after tank installation the cutout area shall be backfilled with grout or other material that will provide localized support.

3.4 FIELD QUALITY CONTROL

- A. Functional Test:
 - 1. Conduct on each tank.
 - 2. Hydrostatic leak test with the tank full of clean water. Allow water to stand for 24 hours. No leakage permitted.

3.5 MANUFACTURERS' SERVICES

- A. A Manufacturer's representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services herein under, travel time excluded:
 - 1. (2) person-days for installation assistance, inspection, and certification of the installation. Provide certificate.
 - 2. (1) person-day for pre-startup classroom or job site training of Owner's personnel.
- B. Training of Owner's personnel shall be at such times and at such locations as requested by Owner.
- C. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
- D. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.6 SUPPLEMENTS

- A. The supplements listed below are part of this Specification.
 - 1. 43 41 16.1

GARVER TANK DATA SHEET

APPLICABLE TO:

- ☒ PROPOSAL
☐ PURCHASE
☐ RECORD

Tank Equipment No. FTK10 FTK11, FTK12

Information not specified to be supplied by vendor as applicable

GENERAL INFORMATION

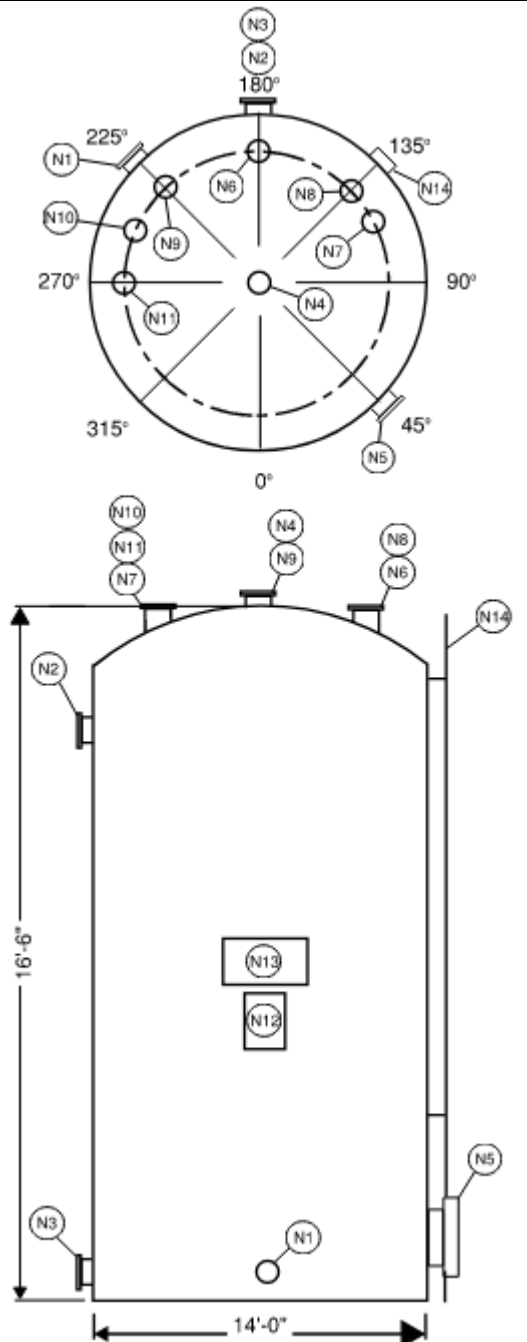
Chemical: 50% Sodium Hydroxide (Caustic Soda)		
Working Capacity: 18,900 GAL	Location: INDOORS	
Design Code: ASTM / ASME	Roof: DOMED	
Material: FRP	Shell: VERT CYL	
Liquid Temp: 50 - 120 °F	Bottom: SLOPED TO OUTLET	
COATING	EXTERNAL	INTERNAL
Surface Prep		
Primer		
Finish Coat		
Insulation Thk		
Material (Resin)	Vinyl Ester	Vinyl Ester
Cladding		

NOZZLE SCHEDULE

MK	Size/Type	Service	Projection	Radial CL
N1	3" FLG	OUTLET (NOTE 3)	6"	SIDE
N2	4" FLG	OVERFLOW (NOTE 2)	6"	SIDE
N3	3" FLG	DRAIN	6"	SIDE
N4	4" FLG	VENT	6"	TOP/CENT ER
N5	24"	MANWAY	6"	SIDE
N6	3" FLG	FILL		TOP
N7	8" FLG	INSPECTION WITH HINGED COVER	6"	TOP
N8	4" FLG	LEVEL SENSOR	6"	TOP
N9	3" FLG	WATER FILL	6"	SIDE
N10	1" FLG	LEVEL GAUGE (NOTE 5)	3"	SIDE
N11	6" FLG	RECIRCULATION INLET	6"	TOP
N12		MANUFACTURER NAME PLATE		SIDE
N13		CHEMICAL LABEL		SIDE
N14		LADDER		SIDE

ACCESSORIES

Level Indicator	X	Exterior Pigmented Gel Coat	
Ladder ☐ Int ☒ Ext	X	Inlet Baffle	
Stairs		Lifting Lugs	X
Walkway		Thief Hatch	
Platform ☐ Clips ☐		Access Manways	X
Volume Level Tape	X	Anchor Lugs	X
Down Corner ☐ Int ☐ Ext		Syphon Drain	
Insulate		Visual Liquid Level Gauge	X
Heat Trace			
Design Maintain (Min) Temp:			
High Limit (Cut-Off) Temp:			



NOTES:

1. SEE SPECIFICATIONS FOR ADDITIONAL INFO.
2. EXTEND FILL LINE (N6) AND OVERFLOW (N2) TO 12" FROM TANK BOTTOM. INTERNAL DROP PIPES TO HAVE ANTI-SIPHON FITTINGS . PROVIDE INTERNAL SUPPORTS.
3. OUTLET (N1) SHALL BE LOCATED AT INVERT OF TANK.
4. ALL NOZZLES SHALL BE CONICAL GUSSET NOZZLE LOCATION IN THE ELEVATION
5. EXTERIOR VISUAL LEVEL GAUGE TO BE REVERSE FLOAT LEVEL GAUGE
6. VIEW MAY BE ROTATED FOR CLARITY AND DIMENSIONING
7. REFERENCE DRAWINGS FOR TRUE TANK AND FITTING ORIENTATION

GARVER TANK DATA SHEET

APPLICABLE TO:

- ☒ PROPOSAL
☐ PURCHASE
☐ RECORD

Tank Equipment No. FTK01, FTK02, FTK03

Information not specified to be supplied by vendor as applicable

GENERAL INFORMATION

Chemical: 50% Aluminum Chlorohydrate (ACH)		
Working Capacity: 18,900 GAL	Location: Indoors	
Design Code: ASTM / ASME	Roof: DOMED	
Material: FRP	Shell: VERT CYL	
Ambient Temp: 20 - 90 °F	Bottom: SLOPED TO OUTLET	
COATING	EXTERNAL	INTERNAL
Surface Prep		
Primer		
Finish Coat		
Insulation Thk		
Material (Resin)	Vinyl Ester	Vinyl Ester
Cladding		

NOZZLE SCHEDULE

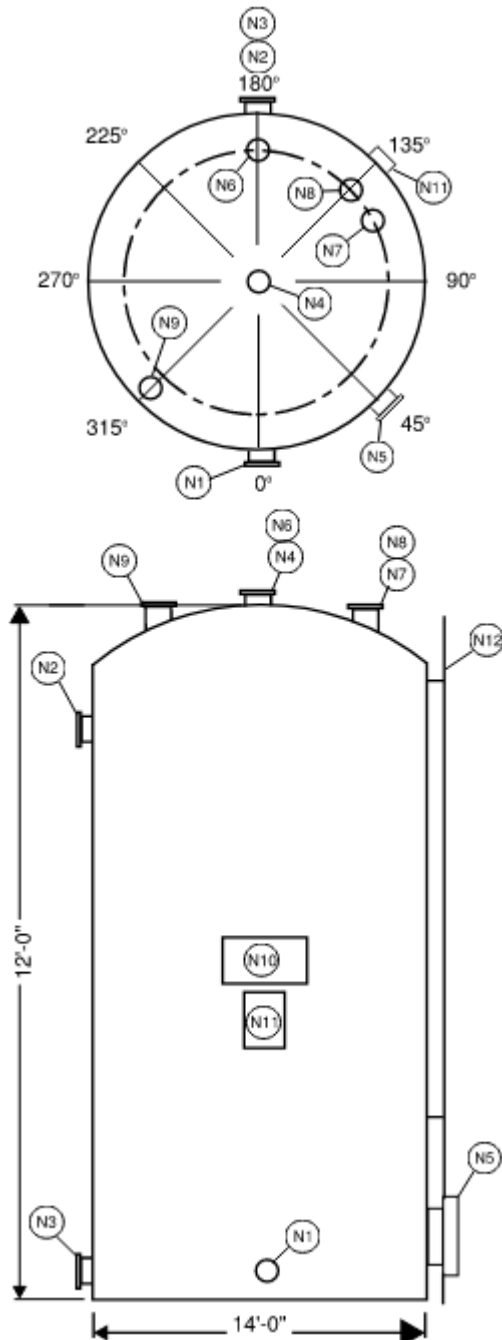
MK	Size/Type	Service	Projection	Radial CL
N1	3" FLG	OUTLET (NOTE 3)	6"	SIDE
N2	4" FLG	OVERFLOW (NOTE 2)	6"	SIDE
N3	3" FLG	DRAIN	6"	SIDE
N4	4" FLG	VENT	6"	TOP/CENT ER
N5	24"	MANWAY	6"	SIDE
N6	3" FLG	FILL		TOP
N7	8" FLG	INSPECTION WITH HINGED COVER	6"	TOP
N8	4" FLG	LEVEL SENSOR	6"	TOP
N9	1" FLG	LEVEL GAUGE (NOTE 5)	3"	SIDE
N10		MANUFACTURER NAME PLATE		SIDE
N11		CHEMICAL LABEL		SIDE
N12		LADDER		SIDE

ACCESSORIES

Level Indicator	X	Exterior Pigmented Gel Coat	
Ladder ☐ Int ☒ Ext	X	Inlet Baffle	
Stairs		Lifting Lugs	X
Walkway		Thief Hatch	
Platform Clips ☐		Access Manways	X
Volume Level Tape	X	Anchor Lugs	X
Down Corner ☐ Int ☐ Ext		Syphon Drain	
Insulate		Visual Liquid Level Gauge	X
Heat Trace			

Design Maintain (Min) Temp:

High Limit (Cut-Off) Temp:



NOTES:

1. SEE SPECIFICATIONS FOR ADDITIONAL INFO.
2. EXTEND FILL LINE (N6) AND OVERFLOW (N2) TO 12" FROM TANK BOTTOM. INTERNAL DROP PIPES TO HAVE ANTI-SIPHON FITTINGS . PROVIDE INTERNAL SUPPORTS.
3. OUTLET (N1) SHALL BE LOCATED AT INVERT OF TANK.
4. ALL NOZZLES SHALL BE CONICAL GUSSET NOZZLE LOCATION IN THE ELEVATION
5. EXTERIOR VISUAL LEVEL GAUGE TO BE REVERSE FLOAT LEVEL GAUGE
6. VIEW MAY BE ROTATED FOR CLARITY AND DIMENSIONING
7. REFERENCE DRAWINGS FOR TRUE TANK AND FITTING ORIENTATION

GARVER TANK DATA SHEET

APPLICABLE TO:
☒ PROPOSAL
☐ PURCHASE
☐ RECORD

Tank Equipment No. FTK08

Information not specified to be supplied by vendor as applicable

GENERAL INFORMATION

Chemical: 25% Hydrofluorsilicic Acid (HFS)		
Working Capacity: 12,600 GAL	Location: Indoors	
Design Code: ASTM / ASME	Roof: DOMED	
Material: FRP	Shell: VERT CYL	
Ambient Temp: 20 - 90 °F	Bottom: SLOPED TO OUTLET	
COATING	EXTERNAL	INTERNAL
Surface Prep		
Primer		
Finish Coat		
Insulation Thk		
Material (Resin)	Vinyl Ester	Vinyl Ester
Cladding		

NOZZLE SCHEDULE

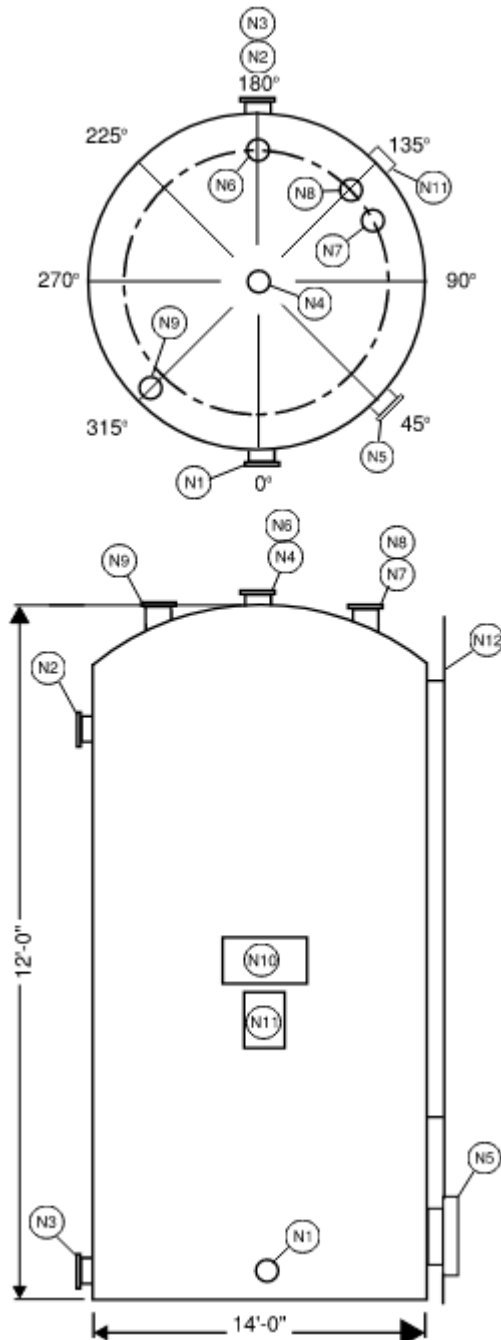
MK	Size/Type	Service	Projection	Radial CL
N1	3" FLG	OUTLET (NOTE 3)	6"	SIDE
N2	4" FLG	OVERFLOW (NOTE 2)	6"	SIDE
N3	3" FLG	DRAIN	6"	SIDE
N4	4" FLG	VENT	6"	TOP/CENT ER
N5	24"	MANWAY	6"	SIDE
N6	3" FLG	FILL		TOP
N7	8" FLG	INSPECTION WITH HINGED COVER	6"	TOP
N8	4" FLG	LEVEL SENSOR	6"	TOP
N9	1" FLG	LEVEL GAUGE (NOTE 5)	3"	SIDE
N10		MANUFACTURER NAME PLATE		SIDE
N11		CHEMICAL LABEL		SIDE
N12		LADDER		SIDE

ACCESSORIES

Level Indicator	X	Exterior Pigmented Gel Coat	
Ladder ☐ Int ☒ Ext	X	Inlet Baffle	
Stairs		Lifting Lugs	X
Walkway		Thief Hatch	
Platform Clips ☐		Access Manways	X
Volume Level Tape	X	Anchor Lugs	X
Down Corner ☐ Int ☐ Ext		Syphon Drain	
Insulate		Visual Liquid Level Gauge	X
Heat Trace			

Design Maintain (Min) Temp:

High Limit (Cut-Off) Temp:



NOTES:

1. SEE SPECIFICATIONS FOR ADDITIONAL INFO.
2. EXTEND FILL LINE (N6) AND OVERFLOW (N2) TO 12" FROM TANK BOTTOM. INTERNAL DROP PIPES TO HAVE ANTI-SIPHON FITTINGS . PROVIDE INTERNAL SUPPORTS.
3. OUTLET (N1) SHALL BE LOCATED AT INVERT OF TANK.
4. ALL NOZZLES SHALL BE CONICAL GUSSET NOZZLE LOCATION IN THE ELEVATION
5. EXTERIOR VISUAL LEVEL GAUGE TO BE REVERSE FLOAT LEVEL GAUGE
6. VIEW MAY BE ROTATED FOR CLARITY AND DIMENSIONING
7. REFERENCE DRAWINGS FOR TRUE TANK AND FITTING ORIENTATION

GARVER TANK DATA SHEET

APPLICABLE TO:
☒ PROPOSAL
☐ PURCHASE
☐ RECORD

Tank Equipment No. FTK06

Information not specified to be supplied by vendor as applicable

GENERAL INFORMATION

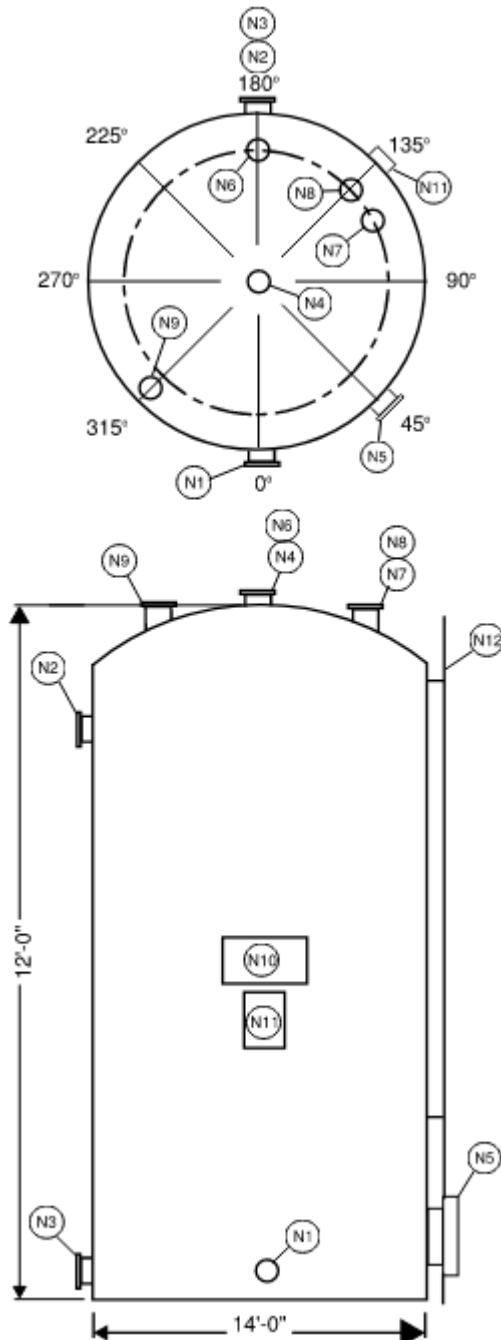
Chemical: Clarifloc C-378 Cationic Polymer		
Working Capacity: 12,600 GAL	Location: Indoors	
Design Code: ASTM / ASME	Roof: DOMED	
Material: FRP	Shell: VERT CYL	
Ambient Temp: 20 - 90 °F	Bottom: SLOPED TO OUTLET	
COATING	EXTERNAL	INTERNAL
Surface Prep		
Primer		
Finish Coat		
Insulation Thk		
Material (Resin)	Vinyl Ester	Vinyl Ester
Cladding		

NOZZLE SCHEDULE

MK	Size/Type	Service	Projection	Radial CL
N1	3" FLG	OUTLET (NOTE 3)	6"	SIDE
N2	4" FLG	OVERFLOW (NOTE 2)	6"	SIDE
N3	3" FLG	DRAIN	6"	SIDE
N4	4" FLG	VENT	6"	TOP/CENTER
N5	24"	MANWAY	6"	SIDE
N6	3" FLG	FILL		TOP
N7	8" FLG	INSPECTION WITH HINGED COVER	6"	TOP
N8	4" FLG	LEVEL SENSOR	6"	TOP
N9	1" FLG	LEVEL GAUGE (NOTE 5)	3"	SIDE
N10		MANUFACTURER NAME PLATE		SIDE
N11		CHEMICAL LABEL		SIDE
N12		LADDER		SIDE

ACCESSORIES

Level Indicator	X	Exterior Pigmented Gel Coat	
Ladder ☐ Int ☒ Ext	X	Inlet Baffle	
Stairs		Lifting Lugs	X
Walkway		Thief Hatch	
Platform Clips ☐		Access Manways	X
Volume Level Tape	X	Anchor Lugs	X
Down Corner ☐ Int ☐ Ext		Syphon Drain	
Insulate		Visual Liquid Level Gauge	X
Heat Trace			
Design Maintain (Min) Temp:			
High Limit (Cut-Off) Temp:			



NOTES:

1. SEE SPECIFICATIONS FOR ADDITIONAL INFO.
2. EXTEND FILL LINE (N6) AND OVERFLOW (N2) TO 12" FROM TANK BOTTOM. INTERNAL DROP PIPES TO HAVE ANTI-SIPHON FITTINGS . PROVIDE INTERNAL SUPPORTS.
3. OUTLET (N1) SHALL BE LOCATED AT INVERT OF TANK.
4. ALL NOZZLES SHALL BE CONICAL GUSSET NOZZLE LOCATION IN THE ELEVATION
5. EXTERIOR VISUAL LEVEL GAUGE TO BE REVERSE FLOAT LEVEL GAUGE
6. VIEW MAY BE ROTATED FOR CLARITY AND DIMENSIONING
7. REFERENCE DRAWINGS FOR TRUE TANK AND FITTING ORIENTATION

END OF SECTION

SECTION 43 42 56 – SEALLESS MAGNETIC DRIVE CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Non-metallic Sealless Magnetic Drive Centrifugal Pumps, drivers, and accessories.
- B. Related Sections:
 - 1. Section 26 05 93 – Electric Motors.
 - 2. Section 40 05 51 – Common Requirements for Process Valves.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
- B. ANSI International:
 - 1. ANSI B73.3M
 - 2. ANSI B16.5
- C. ASTM International:
 - 1. A27 – Standard Specification for Steel Castings, Carbon, for General Application.
 - 2. A29 – Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought.
 - 3. A48 – Standard Specification for Gray Iron Castings.
 - 4. A276 – Standard Specification for Stainless Steel Bars and Shapes.
 - 5. A536 – Standard Specification for Ductile Iron Castings.
 - 6. B91 – Standard Specification for Magnesium-Alloy Forgings.
 - 7. B505 – Standard Specification for Copper Alloy Continuous Castings.
- D. Hydraulic Institute Standards
- E. NEC (National Electric Code)

1.3 DEFINITIONS

- A. Nonmetallic magnetic drive pumps:
 - 1. Use an encapsulated inner rotating assembly including a set of inner magnets within a containment shell or rear casing. Inner magnets are magnetically coupled or driven by outer magnet ring or drive magnet coupled to a conventional drive motor. Liquid end is hermetically sealed by static O-ring(s) or gasket(s).
- B. Close-coupled drivers:
 - 1. Conventional drivers mounted directly to the pumps frame. No base, coupling, or guards are required for this mounting style.
- C. Non-contact bearing/magnet system:
 - 1. Oversized drive and driven magnet set positioned such that reverse axial thrusting is reduced during adverse operating conditions minimizing contact of reverse axial thrust collars. This prevents contact with parts that close off circulation of air or fluid between radial bearing and pump shaft. Radial bearing is also positioned forward to maximize exposure to fluid/air circulation reducing frictional heat generation.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit manufacturer information, including installation instructions, accessories, performance curves with specified operating point plotted, capacities and pressure differentials, power, rpm, sound power levels for both inlet and outlet at rated capacity, electrical characteristics, and connection requirements.
- C. Shop Drawings:
 - 1. Furnish diagrams showing the complete layout of the system, including equipment, piping, valves, wiring and ladder diagrams, controls, and control sequences.
 - 2. Indicate size and configuration of assembly, mountings, weights, and accessory connections.
 - 3. Indicate manufacturer's specified displacement tolerances for vibration at operational speed as specified for pumps.
- D. Manufacturer's Certificate:
 - 1. Certify that products meet or exceed specified requirements.
- E. Manufacturer Instructions:
 - 1. Submit detailed instructions on installation requirements, including storage and handling procedures, anchoring, and layout.
- F. Source Quality-Control Submittals:
 - 1. Indicate results of shop tests and inspections.
- G. Field Quality-Control Submittals:
 - 1. Indicate results of Contractor-furnished tests and inspections.
- H. Manufacturer Reports:
 - 1. Certify that equipment has been installed according to manufacturer instructions.
- I. Qualifications Statements:
 - 1. Submit qualifications for manufacturer and installer.
 - 2. Submit manufacturer's approval of installer.
- J. Closeout Submittals:
 - 1. Section 01 77 00 –Closeout Procedures for submittal requirements.
 - 2. Project Record Documents:
 - a. Record actual locations and final orientation of pumps and appurtenances.

1.5 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer:
 - 1. Company specializing in performing Work of this Section with minimum three years' experience and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection:
 - 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing them in clean, dry locations remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.7 WARRANTY

- A. Provide a warranty for a period of 12 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.
- B. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 NONMETALLIC MAGNET DRIVE PUMPS

- A. Manufacturers:
 - 1. March Pumps
 - 2. Finish Thompson
 - 3. Iwaki
- B. General Design:
 - 1. Pumps shall be a non-metallic magnetic drive type, closed impeller design, male NPT suction and discharge connections, and close-coupled design.
 - 2. Wetted materials shall be compatible with the fluid being pumped.
 - 3. Pumps shall be overhung design with close-coupled drivers.
 - 4. Pumps shall comply with applicable sections of Hydraulic Institute Standards unless otherwise noted.
 - 5. Pumps, drivers and accessories shall be suitable for continuous operation at the specified operating conditions, and at flows ranging from the specified minimum flow to end-of-curve conditions.
 - 6. Pump head-capacity curve characteristics shall rise continuously from rated capacity to specified minimum flow. Pump rated capacity shall not exceed capacity at the best efficiency point. Pump design and selection shall permit a 5% head increase at rated flow by installing a new impeller unless otherwise noted.
 - 7. Required Net Positive Suction Head (NPSHr) shall be based on water. Available NPSHa shall exceed required NPSHr by a minimum of two feet.
 - 8. Any electrical drives or accessories shall be suitable for the specified electrical area classification and the environment of the installation.
 - 9. The impeller assembly shall be able to be removed without disturbing the piping connections. The liquid end shall be able to be removed without removing the motor frame adapter from the motor. The liquid and drive ends shall be independently serviceable.
 - 10. Pump shall have extended run dry ability when equipped with a carbon bushing.

- C. Pump Casing:
 - 1. Design:
 - a. Design: Single Piece Injection Molded
 - b. Material: Glass Fiber Reinforced Polypropylene
 - c. Connections: Male NPT for both suction and discharge connections. Connections shall have options for adjustable ANSI Class 150, standard hole pattern flanges or unions.
 - d. Casing and containment shell shall form volute for maximum hydraulic efficiency.
 - e. Casing shall be designed for specified design pressures, temperatures and hydrostatic test pressures.
- D. Impeller
 - 1. Closed type design, one-piece construction, material compatible with fluid being pumped.
 - 2. Material:
 - a. Glass Fiber Reinforced Polypropylene
 - 3. Allow for individual replacement.
 - 4. Statically and dynamically balanced after assembly.
- E. Pump Shaft
 - 1. Material: High Purity Alumina Ceramic
 - 2. The pump shaft shall be uniform in diameter and include anti-rotation/positioning flats for securing rear thrust collar in the containment shell as well as positioning shaft in the containment shell.
 - 3. The shaft shall be supported on both ends and replaceable.
- F. Thrust/Liner Ring
 - 1. Alumina Ceramic
- G. Impeller Thrust Ring:
 - 1. PTFE
- H. Bearings:
 - 1. One-piece press fit bearing or shaft bushing. The outside diameter of the bearing or bushing shall have an anti-rotation shape.
 - 2. Carbon
- I. Driven Magnet:
 - 1. Encapsulated with Glass Filled Reinforced Polypropylene.
 - 2. The bore of the inner magnet shall have an anti-rotation/positioning flat that corresponds to the shape of the press fit radial bearing or bushing.
 - 3. Ferrite, Neodymium, Iron Boron
- J. Containment Shell:
 - 1. One-Piece Design
 - 2. Material:
 - a. Glass Fiber Reinforced Polypropylene
- K. Rear Thrust Ring:
 - 1. Material:
 - a. CFRPPS
 - b. SiC
- L. Drive Magnet:
 - 1. Ferrite or Neodymium
 - 2. The drive or outer magnet shall be dynamically balanced and be capable of mounting directly to standard NEMA motors.

- M. Frame:
 - 1. The motor frame adapter shall allow for mounting of standard NEMA C-Faced motors. The Frame shall include a non-metallic, single piece, reinforced plastic design base and shall not use the motor for support.
- N. Drivers
 - 1. Each driver shall have a BHP output equal to or greater than the horsepower required to operate the pump at any point on the head capacity curve, while pumping liquid of the specified specific gravity and viscosity.
 - 2. All magnetic drives shall have torque ratings greater than or equal to the maximum motor torque the driver is rated for.
- O. Electrical Characteristics:
 - 1. See Division 26 – Electrical
 - 2. Voltage: 230/460 V, three-phase, 60 Hz.
- P. Motors:
 - 1. As specified in Section 26 05 93 – Electric Motors.

2.2 CONTROLS

- A. Manually Controlled by a local ON/OFF Switch.

2.3 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 – Quality Requirements for testing, inspection, and analysis requirements.
- B. Provide shop inspection and testing of the completed assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. According to manufacturer instructions.
- B. Provide and connect piping, power and control conduit, and wiring to make the system operational and ready for startup.

3.2 FIELD QUALITY CONTROL

- A. See Section 01 60 00 – Product Requirements for inspecting and testing requirements.
- B. Inspection:
 - 1. Make sure that pumps have been installed correctly and that there is no objectionable heat or vibration.
 - 2. Check pump and motor alignment, proper motor rotation, and pump and drive units for proper lubrication.
- C. Testing:
 - 1. Operate pump on clear water at design point for continuous period of two hours, under supervision of manufacturer's representative and in presence of Architect/Engineer.
 - 2. Verify pump performance by performing time-drawdown test or time-fill test.
- D. Manufacturer Services:
 - 1. Furnish services of authorized manufacturer's representative experienced in the installation of products furnished under this Section for not less than 2 days on Site for

installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.

- E. Equipment Acceptance:
 - 1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
 - 2. Make final adjustments to equipment under the direction of the manufacturer's representative.
- F. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.3 ADJUSTING

- A. See Section 01 70 00 – Execution Requirements for starting and adjusting requirements.
- B. Check control functions and adjust as required.

3.4 DEMONSTRATION

- A. See Section 01 70 00 – Execution Requirements for demonstration and training requirements.
- B. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

3.5 ATTACHMENTS

- A. The attachment list below part of this section:
 - 1. 44 42 56.31.1 – DS – Chemical Transfer Pumps – Sodium Hydroxide

Section 44 42 56.31.11:
NON-METALLIC LINED SEALLESS MAGNETIC DRIVE CENTRIFUGAL PUMP(S)
SODIUM HYDROXIDE

PROJECT: TMUA Mohawk WTP Chemical Tank
 OWNER: TMUA
 EQUIPMENT NAME(S): Sodium Hydroxide Bulk Transfer Pump
 EQUIPMENT TAG NUMBER(S): XPMP01, XPMP02
 CONTROL PANEL(S): See Drawings
 TOTAL PUMPS REQUIRED: 2 (One Duty + 1 Standby)

MANUFACTURERS

SUGGESTED MODEL

March Pumps
Finish Thompson
Iwaki

-- As Recommended by Manufacturer
 -- DB-8P-E-3-M277
 -- MX-400

SERVICE CONDITIONS

PERFORMANCE REQUIREMENTS

Liquid Pumped: Sodium Hydroxide (50% and 25%)
 Specific Gravity at 60°F: 1.52
 Min. NPSH available: 22 ft
 Explosion Proof (Y/N) Y

Capacity (US gpm): Design: 25
 Total Dynamic Head (ft) Design: 30
 Max. Pumping Temperature 90 °F
 Max pump speed at rated capacity 3500 rpm

EQUIPMENT DESCRIPTION

Casing Material: Glass Fiber Polypropylene
 Impeller Type: Enclosed
 Impeller Material: Glass Fiber Polypropylene
 O-Ring: EPDM
 Impeller Thrust Ring: PTFE

Suction Flange: 1.5 in.
 Discharge Flange: 1.5 (1) in.
 Impeller Size: 3 in.
 Bushing: Carbon
 Self-Priming ☐: Non-Self Priming ☒

MOTOR DATA

Type: Chem Duty
 Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.
 Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing marking.
 Motor Horsepower: 1
 Voltage: 230/460
 Phase: 3
 Frequency: 60 Hz
 Synchronous Speed: 3450 rpm (maximum)
 Service Factor: ☐ 1.0 ☒ 1.15
☐ Variable Frequency Drive: See Division 26 – Electrical. Provide Inverter Duty Rated Motors.
 Windings: ☐ One ☐ Two ☒ Thermal protection embedded in windings
 Motor nameplate horsepower shall not be exceeded at any operational point.
 Provide: ☐ Space Heater ☐ Oversize main terminal (conduit) box for motors
☐ Moisture detection switches

Mounting Type: ☒ Horizontal ☐ Vertical
 Enclosure Type: TEFC
 Material: Ductile Iron w/ ETFE lining
 Load Class: _____
☐ Multispeed, Two speed: _____ rpm

SPECIAL FEATURES/NOTES

See Division 26 and Division 40 for general instrumentation and control requirements.

Suggested models are for reference only. Other models meeting the design criteria will be considered.

END OF SECTION

