

SPECIFICATIONS AND CONTRACT DOCUMENTS



BID SET

For the Construction of

MOORE WWTP IMPROVEMENT PROJECTS

MOORE, OKLAHOMA

Moore Bid Number: 2026-007

CWSRF Funding Number: ORF-26-0048-CW

Headworks Improvements
Garver Project No. 2302254

Digester, SBR, & UV/Effluent Pump Station
Building Improvements
Garver Project No. 2500545

Storm Pond Improvements
Garver Project No. 2501328

VOLUME 1

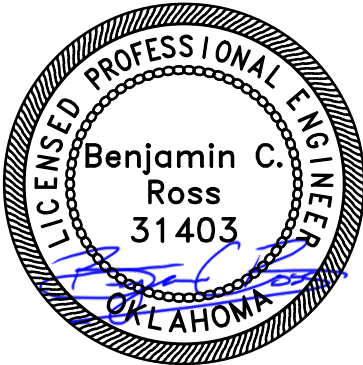
Prepared For:
City of Moore

February 2026



**MOORE WWTP IMPROVEMENT PROJECTS
GARVER PROJECT NOS. 2302254, 2500545, 2501328
CITY OF MOORE PROJECT NO. 2026-007, CWSRF FUNDING NO. ORF-26-0048-CW**

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
Michael Nguyen, P.E.  Digitally Signed:	Division 00
Ben Ross, P.E.  Digitally Signed 01/30/2026	Division 01 Division 02 Division 08 Division 22 Division 23 Division 31 Division 40, except Sections 40 61 13 through 40 75 56 Division 43 Division 44

Kipp Martin, P.E.  Digitally Signed 01/30/2026	Division 03 Division 04 Division 05 Division 07 Division 09 Division 13
SEAL AND SIGNATURE	APPLICABLE DIVISION OR PROJECT RESPONSIBILITY
Hunter Wick, P.E.  Digitally Signed 02/05/2026	Division 26 Division 40, Sections 40 61 13 through 40 75 56

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

MOORE WWTP IMPROVEMENT PROJECTS

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PART 1
BIDDING REQUIREMENTS

CONTRACT DOCUMENTS AND
TECHNICAL SPECIFICATIONS
FOR

Moore WWTP Improvements Projects
BID No. 2026-007
OWRB Loan No. ORF-26-0048-CW

CITY OF MOORE

CLEVELAND COUNTY, OKLAHOMA

SET NO.:

DATE: # February 2026

PREPARED BY:
City of Moore
City Manager's Office

CONTRACT DOCUMENTS

AND

TECHNICAL SPECIFICATIONS

FOR

Moore WWTP Improvement Projects

BID No. 2026-007

OWRB Loan No. ORF-26-0048-CW

for

CITY OF MOORE

CLEVELAND COUNTY, OKLAHOMA

Prepared by:

Garver
750 SW 24th Street
Suite 200
Moore, OK 73160

Approved: # February 2026

Mark Hamm, Mayor

Brooks Mitchell, City Manager

<u>Notice to Bidders</u> <i>Public Construction Contract</i>		Date of Notice: # Feb 9, 2026	Date Documents Available: # Feb 9, 2026
SUBMISSION LOCATION & TIME: BY 1:30 P.M. # March 3, 2026 Purchasing Agent, Moore City Hall, Suite 142 301 N. Broadway Moore, OK 73160 Phone: 405.793.5000			
Bid Opening: Date: # March 3, 2026, Time: 2:00 p.m. Location: 301 N. Broadway, Moore OK, City Council Chamber Room			
Project Title: Moore WWTP Improvement Projects BID NO. 2026-007			
Bid Instructions: Bids timely filed with the Purchasing Agent shall be publicly opened and read aloud at the time and location specified as bids above. Bids received more than ninety-six (96) hours, excluding Saturdays, Sundays and holidays, before the time set for opening of bids, as well received after the time set for opening of bids, will not be considered and will be returned unopened. Within sixty (60) days from the bid opening date, the successful bidder shall execute a written contract embodying all provisions of the bidding documents.			
For Technical Information, contact: Michael Nguyen Project Manager Phone Number: 405.666.2827			
Description of Work: Improvements for Headworks, Digester, SBR, and UV buildings. Improvements to North Storm Pond.			
Estimated Cost Range of Project:		Time for Project Completion:	*Wage Rates:
From: \$20,000,000	To: \$24,000,000	600 Calendar Days	Yes
Plans, Specs & Bidding Documents are Available at the City of Moore's web site: https://www.cityofmoore.com/government/city-bids Hard Copies may be obtained from: Garver (8:00 a.m. to 5:00 p.m. Monday through Friday) 750 SW 24th Street SUITE 200 Moore, OK 73160 Phone: 405.666.2827 Email: MTNguyen@GarverUSA.com			Deposit for hard copies of the Plans & Specifications: N/A
Mandatory Prebid Conference			
Location: 4000 S I-35 Service Rd Moore, OK 73160 WWTP Main Office		Time: 1:30:00 p.m. Date: 20 February 2026	Attendance Mandatory YES
Bid Bond: A cashier's check, a certified check, or a surety bond in the amount of five percent (5%) of the bid shall accompany the sealed proposal of each bidder. Deposits will be returned to the unsuccessful bidders. Deposits will be returned to successful bidder upon execution of contract documents.			
*Bids shall also be made in accordance with the prevailing hourly rate of wages for this locality and project as determined by the Commission of Labor and filed with the Secretary of State in accordance with the provisions of 40 O.S. 1971, 197.1-17, which prevailing hourly rate of wages is made a part of this notice by reference as though fully set forth herein.			

Equal Opportunity in Employment: All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, age or physical handicap. Bidders on this work will be required to comply with the President's Executive Order No. 11246, as amended.

Davis Bacon Act wage rules shall apply. All laborers and mechanics employed by contractors and sub-contractors on projects funded directly by or assisted in whole or in part by and through the Federal Government shall be paid wages at rates not less than those prevailing on projects of a character similar in the locality as determined by the Secretary of Labor in accordance with subchapter IV of Chapter 31 of Title 40, United States Code and 29 CFR parts 1,3, and 5. The Department of Labor provides all pertinent information related to compliance with labor standards, including prevailing wage rates and instructions for reporting. For more information please refer to Oklahoma Water Resources Board Supplemental Conditions, ORF-185 as well as <http://www.beta.sam.gov/>.

American Iron and Steel provisions also apply to projects funded directly by or assisted in whole or in part by and through the Federal Government pursuant to P.L. 113-76, Consolidated Appropriations Act, 2014, Sec. 436 requires that "None of the funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12) shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States." For more information please refer to Oklahoma Water Resources Board Supplemental Conditions ORF-185.

This project is subject to Build America, Buy America (BABA) Act requirements. The BABA Act requires none of the funds made available for a Federal financial assistance program for infrastructure, including each deficient program, may be obligated for a project unless all of the iron, steel, manufactured products, and construction materials used in the project are produced in the United States. The BABA Act requirement does not supersede the AIS requirement, and both provisions still apply and work in conjunction. By submitting a bid/proposal under this solicitation, the Bidder certifies that all iron, steel, manufactured products, and construction materials for the project will meet the BABA requirements in the United States in accordance with the "Infrastructure Investment and Jobs Act, H.R. 3684.

Disbarment and Suspension: Bidders may not be debarred, suspended, or otherwise excluded from participation in the CWSRF under Executive Order 12549.

THE CITY COUNCIL OF THE CITY OF MOORE RESERVES THE RIGHT TO REJECT ANY OR ALL BIDS.
CITY OF MOORE, OKLAHOMA By: Lira Deer, Purchasing Agent

B. SOLICITATION FOR BIDS

NOTICE is hereby given that the CITY OF MOORE, OKLAHOMA, will receive sealed bids at office of Purchasing Agent, Room 142, Moore City Hall, 301 N. Broadway, Moore, Oklahoma, 73160, until **1:30 o'clock P.M., Local Time, on the 3rd day of March 2026**, for the construction of

Moore WWTP Improvement Projects BID NUMBER. 2026-007

1. Bid Requirements.

- a. Bids shall be made in accordance and fully comply with

Solicitation for Bids
Requirements for Bidders
Bidder's Proposal
Plans and Specifications

and other bidding documents on file and available for examination at the Office of the Purchasing Agent in City Hall. These documents are made a part of this notice as though fully set forth herein.

- b. Bids may require compliance with the prevailing hourly rate of wages for this locality and project as determined by the Commission of Labor and filed with the Secretary of State, a copy of which is on file with the City Clerk, in accordance with the provisions of 40 Oklahoma Statute 1991, 196.1-196.14, which prevailing hourly rate of wages is made a part of this solicitation by reference as though fully set forth herein.
- c. A cashier's check, a certified check, or a surety bond in the amount of five percent (5%) of the bid shall accompany the sealed proposal of each bidder. Such deposits will be returned to the unsuccessful bidders.

2. Filing of Bids.

- a. Bids received more than ninety-six (96) hours before the time set for opening of bids, (excluding Saturdays, Sundays, and holidays), and bids received after the time set for opening of bids will not be considered and will be returned unopened.
- b. Bids timely filed with the City of Moore shall be publicly opened and read aloud in the City Council Chamber Room at City Hall immediately after the closing time above stated. No bidder may withdraw a bid within sixty (60) days after the actual

date of the opening thereof. Within sixty (60) days from the bid date, the owner may award a contract to the successful bidder or reject any or all bids for the project.

3. Obtaining Documents.

Complete sets of the Plans, Specifications and all other bidding documents may be obtained from the City of Moore's website, <https://www.cityofmoore.com/government/city-bids>. Bidders may also contact Garver, 750 SW 24th, Suite 200 (phone 405.666.2827, email: MTNguyen@GarverUSA.com) to view hard copies.

4. A **Mandatory PRE-Bid Conference** will be held at **4000 S I-35 Service Rd**, Moore, Oklahoma at **1:30 p.m., Local Time, on 20 February 2026**.
5. Equal Opportunity in Employment: All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, age or physical handicap. Bidders on this work will be required to comply with the President's Executive Order No. 11246, as amended.

Davis Bacon Act wage rules shall apply. All laborers and mechanics employed by contractors and sub-contractors on projects funded directly by or assisted in whole or in part by and through the Federal Government shall be paid wages at rates not less than those prevailing on projects of a character similar in the locality as determined by the Secretary of Labor in accordance with subchapter IV of Chapter 31 of Title 40, United States Code and 29 CFR parts 1,3, and 5. The Department of Labor provides all pertinent information related to compliance with labor standards, including prevailing wage rates and instructions for reporting. For more information please refer to Oklahoma Water Resources Board Supplemental Conditions, ORF-185 as well as <http://www.beta.sam.gov/>.

American Iron and Steel provisions also apply to projects funded directly by or assisted in whole or in part by and through the Federal Government pursuant to P.L. 113-76, Consolidated Appropriations Act, 2014, Sec. 436 requires that "None of the funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12) shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States." For more information please refer to Oklahoma Water Resources Board Supplemental Conditions ORF-185.

This project is subject to Build America, Buy America (BABA) Act requirements. The BABA Act requires none of the funds made available for a Federal financial assistance program for infrastructure, including each deficient program, may be obligated for a project unless all of the iron, steel, manufactured products, and construction materials used in the project are produced in the United States. The BABA Act requirement does not supersede the AIS requirement, and both provisions still apply and work in conjunction. By submitting a

bid/proposal under this solicitation, the Bidder certifies that all iron, steel, manufactured products, and construction materials for the project will meet the BABA requirements in the United States in accordance with the “Infrastructure Investment and Jobs Act, H.R. 3684

In the event of conflict between the Plans and Specifications, the latter shall govern.

In the event of conflict between the Specifications and SRF Supplemental Conditions, the latter shall govern.

Each bidder must fully comply with the requirements, terms and conditions of the Oklahoma Water Resources Board (OWRB), Small, Minority, Women's Businesses Requirements including affirmative steps to contract with small, minority and women's businesses during the performance of this contract. The bidder commits itself to the affirmative steps to contract with small, minority and women's businesses contained herein and all other requirements, terms and conditions of these bid conditions by submitting a properly signed bid. Requirements are contained in Oklahoma Water Resources Board Guidance and Procedures, ORF-267

Disbarment and Suspension: Bidders may not be debarred, suspended, or otherwise excluded from participation in the CWSRF under Executive Order 12549.

6. The City Council of the City of Moore reserves the right to reject any or all bids.

For the CITY OF MOORE, OKLAHOMA

BY: Lira Deer, Purchasing Agent

C. INFORMATION FOR BIDDERS

1. Receipt and Opening of Bids

The City of Moore (herein called the "Owner") invites bids on the forms attached hereto, all blanks of which must be appropriately filled in. Bids will be received by the Owner at the Office of the Purchasing Agent, room 142 until **1:30 P.M., Local Time on 3 March 2026**, and then at 2:00 P.M. will be publicly opened and read aloud in the City Council Chamber, City Hall, at 301 N. Broadway, Moore, Oklahoma. The envelopes containing the bids must be sealed, addressed to the Purchasing Agent, 301 N. Broadway, Moore, Oklahoma, 73160, and designated as bid for the

Moore WWTP Improvement Projects

The Owner may consider informal any bid not prepared and submitted in accordance with the provisions hereof and may waive any informalities or reject any and all bids. Any bid may be withdrawn prior to the above scheduled time for the opening of bids or authorized postponement thereof. Any bid received after the time and date specified shall not be considered. No bidder may withdraw a bid within sixty (60) days after the actual date of the opening thereof.

2. Preparation of Bid

Each bid must be submitted on the prescribed forms. All blanks and spaces for bid prices must be filled in, in ink or typewritten, in both words and figures, and the foregoing certifications must be fully completed and executed when submitted.

Bids and affidavits must be filed in sealed envelopes within the time limit for receiving proposals, as stated in the SOLICITATION FOR BIDS. Bid envelopes shall legibly bear the word "PROPOSAL" with the name of the Project. If forwarded by mail, the sealed envelope containing the bid **must** be enclosed in another envelope addressed as specified in the bid form. The original copy shall be filed with the CITY OF MOORE in the PURCHASING AGENT's office in the MOORE CITY HALL. All blank spaces in the proposal forms shall be correctly filled-in and the bidder shall state the prices, typewritten or written in ink, both in words and numerals, for which he proposes to do the work contemplated or furnish the materials required. All prices shall be distinctly legible.

3. Method of Bidding

The Owner invites the following bid(s): **Lump Sum and Unit Price**

4. Bid Surety

Each bid must be accompanied by cash, a cashier's check, a certified check of the bidder, or a bid bond prepared on the form of bid bond attached hereto, duly executed by the bidder as principal and having as surety thereon a surety company approved by the Owner, in the

amount of five percent (5%) of the bid. Such cash, checks, or bid bonds will be returned promptly after the Owner and the accepted bidder have executed the contract, or, if no award has been made within 60 days after the opening of bids, upon demand of the bidder at any time thereafter, so long as he has not been notified of the acceptance of his bid.

Proposals will not be considered unless the original filed with the City is accompanied by the described Bid Surety made payable to the City of Moore. The proposal guaranty is required as evidence of good faith and as a guarantee that, if awarded the contract, the bidder will execute the contract and furnish the required bonds.

The successful bidder, upon his failure or refusal to execute and deliver the contract and bonds required within ten (10) days after he has received notice of the acceptance of his bid, shall forfeit to the Owner, as liquidated damages for such failure or refusal, the security deposited provided with his bid.

5. Qualification/Disqualification of Bidders

The Owner may make such investigations as he deems necessary to determine the ability of the bidder to perform the work, and the bidder shall furnish to the Owner all such information and data for this purpose as the Owner may request. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of, such bidder fails to satisfy the Owner that such bidder is properly qualified to carry out contract requirements and complete the work contemplated therein. Conditional bids will not be accepted.

Bidders will be disqualified and their proposals not considered for any of the following specific reasons (These reasons are not all inclusive):

- a. Where more than one proposal for an individual firm, partnership, or corporation is filed under the same or different names; and where such proposals are not identical in every respect
- b. Reason for believing that collusion exists among the bidders
- c. Reasonable grounds for believing that the bidder holds interest in more than one proposal for the work contemplated or materials to be furnished
- d. Incomplete work that, in the judgment of the City, will hinder or prevent the prompt commencement or completion of this project

6. Power of Attorney

Attorneys-in-fact who sign bid bonds or contract bonds must submit with each bond a certified and effectively dated copy of their power of attorney.

If the proposal is submitted by an individual, his name must be signed by him or his duly authorized agent and his post office address given. If the proposal is submitted by a firm or

partnership, the name and post office address of each member of the firm must be given with the proposal signed by a duly authorized member of the firm or partnership. If the proposal is made by a company or corporation, the state in which the company or corporation is chartered, and business address must be given; and the proposal must be signed by a duly authorized official or agent. Powers of Attorney, authorizing agents, or others to sign proposals must be properly certified and on file with the City Clerk.

7. Time of Completion and Liquidated Damages

The Contractor hereby agrees to commence work under the Contract on a date specified in a written "Notice to Proceed" of the Owner, and to fully complete the project within **600 consecutive calendar days**. The Contractor further agrees to pay as liquidated damages, the sum of **One Thousand Five Hundred Dollars and 00/100 (\$1,500.00) for each consecutive calendar day** thereafter as provided in the Contract and General Conditions.

8. Rejection of Proposals

The City reserves the right to reject any or all proposals submitted, all of which are subject to this reservation. Proposals shall be rejected for any of the following specified reasons (These reasons are not all inclusive):

- a. Proposals received after the time limit stated in the solicitation
- b. Proposal prices obviously unbalanced
- c. Proposals that are incomplete insofar as the Non-Collusion Affidavit, required signatures, or containing any irregularities of substance

9. Notice of Award

The Owner will make every reasonable attempt to award the contract within ten (10) days of the bid opening date but reserves the right to examine all the bids in their entirety and to take whatever time may be required, in the best interest of the Owner, to accomplish a complete and fair bid analysis.

10. Method of Award - Lowest Responsible Bidder

Award of contract will be made by the City Council, upon recommendation of the City Manager, to the lowest responsible bidder submitting a responsive bid and meeting the requirements of the City. The Owner may reject all bids or may award the contract with any selected alternatives based upon available funding.

11. Cancellation of Award

The City reserves the right to cancel the award of any contract at any time before the execution of said contract without liability against the City.

12. Obligation of Bidder

At the time of the opening of bids, each bidder will be presumed to have inspected the site and to have read and to be thoroughly familiar with the plans and contract documents (including all addenda). The failure or omission of any bidder to examine any form, instrument, or document shall not relieve any bidder from any obligation in respect of his bid.

Each bidder must inform himself fully of the conditions relating to the construction of the project and the employment of labor thereon. Failure to do so will not relieve a successful bidder of his obligation to furnish all material and labor necessary to carry out the provisions of the contract. Insofar as possible, the contractor must employ methods or means that will not cause any interruption of or interference with the work of any other contractor.

All bidders, by submittal of a proposal, represent that they have examined the site prior to submittal and are fully informed regarding facilities and conditions affecting work, costs, risks, and obligations to be met, regardless of any omissions of the plans or specifications.

Any neglect or failure on the part of the bidder to obtain reliable information regarding the conditions to be encountered shall not relieve the successful bidder from any risks or liabilities or from the responsibility for the completion and acceptance of the project.

13. MANDATORY Pre-Bid Conference

A Mandatory Pre-Bid Conference will be held at 4000 S I-35 Service Rd, Moore, OK, at **1:30 p.m. on 20 February 2026.**

14. Addenda and Interpretations

No interpretation of the means of the plans, specifications, or other pre-bid documents will be made to any bidder orally.

Each written request for such interpretation should be addressed to the project's engineering company, Garver. Requests for Information shall be sent to the Project Manager, Michael Nguyen, MTNguyen@GarverUSA.com and copied to jihler@cityofmoore.com. To be given consideration, each such request must be received at least five (5) days prior to the date fixed for the opening of bids. Any and all such interpretations and any supplemental instructions will be in the form of written addenda to the specifications which, if issued, will be posted to the City of Moore's web site 48 hours prior to the bid opening deadline. Failure of any bidder to receive any such addendum or interpretation shall not relieve such bidder from any obligation under his bid as submitted. All addenda so listed shall become part of the contract documents.

15. Security for Faithful Performance

The Contractor shall deliver the executed contract and all required surety bonds within ten (10) days upon receipt of the contract from the Owner. With the execution and delivery of the Contract, the Contractor shall furnish and file with the City in the amounts herein required, the surety bonds listed below. The surety on such bonds shall be a duly authorized surety company satisfactory to the Owner.

- a. A good and sufficient Performance Bond in an amount equal to one hundred percent (100%) of the approximate total amount of the Contract, guaranteeing the full and faithful execution of the work and performance of the Contract and for the protection of the City and all property owners interested against any improper execution of the work or the use of inferior materials.
- b. A good and sufficient Statutory Bond in an amount equal to one hundred percent (100%) of the approximate total amount of the Contract, guaranteeing payment for all labor, materials, and equipment used in the construction of the project.
- c. A good and sufficient Maintenance Bond in an amount equal to one hundred percent (100%) of the total amount of the Contract, guaranteeing the maintenance in good condition of such project for a period of two (2) years from and after the time of its completion and acceptance by the City.

No surety will be accepted who is in default or delinquent on any bond or who holds interest in any litigation against the City. All bonds shall be made on forms furnished by the City and shall be executed by surety companies licensed to do business in the State of Oklahoma and shall conform to the requirements as set forth herein. Each Bond shall be executed by the Contractor and the Surety.

Should any surety on the Contract be determined unsatisfactory at any time by the City, notice will be given to the Contractor to that effect; and the Contractor shall forthwith substitute a new Surety or Sureties satisfactory to the City. No payment will be made under the Contract until the new Surety or Sureties, as required, have qualified and have been accepted by the City. The Contract shall not be operative, nor shall any payments be due until approval of the bonds has been made by the City.

16. Laws and Regulations

The bidder's attention is directed to the fact that all applicable state laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the contract throughout and they will be deemed to be included in the contract the same as though herein written out in full.

17. Sales Tax Exemption

Pursuant to Oklahoma Statutes, Title 68, 1356(10), Contractors and Subcontractors shall be exempted from the tax levied on the sale of tangible personal property or services necessary for the completion of this construction contract. Any Contractor or Subcontractor making purchases for this contract on behalf of the City of Moore shall certify, in writing, on the copy of the invoice or sales ticket to be retained by the vendor, that the purchases are made for and on behalf of the City of Moore.

Contractors and Subcontractors shall request a written Sales Tax Exemption by contacting the Purchasing Department, City of Moore, 301 N. Broadway, Moore, Oklahoma, 73160, Ph. 405.793.5022, who will issue such exemption on an individual project basis. It shall be the Contractor's and Subcontractor's responsibility to secure the Sales Tax Exemption, and failure to do so will not lessen their liability for payment of the sales tax.

Two Tax Commission interpretations of the Oklahoma statutes Title 68, 1356(10) are listed below to avoid contention among the City of Moore, its contractors, and the Tax Commission:

"Exemptions apply to materials permanently incorporated into the project, but not to concrete forms nor to other tools."

"The same reasoning precludes exceptions being applied to rental items."

The Contractor shall certify that purchases are made for or are on behalf of the City of Moore. Persons who make wrongful or erroneous certification(s) shall be guilty of a misdemeanor and shall be punished as provided in the statutes.

18. Safety Standards and Accident Prevention

With respect to all work performed under this contract, the Contractor shall:

- a. Comply with the safety standard provisions of applicable laws, building and construction codes, and the "Manual of Accident Prevention in Construction" published by the Associated General Contractors of America, the requirements of the Occupational Safety and Health Act of 1970 (Public Law 91-596), and the requirements of Title 29 of the Code of Federal Regulations.
- b. Exercise every precaution at all times for the prevention of accidents and the protection of persons (including employees) and property.
- c. Maintain as required by OSHA standards, all required articles necessary for giving first aid to the injured.

19. Access to Site

Access to the site is illustrated on the location map. It shall be the Contractor's responsibility to determine restrictions, if any, as to loads, bridge and road clearances, channel depths, and private property limitations that may influence access to the site.

20. Notice of Special Conditions

Attention is particularly called to those parts of the contract documents and specifications which deal with the following:

- a. Time for Completion and Liquidated Damages
- b. Wage rates and Insurance Requirements
- c. Inspection and Testing of Materials
- d. Stated allowances

21. Payments to Contractor

The Owner will make progress payments to the Contractor no more than once per month upon request of the Contractor. Pay requests take approximately 3-4 weeks to process.

Such payment will be made on the basis of an agreed estimate of work performed since the previous pay request, provided that the Contractor and the City Manager shall have previously come to an agreement as to the amount of the request prior to submission.

The City shall retain 5% of the amount of each estimate until the project is complete.

D. BID DOCUMENTS

1. CONTRACTOR'S CHECKLIST OF REQUIRED ITEMS

Completed*

1.	Bid Proposal	_____
2.	Bid Bond	_____
3.	Anti-Collusion Affidavit	_____
4.	Business Relationships Affidavit	_____
5.	Experience and Capability Questionnaire	_____
6.	CWSRF Documents	_____

*Check when filled out, signed, and included with submission of bid packet.

2.BID PROPOSAL

Date: _____

The Honorable Mayor and City Council
City of Moore
301 N. Broadway
Moore, Oklahoma 73160

RE: Proposal of _____ (hereinafter called "Bidder") a corporation/partnership/individual (strike out inapplicable term) organized and existing under the laws of the State of _____.

Gentlemen:

The Bidder, in compliance with your invitation for bids for the construction of

**Moore WWTP Improvement Projects
BID NO. 2026-007**

having examined the Plans and Specifications with related documents and the site of the proposed work and being familiar with all of the conditions surrounding construction of the proposed project (including availability of material and labor), hereby proposes to furnish all labor, materials, and supplies to construct the project in accordance with the Contract Documents, within the time set forth therein, and at the prices stated below. These prices are to cover all expenses incurred in performing the work required under the Contract Documents, of which this Proposal will be made a part.

Bidder hereby agrees to commence work under this contract on a date to be specified in written "Notice to Proceed" of the Owner and to fully complete the project within **600 consecutive calendar days** thereafter as stipulated here in. Bidder further agrees to pay as liquidated damages the sum of **One Thousand Five Hundred and 00/00 Dollars (\$1,500.00) for each consecutive calendar day** thereafter that the Contract is not completed as provided in the General Conditions.

Bidder acknowledges receipt of the following Addenda:

Bidder agrees to perform all of the construction work described in the Specifications and shown on the Drawings for the following **Lump Sum** and **Unit Price**:

BID SCHEDULE
Moore WWTP Improvement Projects
BASE BID

ITEM #	EST. QTY.	UNIT	DESCRIPTION	UNIT PRICE	ITEM TOTAL
1	1	L.S.	All Work as defined in the Contract Documents except those items listed separately below, for the lump sum of:	\$	\$
Unit Price In Words			Dollars		
2	1	L.S.	Headworks bypass pumping, for the lump sum of:	\$	\$
Unit Price In Words			Dollars		
3	770	S.F.	Headworks Concrete Removal and Repair (0.5 in. to 3 in.), per square foot.	\$	\$
Unit Price In Words			Dollars		
4	6250	S.F.	Headworks Concrete Coating (includes up to 0.49 in. of concrete repair if needed), per square foot.	\$	\$
Unit Price In Words			Dollars		
5	100	L.F.	Headworks Building Steel Truss Repairs, per linear foot.	\$	\$
Unit Price In Words			Dollars		
6	50	L.F.	UV Building Steel Truss Repairs, per linear foot.	\$	\$
Unit Price In Words			Dollars		
7	200	E.A.	Digester Facility: chipping out concrete around existing building anchor bolts, cutting of anchor bolts, and filling with non-shrink grout, for the lump sum of:	\$	\$
Unit Price In Words			Dollars		
8	87	E.A.	Digester Facility: grinding embeds of existing interior platform smooth, applying cold galvanizing, for the lump sum of:	\$	\$
Unit Price In Words			Dollars		
9	1	L.S.	Utility Allowance, for the lump sum of:	N/A	\$50,000
Unit Price In Words: Fifty Thousand Dollars					
10	1	L.S.	Contingency Allowance 1 for Work Change Directives (miscellaneous work on a change authorization basis) required during completion of the Project to be used solely at the discretion of the OWNER and ENGINEER, for the lump sum of:	N/A	\$ 750,000
Unit Price In Words: Seven Hundred and Fifty Thousand Dollars					
TOTAL AMOUNT BID			\$		
Total Amount Bid In Words			Dollars		

Amounts are to be shown in both words and figures. In case of any discrepancy, the amount shown in words will govern.

The above unit prices shall include all costs for labor, materials, overhead, profit, insurance, etc., to cover the finished work of the several kinds called for.

Equal Opportunity in Employment: All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, age or physical handicap. Bidders on this work will be required to comply with the President's Executive Order No. 11246, as amended.

Davis Bacon Act wage rules shall apply. All laborers and mechanics employed by contractors and sub-contractors on projects funded directly by or assisted in whole or in part by and through the Federal Government shall be paid wages at rates not less than those prevailing on projects of a character similar in the locality as determined by the Secretary of Labor in accordance with subchapter IV of Chapter 31 of Title 40, United States Code and 29 CFR parts 1,3, and 5. The Department of Labor provides all pertinent information related to compliance with labor standards, including prevailing wage rates and instructions for reporting. For more information please refer to Oklahoma Water Resources Board Supplemental Conditions, ORF-185 as well as <http://www.beta.sam.gov/>.

American Iron and Steel provisions also apply to projects funded directly by or assisted in whole or in part by and through the Federal Government pursuant to P.L. 113-76, Consolidated Appropriations Act, 2014, Sec. 436 requires that "None of the funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12) shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States." For more information please refer to Oklahoma Water Resources Board Supplemental Conditions ORF-185.

This project is subject to Build America, Buy America (BABA) Act requirements. The BABA Act requires none of the funds made available for a Federal financial assistance program for infrastructure, including each deficient program, may be obligated for a project unless all of the iron, steel, manufactured products, and construction materials used in the project are produced in the United States. The BABA Act requirement does not supersede the AIS requirement, and both provisions still apply and work in conjunction. By submitting a bid/proposal under this solicitation, the Bidder certifies that all iron, steel, manufactured products, and construction materials for the project will meet the BABA requirements in the United States in accordance with the "Infrastructure Investment and Jobs Act, H.R. 3684.

Each bidder must fully comply with the requirements, terms and conditions of the Oklahoma Water Resources Board (OWRB), Small, Minority, Women's Businesses Requirements including affirmative steps to contract with small, minority and women's businesses during the performance of this contract. The bidder commits itself to the affirmative steps to contract with

small, minority and women's businesses contained herein and all other requirements, terms and conditions of these bid conditions by submitting a properly signed bid. Requirements are contained in Oklahoma Water Resources Board Guidance and Procedures, ORF-267 (Revised 07/09).

Disbarment and Suspension: Bidders may not be debarred, suspended, or otherwise excluded from participation in the CWSRF under Executive Order 12549.

Bidder understands that the Owner reserves the right to reject any or all bids and to waive any informality in the bidding.

The Bidder agrees that this bid shall be good and may not be withdrawn for a period of sixty (60) calendar days after the scheduled closing time for receiving bids.

Upon receipt of written notice of acceptance of this bid, Bidder will execute the formal Contract attached within ten (10) days and deliver all bonds as required by the General Conditions. The bid security attached in the sum of _____ DOLLARS (\$_____) is to become the property of the Owner in the event the Contract and Bonds are not executed within the time set forth above, as liquidated damages for the delay and additional expense to the Owner caused thereby.

RESPECTFULLY SUBMITTED,

By: _____

Title: _____

Address: _____

3. BID BOND

The Bidder shall provide the Bid Bond by the means of a cashier's check, a certified check, or a surety bond in the amount of five percent (5%) of the bid.

4. ANTICOLLUSION AFFIDAVIT

The following affidavit is submitted by Bidder as a part of this bid and proposal:

STATE OF OKLAHOMA }
CLEVELAND COUNTY }

The undersigned deponent, of lawful age, being duly sworn, upon his oath, deposes and says that:

- he has lawful authority to execute the within and foregoing proposal;
- he has executed the same by subscribing his name hereto under oath for and on behalf of said bidder;
- bidder has not, directly or indirectly, entered into an agreement; expressed or implied, with any bidder(s) having as its object controlling of the price or amount of such bid(s), the limiting of the bids or the bidders, the parceling or farming out to any bidder(s) or other persons of any part of the contract or any part of the subject matter of the bid(s) or of the profits thereof; and
- he has not and will not divulge the sealed bid to any person whomsoever, except those having a partnership or other financial interest with him in said bid(s) until after the said sealed bid(s) are opened.

Deponent further states that:

- the bidder has not been a party to any collusion among bidders or prospective bidders in any restraint of freedom of competition by agreement to bid at a fixed price, or to refrain from bidding;
- the bidder has not been a party to any collusion with any City official or employee as to quantity, quality, or price in the prospective contract, or any other terms of said prospective contract;
- the bidder has not been in any discussions between bidders and any City official concerning exchange of money or other thing of value for special consideration in the letting of a contract;
- the bidder has not paid, given, or donated or agreed to pay, give, or donate to any officer or employee of the CITY OF MOORE any money or other thing of value, either directly or indirectly, in the procuring of the award of contract pursuant to this bid.

SIGNED: _____
(Name of Bidder)

BY: _____

Title: _____

Subscribed and sworn to before me this _____ day of _____, 2026.

Notary Public

My Commission Expires: _____

5. BUSINESS RELATIONSHIPS AFFIDAVIT

STATE OF OKLAHOMA }

CLEVELAND COUNTY }

_____, of lawful age, being first duly sworn, on oath says that he is the agent authorized by the bidder to submit the attached bid. Affidavit 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 hereinabove mentioned exist, affiant should so state.)

Signed: _____

By: _____

Title: _____

Subscribed and sworn to before me this _____ day of _____, 2026.

Notary Public

My Commission Expires:

6. EXPERIENCE AND CAPABILITY QUESTIONNAIRE

_____, 2026

The Honorable Mayor and City Council
City of Moore
301 N. Broadway Street
Moore, Oklahoma 73160

Gentlemen:

Re: **Moore WWTP Improvement Projects, Project No. 2026-007**

The following information is submitted in answer to the questions listed below:

1. How many years experience as a general contractor have you had in construction similar to the project upon which the attached proposal is submitted?

2. If you have constructed similar projects, list at least three contracts, giving name and location of each project, amount and date of contract, and the owner or agency for whom the work was performed (list only prime contracts).

3. What is the largest project you have ever undertaken as the Prime Contractor? Give location, amount, and date of contract, type of construction, etc.

4. Have you ever failed to complete a contract or been involved in litigation regarding the acceptance of final settlement for work performed? _____. If the answer is "Yes", explain fully.

5. If you are the successful bidder on this project, do you propose to sublet or assign the project or any part thereof to some other contractor?

6. Is your organization an established business, with construction equipment and personnel ready to start work on this project if you are the successful bidder?

7. List all the projects that you have under contract this date, upon which final acceptance has not been made, giving the following information:

CONTRACT NO. 1

Name of Project _____
Owner _____ Location _____
Amount of Contract _____ Date of Contract _____
Time Allowed for Construction _____
Percent of Time Elapsed _____
Percent of Work Actually Accomplished _____
Has there been any litigation? _____
If answer to above question is "Yes", explain fully:

CONTRACT NO. 2

Name of Project _____
Owner _____ Location _____
Amount of Contract _____ Date of Contract _____
Time Allowed for Construction _____
Percent of Time Elapsed _____
Percent of Work Actually Accomplished _____
Has there been any litigation? _____
If answer to above question is "Yes", explain fully:

CONTRACT NO. 3

Name of Project _____
Owner _____ Location _____
Amount of Contract _____ Date of Contract _____
Time Allowed for Construction _____
Percent of Time Elapsed _____
Percent of Work Actually Accomplished _____
Has there been any litigation? _____
If answer to above question is "Yes", explain fully:

CONTRACT NO. 4

Name of Project _____

Owner _____ Location _____

Amount of Contract _____ Date of Contract _____

Time Allowed for Construction _____

Percent of Time Elapsed _____

Percent of Work Actually Accomplished _____

Has there been any litigation? _____

If answer to above question is "Yes", explain fully:

(Attach additional sheets if required)

8. We submit the following list of major construction equipment now owned by us and available for the work that may be awarded, which is in operating condition and good state of repair.

<u>No.</u>	<u>Item</u>	<u>Type</u>	<u>Size or Capacity</u>	<u>Present Value</u>

Firm Name

Agent Signature

Title

STATE OF OKLAHOMA }
COUNTY OF CLEVELAND }

_____, of legal age, being first duly sworn, upon his oath deposes and says that he executed the above questionnaire on behalf of the Bidder therein named; and that he had lawful authority to do so, and that the information contained therein is true and correct to the best of his knowledge and belief; that he has truthfully answered the questions set forth, and that he has not knowing withheld any information which might affect his status as bidder.

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

Notary Public

My Commission Expires: _____

PART 2
CONTRACT FORMS

E. CONTRACT

THIS CONTRACT made and entered into this ____ day of _____, 2026, by and between CITY OF MOORE, Oklahoma, a Municipal Corporation, acting by and through the Mayor and City Council, party of the first part, hereinafter referred to as "CITY", and _____, party of the second part, hereinafter referred to as "CONTRACTOR".

WITNESSETH:

WHEREAS, the CITY has caused to be prepared in accordance with law, certain Contract Documents and Technical Specifications (including Plans) for the work hereinafter described, and has caused a Solicitation for Bids to be given and advertised as required by law, and has received sealed proposals for the furnishing of all labor and materials for

Moore WWTP Improvement Projects, Project No. 2026-007

and

WHEREAS, the Contractor in response to said Solicitation for Bids submitted to the CITY in the manner and at the time specified a sealed proposal in accordance with the terms and provisions of said Contract Documents and Technical Specifications, Plans and Addenda(s) associated with this project; and

WHEREAS, the CITY, in the manner provided by law, has publicly opened, examined, and canvassed all the proposals submitted and has determined and declared the above named Contractor to be the best responsive bidder on the above described project; and

WHEREAS, the City, has duly awarded this Contract to said Contractor for the sum specified in the Contractor's proposal, to wit:

Said proposal of _____ Dollars (\$) _____ is
incorporated by reference into this contract.

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

1. The Contractor shall, in a good and first-class workmanlike manner, at his own cost and expense, furnish all labor and materials, tools, and equipment required to perform and complete said work in strict accordance with this Contract, the Contract Documents and Technical Specifications and all applicable Plans and Addenda, all of which are on file in the office of the City Manager, 301 N. Broadway, Moore, OK, 73160, and hereby incorporated by reference and made a part of this Contract as if the same were each herein set out at length.

2. The CITY will make progress payments to the Contractor no more than once per month upon request of the Contractor.

Such payment will be made on the basis of an agreed estimate of work performed since the previous pay request, provided that the Contractor and the City Manager shall have previously come to an agreement as to the amount of the request prior to submission.

The City shall retain five percent (5%) of the amount of each estimate until the project is complete. This retainage shall not be released until final acceptance of project by the City Council.

Each monthly estimate for payment must contain or have attached an affidavit for payment, as set forth in the Contract Documents and Technical Specifications.

On completion of the work, but prior to the acceptance by the CITY, it shall be the duty of the City Manager, or his authorized designee, to determine that said work has been completed and fully performed in accordance with said Contract Documents and Technical Specifications and all applicable Plans and Addenda; and upon making such determination said official shall make his final certificate to the CITY.

The Contractor hereby agrees to commence work under this Contract on a date to be specified in a written "Work Order" of the CITY and to fully complete the project within **Six Hundred (600) consecutive calendar days**. The Contractor further agrees to pay as liquidated damages, the sum of **One Thousand Five Hundred Dollars and 00/100 (\$1,500.00) for each consecutive calendar day** thereafter as provided in Article 15 of the General Conditions section of the Contract Documents and Technical Specifications.

The Contractor shall furnish proof that all claims and obligations incurred by him in connection with the performance of said work have been fully paid and settled; said information shall be in the form of an affidavit constituting the Contractor's Release to City as set forth in the Contract Documents and Technical Specifications; thereupon, the final estimate (including any retained amounts) will be approved and paid.

3. Discrimination. The Contractor agrees in connection with the performance of work under this contract as follows:
 - a. The Contractor will not discriminate against any employee or applicant for employment because of race, creed, color, sex, national origin, disability, age or ancestry. Such actions shall include, but not be limited to the following: employment, upgrading, demotion or transfer, recruiting or recruitment, advertising, layoff, termination, rates of pay or other forms of compensation, and selection for training, (including apprenticeship.) The Contractor agrees to include this non-discrimination clause in any subcontracts connected with the performance of this Contract.

- b. The Contractor and subcontractor shall agree to post in a conspicuous place available to employees and applicants for employment, notice to be provided by the City of Moore setting forth provisions of this section.
 - c. In the event of the Contractor's non-compliance with the above non-discrimination clause, this Contract may be terminated by the CITY. The Contractor may also be declared by the CITY to be ineligible for future contracts with the CITY until satisfactory proof of intent to comply shall be made by the Contractor.
- 4. Use of Subcontractors. The Contractor shall actively solicit bids for the subcontracting of goods or services from qualified minority businesses. At the request of the CITY, the Contractor shall furnish evidence of compliance with this requirement of minority solicitation. The Contractor further agrees to consider the grant of subcontracts to minority bidders on the basis of substantially equal proposals in the light most favorable to said minority businesses.
 - 5. Entire Contract. This Contract and all the documents incorporated by reference contain the entire understanding and agreement of the parties upon the subject matter hereof. There is no agreement, oral or otherwise, which is not set forth in writing hereto or attached. This Contract includes the following items: this Contract, the Contract Documents and Technical Specifications, all applicable Plans and Addenda and the Contractor's Proposal.
 - 6. Modification and Termination. This Contract cannot be modified or terminated except in writing signed by both parties or as otherwise provided herein.
 - 7. Assignment. This Contract shall not be assigned without the written consent of the CITY.
 - 8. Bankruptcy. If the Contractor becomes bankrupt or insolvent, or if a petition in bankruptcy is filed against the Contractor, or if a receiver is appointed for the Contractor, the CITY shall have the right to terminate this Contract upon written notice to the Contractor without prejudice to any claim for damages or any other right of the CITY under this Contract to the time of such termination.
 - 9. Variables in Cost. The parties hereto assume and understand that the variables in Contractor's cost of performance may fluctuate; consequently, the parties hereto agree that any fluctuations in Contractor's costs will in no way alter the Contractor's obligations under this Contract nor excuse performance or delay on his part.
 - 10. Choice of Laws and Venue. This Contract shall be governed by the laws of the State of Oklahoma. Any lawsuit brought concerning this Contract shall be filed with the appropriate state court, Cleveland County, Oklahoma or with the United States District Court for Western District of Oklahoma, as applicable.
 - 11. Equal Opportunity in Employment: All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, age or physical

handicap. Bidders on this work will be required to comply with the President's Executive Order No. 11246, as amended.

Davis Bacon Act wage rules shall apply. All laborers and mechanics employed by contractors and sub-contractors on projects funded directly by or assisted in whole or in part by and through the Federal Government shall be paid wages at rates not less than those prevailing on projects of a character similar in the locality as determined by the Secretary of Labor in accordance with subchapter IV of Chapter 31 of Title 40, United States Code and 29 CFR parts 1,3, and 5. The Department of Labor provides all pertinent information related to compliance with labor standards, including prevailing wage rates and instructions for reporting. For more information please refer to Oklahoma Water Resources Board Supplemental Conditions, ORF-185 as well as <http://www.beta.sam.gov/>.

American Iron and Steel provisions also apply to projects funded directly by or assisted in whole or in part by and through the Federal Government pursuant to P.L. 113-76, Consolidated Appropriations Act, 2014, Sec. 436 requires that “None of the funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12) shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States.” For more information please refer to Oklahoma Water Resources Board Supplemental Conditions ORF-185.

This project is subject to Build America, Buy America (BABA) Act requirements. The BABA Act requires none of the funds made available for a Federal financial assistance program for infrastructure, including each deficient program, may be obligated for a project unless all of the iron, steel, manufactured products, and construction materials used in the project are produced in the United States. The BABA Act requirement does not supersede the AIS requirement, and both provisions still apply and work in conjunction. By submitting a bid/proposal under this solicitation, the Bidder certifies that all iron, steel, manufactured products, and construction materials for the project will meet the BABA requirements in the United States in accordance with the “Infrastructure Investment and Jobs Act, H.R. 3684.

Each bidder must fully comply with the requirements, terms and conditions of the Oklahoma Water Resources Board (OWRB), Small, Minority, Women's Businesses Requirements including affirmative steps to contract with small, minority and women's businesses during the performance of this contract. The bidder commits itself to the affirmative steps to contract with small, minority and women's businesses contained herein and all other requirements, terms and conditions of these bid conditions by submitting a properly signed bid. Requirements are contained in Oklahoma Water Resources Board Guidance and Procedures, ORF-267 (Revised 07/09).

Disbarment and Suspension: Bidders may not be debarred, suspended, or otherwise excluded from participation in the CWSRF under Executive Order 12549.

12. This Contract requires proper signature and acceptance by the Contractor and approval by the Moore City Council before it becomes effective.

IN WITNESS WHEREOF, the parties hereto have caused this instrument to be executed, in three (3) originals, the day and year first above written.

(FOR CORPORATIONS ONLY)

Name of Corporation

By _____

Title _____

ATTEST:

Title _____
(AFFIX SEAL)

(FOR PARTNERSHIPS AND PROPRIETORSHIPS)

Name of Partnership or Proprietorship

By _____

Title _____

COUNTY OF CLEVELAND }
STATE OF OKLAHOMA }

Before me the undersigned, a Notary Public in and for said state, on this ____ day of _____, 2026, personally appeared _____, a member of the partnership/proprietorship _____ to me known to be the identical person who executed the within and foregoing instrument on behalf of said partnership/proprietorship and acknowledged to me that _____ (he/she) executed the same as _____ (his/her) free and voluntary act and deed, and for the free and voluntary act and deed of said partnership/proprietorship, for the uses and purposes therein set forth.

Notary Public

My Commission Expires _____

CITY OF MOORE, OKLAHOMA
A Municipal Corporation

Mark Hamm, MAYOR

ATTEST:

Vanessa Kemp, CITY CLERK

APPROVED as to form and legality this _____ day of _____, 2026.

Brian Miller, CITY ATTORNEY

F. PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS that

_____ as Principal, and
(full name and address)

_____ as Surety, a
(full name and address)

corporation organized under the laws of the State of _____, and authorized to transact business in the State of Oklahoma, are hereby held and firmly bound unto the CITY OF MOORE, as OWNER, in the penal sum

of _____ DOLLARS (\$_____) for the payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, trustees, successors, and assigns, firmly by these presents.

The condition of this obligation is such that WHEREAS, said Principal entered into a written contract with the CITY OF MOORE, OKLAHOMA, dated on the _____ day of _____, 2026, for

Moore WWTP Improvement Projects, Project No. 2026-007

all in compliance with the plans and specifications therefore, made a part of said Contract and on file in the Office of the City Clerk, City of Moore, City Hall, 301 N. Broadway, Oklahoma 73160.

NOW, THEREFORE, if said Principal shall

- (1) in all particulars, well, truly and faithfully perform and abide by said Contract, each and every covenant, and part thereof and shall fulfill all obligations resting upon said Principal by the terms of said Contract and said specifications; and
- (2) if said Principal shall promptly pay, or cause to be paid, all labor, materials and/or repairs and all bills for labor performed on said work, whether by subcontract or otherwise.

then this obligation shall be null and void. **Otherwise** said obligation shall 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 or procedure herein fixed shall have the effect of releasing the sureties, or any of them, from the obligation of this bond.

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 to do so, the day and year above written.

Dated this ____ day of _____, 20__.

Principal:

Surety:

(Name of Contractor)

By: _____
(Name & Title)

By: _____
Attorney-in-Fact (Affix Seal)

(FOR CORPORATIONS ONLY)

ATTEST:

(Name & Title) (Affix Seal)

(FOR PARTNERSHIPS AND PROPRIETORSHIPS)

Notarized on this ____ day of _____, 20__

Notary: _____ My commission expires:

G. STATUTORY BOND

KNOW ALL MEN BY THESE PRESENTS that

_____ as Principal, and
(full name and address)

_____ as Surety, a
(full name and address)

corporation organized under the laws of the State of _____, and authorized to transact business in the State of Oklahoma, are hereby held and firmly bound unto the CITY OF MOORE, as OWNER, in the penal sum of

_____ DOLLARS
(\$_____) 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 CITY OF MOORE, OKLAHOMA, dated on the _____ day of _____, 20____, for

Moore WWTP Improvement Projects, Project No. 2026-007

all in compliance with the plans and specifications therefore, made a part of said Contract and on file in the Office of the City Clerk, City Hall, City of Moore, City Hall, 301 N. Broadway, Moore, Oklahoma 73160.

NOW, THEREFORE, if said Principal shall fail or neglect to pay all indebtedness incurred by said Principal or subcontractors 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. 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 obligations of this bond.

IN WITNESS WHEREOF, 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 year and day first above written.

Dated this _____ day of _____, 20__.

Principal:

Surety:

(Name of Contractor)

By: _____
(Name & Title)

By: _____
Attorney-in-Fact (Affix Seal)

(FOR CORPORATIONS ONLY)

ATTEST:

(Name & Title) (Affix Seal)

(FOR PARTNERSHIPS AND PROPRIETORSHIPS)

Notarized on this _____ day of _____, 20__

Notary: _____ My commission expires: _____

H. MAINTENANCE BOND

KNOW ALL MEN BY THESE PRESENTS that

_____ as Principal, and
(full name and address)

_____ as Surety, a
(full name and address)

corporation organized under the laws of the State of _____, and authorized to transact business in the State of Oklahoma, are hereby held and firmly bound unto the CITY OF MOORE, as OWNER, in the penal sum of

_____ DOLLARS
(\$ _____) in lawful money of the United States of America, said sum being equal to One Hundred Percent (100%) of the Contract price, for two (2) years after completion and acceptance of the project, 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 CITY OF MOORE, OKLAHOMA, dated on the _____ day of _____, 202____, for

Moore WWTP Improvement Projects, Project No. 2026-007

all in compliance with the plans and specifications therefore, made a part of this contract and file in the Office of the City Clerk of the City of Moore, City Hall, Moore, City Hall, 301 N. Broadway, Moore, Oklahoma 73160.

NOW, THEREFORE, if said Principal shall pay or cause to be paid to the CITY OF MOORE, OKLAHOMA all damage, loss and expense which may result by reason of defective materials and/or workmanship in connection with said work for a period of TWO (2) years, from and after acceptance of said project by the CITY OF MOORE 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 CITY OF MOORE harmless 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 obligations of the bond.

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 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 to do so, the day and year first above written.

Dated this _____ day of _____, 20__.

Principal:

Surety:

(Name of Contractor)

By: _____
(Name & Title)

By: _____
Attorney-in-Fact (Affix Seal)

(FOR CORPORATIONS ONLY)

ATTEST:

(Name & Title) (Affix Seal)

(FOR PARTNERSHIPS AND PROPRIETORSHIPS)

Notarized on this _____ day of _____, 20__

Notary: _____ My commission expires: _____

LIST OF MANUFACTURERS

[illegible]

PART 2
CONTRACT FORMS

NOTICE OF AWARD

Date of Issuance:

Owner: **City of Moore**

Owner's Project No.:

**Client
Number
Project
Number**

Engineer: **Garver, LLC**

Engineer's Project No:

Project: **Moore WWTP Improvement Projects**

Contract Name:

Bidder:

Bidder's Address:

You are notified that Owner has accepted your Bid dated **[date]** for the above Contract, and that you are the Successful Bidder and are awarded a Contract for:

[Describe Work, alternates, or sections of Work awarded]

The Contract Price of the awarded Contract is **\$(Contract Price)**. Contract Price is subject to adjustment based on the provisions of the Contract, including but not limited to those governing changes, Unit Price Work, and Work performed on a cost-plus-fee basis, as applicable.

[Number of copies sent] unexecuted counterparts of the Agreement accompany this Notice of Award, and one copy of the Contract Documents accompanies this Notice of Award, or has been transmitted or made available to Bidder electronically.

☐ Drawings will be delivered separately from the other Contract Documents.

You must comply with the following conditions precedent within 15 days of the date of receipt of this Notice of Award:

1. Deliver to Owner **three** counterparts of the Agreement, signed by Bidder (as Contractor).
2. Deliver with the signed Agreement(s) the Contract security (such as required performance and payment bonds) and insurance documentation, as specified in the Instructions to Bidders and in the General Conditions, Articles 2 and 6.
3. Other conditions precedent (if any): [Describe other conditions that require Successful Bidder's compliance]

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award, and declare your Bid security forfeited.

Within 10 days after you comply with the above conditions, Owner will return to you one fully signed counterpart of the Agreement, together with any additional copies of the Contract Documents as indicated in Paragraph 2.02 of the General Conditions.

Owner: _____

By (signature): _____

Name (printed): _____

Title: _____

Copy: Engineer

EJCDC® C-510, Notice of Award.

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NOTICE TO PROCEED

Owner: City of Moore Owner's Project No.: Client Number
Engineer: Garver Engineer's Project No.: Project Number
Contractor: _____ Contractor's Project No.: _____
Project: Moore WWTP Improvement Projects
Contract Name: _____
Effective Date of Contract: _____

Owner hereby notifies Contractor that the Contract Times under the above Contract will commence to run on **[date Contract Times are to start]** pursuant to Paragraph 4.01 of the General Conditions.

On that date, Contractor shall start performing its obligations under the Contract Documents. No Work will be done at the Site prior to such date.

In accordance with the Agreement:

The number of days to achieve Substantial Completion is **[number of days, from Agreement]** from the date stated above for the commencement of the Contract Times, resulting in a date for Substantial Completion of **[date, calculated from commencement date above]**; and the number of days to achieve readiness for final payment is **[number of days, from Agreement]** from the commencement date of the Contract Times, resulting in a date for readiness for final payment of **[date, calculated from commencement date above]**.

Before starting any Work at the Site, Contractor must comply with the following:

[Note any access limitations, security procedures, or other restrictions]

Owner: City of Moore
By (signature): _____
Name (printed): _____
Title: _____
Date Issued: _____
Copy: Engineer

EJCDC® C-550, Notice to Proceed.

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PERFORMANCE BOND

Contractor Name: [Full formal name of Contractor] Address (<i>principal place of business</i>): [Address of Contractor's principal place of business]	Surety Name: [Full formal name of Surety] Address (<i>principal place of business</i>): [Address of Surety's principal place of business]
Owner Name: City of Moore Mailing address (<i>principal place of business</i>): Client Address, Moore, OK 73160	Contract Description (<i>name and location</i>): Moore WWTP Improvement Projects, Moore, Oklahoma Contract Price: [Amount from Contract] Effective Date of Contract: [Date from Contract]
Bond Bond Amount: [Amount] Date of Bond: [Date] <i>(Date of Bond cannot be earlier than Effective Date of Contract)</i> Modifications to this Bond form: ☐ None ☐ See Paragraph 16	
Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Performance Bond, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.	
Contractor as Principal	Surety
<i>(Full formal name of Contractor)</i>	<i>(Full formal name of Surety) (corporate seal)</i>
By: _____ <i>(Signature)</i>	By: _____ <i>(Signature)(Attach Power of Attorney)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
Attest: _____ <i>(Signature)</i>	Attest: _____ <i>(Signature)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
<i>Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.</i>	

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.
2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:
 - 3.1. The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice may indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement does not waive the Owner's right, if any, subsequently to declare a Contractor Default;
 - 3.2. The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and
 - 3.3. The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.
4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.
5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:
 - 5.1. Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;
 - 5.2. Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;
 - 5.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or
 - 5.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:
 - 5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or
 - 5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.
6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment, or the Surety has denied liability, in

whole or in part, without further notice, the Owner shall be entitled to enforce any remedy available to the Owner.

7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner will not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety will not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:
 - 7.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
 - 7.2. additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and
 - 7.3. liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.
8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.
9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.
10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and must be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.
12. Notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears.
13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted therefrom and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.
14. Definitions
 - 14.1. *Balance of the Contract Price*—The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.
 - 14.2. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.
 - 14.3. *Contractor Default*—Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.
 - 14.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

- 14.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
16. Modifications to this Bond are as follows: **None**

EJCDC® C-610, Performance Bond.
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PAYMENT BOND

Contractor Name: [Full formal name of Contractor] Address (<i>principal place of business</i>): [Address of Contractor's principal place of business]	Surety Name: [Full formal name of Surety] Address (<i>principal place of business</i>): [Address of Surety's principal place of business]
Owner Name: City of Moore Mailing address (<i>principal place of business</i>): Client Address, Moore, OK 73160	Contract Description (<i>name and location</i>): Moore WWTP Improvement Projects, Moore, Oklahoma Contract Price: [Amount, from Contract] Effective Date of Contract: [Date, from Contract]
Bond Bond Amount: [Amount] Date of Bond: [Date] <i>(Date of Bond cannot be earlier than Effective Date of Contract)</i> Modifications to this Bond form: ☐ None ☐ See Paragraph 18	
Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.	
Contractor as Principal	Surety
<i>(Full formal name of Contractor)</i>	<i>(Full formal name of Surety) (corporate seal)</i>
By: _____ <i>(Signature)</i>	By: _____ <i>(Signature)(Attach Power of Attorney)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
Attest: _____ <i>(Signature)</i>	Attest: _____ <i>(Signature)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
<i>Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.</i>	

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.
2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond will arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.
4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.
5. The Surety's obligations to a Claimant under this Bond will arise after the following:
 - 5.1. Claimants who do not have a direct contract with the Contractor
 - 5.1.1. have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and
 - 5.1.2. have sent a Claim to the Surety (at the address described in Paragraph 13).
 - 5.2. Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).
6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.
7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:
 - 7.1. Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and
 - 7.2. Pay or arrange for payment of any undisputed amounts.
 - 7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.
8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.
9. Amounts owed by the Owner to the Contractor under the Construction Contract will be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all

funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfying obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.
11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit will be applicable.
13. Notice and Claims to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.
14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted here from and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.
15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.
16. Definitions
 - 16.1. *Claim*—A written statement by the Claimant including at a minimum:
 - 16.1.1. The name of the Claimant;
 - 16.1.2. The name of the person for whom the labor was done, or materials or equipment furnished;
 - 16.1.3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;
 - 16.1.4. A brief description of the labor, materials, or equipment furnished;
 - 16.1.5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
 - 16.1.6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;
 - 16.1.7. The total amount of previous payments received by the Claimant; and
 - 16.1.8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.
 - 16.2. *Claimant*—An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute

against the real property upon which the Project is located. The intent of this Bond is to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

- 16.3. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.
 - 16.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.
 - 16.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
18. Modifications to this Bond are as follows: **None**

EJCDC® C-615, Payment Bond.
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WARRANTY BOND

Contractor Name: [Full formal name of Contractor] Address (<i>principal place of business</i>): [Address of Contractor's principal place of business]	Surety Name: [Full formal name of Surety] Address (<i>principal place of business</i>): [Insert address of Surety's principal place of business]
Owner Name: City of Moore Address (<i>principal place of business</i>): Client Address, Moore, OK 73160	Construction Contract Description (<i>name and location</i>): Moore WWTP Improvement Projects, Moore, Oklahoma Contract Price: [Amount from Contract] Effective Date of Contract: [Date from Contract] Contract's Date of Substantial Completion: [Date from Contract]
Bond Bond Amount: [Amount] Date of Bond: [Date] Modifications to this Bond form: ☐ None ☐ See Paragraph 9	
Bond Period: Commencing 364 days after Substantial Completion of the Work under the Construction Contract, and continuing until [insert number of years, typically either two or three] years after such Substantial Completion.	
Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth herein, do each cause this Warranty Bond to be duly executed by an authorized officer, agent, or representative.	
Contractor as Principal	Surety
By: _____ <i>(Signature)</i>	By: _____ <i>(Signature) (Attach Power of Attorney)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
Attest: _____ <i>(Signature)</i>	Attest: _____ <i>(Signature)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
<i>Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.</i>	

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract's Correction Period Obligations. The Construction Contract is incorporated herein by reference.
2. If the Contractor performs the Correction Period Obligations, the Surety and the Contractor shall have no obligation under this Warranty Bond.
3. If Owner gives written notice to Contractor and Surety during the Bond Period of Contractor's obligation under the Correction Period Obligations, and Contractor does not fulfill such obligation, then Surety shall be responsible for fulfillment of such Correction Period Obligations. Surety shall either fulfill the Correction Period Obligations itself, through its agents or contractors, or, in the alternative, Surety may waive the right to fulfill the Correction Period Obligations itself, and reimburse the Owner for all resulting costs incurred by Owner in performing Contractor's Correction Period Obligations, including but not limited to correction, removal, replacement, and repair costs.
4. The Surety's liability is limited to the amount of this Warranty Bond. Renewal or continuation of the Warranty Bond will not modify such amount, unless expressly agreed to by Surety in writing.
5. The Surety shall have no liability under this Warranty Bond for obligations of the Contractor that are unrelated to the Construction Contract. No right of action will accrue on this Warranty Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.
6. Any proceeding, legal or equitable, under this Warranty Bond may be instituted in any court of competent jurisdiction in the location in which the Work or part of the Work is located and must be instituted within two years after the Surety refuses or fails to perform its obligations under this Warranty Bond.
7. Written notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown in this Warranty Bond.
8. Definitions
 - 8.1. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page of this Warranty Bond, including all Contract Documents and changes made to the agreement and the Contract Documents.
 - 8.2. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
 - 8.3. *Correction Period Obligations*—The duties, responsibilities, commitments, and obligations of the Contractor with respect to correction or replacement of defective Work, as set forth in the Construction Contract's Correction Period clause, EJCDC® C-700, Standard General Conditions of the Construction Contract (2018), Paragraph 15.08, as duly modified.
 - 8.4. *Substantial Completion*—As defined in the Construction Contract.
 - 8.5. *Work*—As defined in the Construction Contract.
9. Modifications to this Bond are as follows: **None**

EJCDC® C-612, Warranty Bond.
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WORK CHANGE DIRECTIVE NO. [Number of Work Change Directive]

Owner:	City of Moore	Owner's Project No.:	Client Number
Engineer:	Garver	Engineer's Project No.:	Project Number
Contractor:		Contractor's Project No.:	
Project:	Moore WWTP Improvement Projects		
Contract Name:			
Date Issued:	Effective Date of Work Change Directive:		

Contractor is directed to proceed promptly with the following change(s):

Description:

[Description of the change to the Work]

Attachments:

[List documents related to the change to the Work]

Purpose for the Work Change Directive:

[Describe the purpose for the change to the Work]

Directive to proceed promptly with the Work described herein, prior to agreeing to change in Contract Price and Contract Time, is issued due to:

☐ Non-agreement on pricing of proposed change. ☐ Necessity to proceed for schedule or other reasons.

Estimated Change in Contract Price and Contract Times (non-binding, preliminary):

Contract Price: \$ _____ **[increase] [decrease] [not yet estimated].**

Contract Time: _____ days **[increase] [decrease] [not yet estimated].**

Basis of estimated change in Contract Price:

☐ Lump Sum ☐ Unit Price ☐ Cost of the Work ☐ Other

Recommended by Engineer	Authorized by Owner
By: _____	_____
Title: _____	_____
Date: _____	_____

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CHANGE ORDER NO. [Number of Change Order]

Owner: **City of Moore** Owner's Project No.: **Client Number**
Engineer: **Garver** Engineer's Project No.: **Project Number**
Contractor: Contractor's Project No.:
Project: **Moore WWTP Improvement Projects**
Contract Name:
Date Issued: Effective Date of Change Order:

The Contract is modified as follows upon execution of this Change Order:

Description:

[Description of the change]

Attachments:

[List documents related to the change]

Change in Contract Price	Change in Contract Times [State Contract Times as either a specific date or a number of days]
Original Contract Price: \$ _____	Original Contract Times: Substantial Completion: _____ Ready for final payment: _____
[Increase] [Decrease] from previously approved Change Orders No. 1 to No. [Number of previous Change Order] : \$ _____	[Increase] [Decrease] from previously approved Change Orders No.1 to No. [Number of previous Change Order] : Substantial Completion: _____ Ready for final payment: _____
Contract Price prior to this Change Order: \$ _____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for final payment: _____
[Increase] [Decrease] this Change Order: \$ _____	[Increase] [Decrease] this Change Order: Substantial Completion: _____ Ready for final payment: _____
Contract Price incorporating this Change Order: \$ _____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for final payment: _____

	Recommended by Engineer (if required)	Accepted by Contractor
By:	_____	_____
Title:	_____	_____
Date:	_____	_____
	Authorized by Owner	Approved by Funding Agency (if applicable)
By:	_____	_____
Title:	_____	_____
Date:	_____	_____

EJCDC® C-941, Change Order EJCDC® C-941, Change Order, Rev.1.
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CERTIFICATE OF SUBSTANTIAL COMPLETION

Owner:	City of Moore	Owner's Project No.:	Client Number
Engineer:	Garver	Engineer's Project No.:	Project Number
Contractor:		Contractor's Project No.:	
Project:	Moore WWTP Improvement Projects		
Contract Name:			

This ☐ Preliminary ☐ Final Certificate of Substantial Completion applies to:

☐ All Work ☐ The following specified portions of the Work:

[Describe the portion of the work for which Certificate of Substantial Completion is issued]

Date of Substantial Completion: **[Enter date, as determined by Engineer]**

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Work or portion thereof designated above is hereby established, subject to the provisions of the Contract pertaining to Substantial Completion. The date of Substantial Completion in the final Certificate of Substantial Completion marks the commencement of the contractual correction period and applicable warranties required by the Contract.

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

Amendments of contractual responsibilities recorded in this Certificate should be the product of mutual agreement of Owner and Contractor; see Paragraph 15.03.D of the General Conditions.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work must be as provided in the Contract, except as amended as follows:

Amendments to Owner's Responsibilities: ☐ None ☐ As follows:

[List amendments to Owner's Responsibilities]

Amendments to Contractor's Responsibilities: ☐ None ☐ As follows:

[List amendments to Contractor's Responsibilities]

The following documents are attached to and made a part of this Certificate:

[List attachments such as punch list; other documents]

This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents, nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract Documents.

Engineer

By (signature): _____

Name (printed): _____

Title: _____

EJCDC® C-625, Certificate of Substantial Completion.
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NOTICE OF ACCEPTABILITY OF WORK

Owner:	City of Moore	Owner's Project No.:	Client Number Project Number
Engineer:	Garver	Engineer's Project No.:	
Contractor:		Contractor's Project No.:	
Project:	Moore WWTP Improvement Projects		
Contract Name:			
Notice Date:		Effective Date of the Construction Contract:	

The Engineer hereby gives notice to the Owner and Contractor that Engineer recommends final payment to Contractor, and that the Work furnished and performed by Contractor under the Construction Contract is acceptable, expressly subject to the provisions of the Construction Contract's Contract Documents ("Contract Documents") and of the Agreement between Owner and Engineer for Professional Services dated **[date of professional services agreement]** ("Owner-Engineer Agreement"). This Notice of Acceptability of Work (Notice) is made expressly subject to the following terms and conditions to which all who receive and rely on said Notice agree:

1. This Notice has been prepared with the skill and care ordinarily used by members of the engineering profession practicing under similar conditions at the same time and in the same locality.
2. This Notice reflects and is an expression of the Engineer's professional opinion.
3. This Notice has been prepared based on Engineer's actual knowledge and information as of the Notice Date.
4. This Notice is based entirely on and expressly limited by the scope of services Engineer has been employed by Owner to perform or furnish during construction of the Project (including observation of the Contractor's Work) under the Owner-Engineer Agreement, and applies only to facts that are within Engineer's knowledge or could reasonably have been ascertained by Engineer as a result of carrying out the responsibilities specifically assigned to Engineer under such Owner-Engineer Agreement.
5. This Notice is not a guarantee or warranty of Contractor's performance under the Construction Contract, an acceptance of Work that is not in accordance with the Contract Documents, including but not limited to defective Work discovered after final inspection, nor an assumption of responsibility for any failure of Contractor to furnish and perform the Work thereunder in accordance with the Contract Documents, or to otherwise comply with the Contract Documents or the terms of any special guarantees specified therein.
6. This Notice does not relieve Contractor of any surviving obligations under the Construction Contract and is subject to Owner's reservations of rights with respect to completion and final payment.

Engineer

By (signature): _____
Name (printed): _____
Title: _____

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PART 3

CONDITIONS OF THE CONTRACT

General Conditions

The General Conditions, Section 00 72 00, have not been modified or amended in any way from the original publication of the Standard General Conditions of the Construction Contract, EJCDC® C-700 (2018 Edition). Any modifications to these General Conditions have been made in the Supplementary Conditions, Section 00 73 00.

Supplementary Conditions

The Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract, EJCDC® C-700 (2018 Edition), Section 00 72 00. All provisions that are not so amended or supplemented remain in full force and effect.

The address system used in the Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added thereto.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

- A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.
1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
 2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.
 3. *Application for Payment*—The document prepared by Contractor, in a form acceptable to Engineer, to request progress or final payments, and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
 4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
 5. *Bidder*—An individual or entity that submits a Bid to Owner.
 6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.
 7. *Bidding Requirements*—The Advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.
 8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.
 9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.
 10. *Claim*
 - a. A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment of Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract.
 - b. A demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision

- regarding a Change Proposal, or seeking resolution of a contractual issue that Engineer has declined to address.
- c. A demand or assertion by Owner or Contractor, duly submitted in compliance with the procedural requirements set forth herein, made pursuant to Paragraph 12.01.A.4, concerning disputes arising after Engineer has issued a recommendation of final payment.
 - d. A demand for money or services by a third party is not a Claim.
- 11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.
 - 12. *Contract*—The entire and integrated written contract between Owner and Contractor concerning the Work.
 - 13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.
 - 14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.
 - 15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.
 - 16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.
 - 17. *Cost of the Work*—See Paragraph 13.01 for definition.
 - 18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.
 - 19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.
 - 20. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.
 - 21. *Electronic Means*—Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow: (a) the transmission or communication of Electronic Documents; (b) the documentation of transmissions, including sending and receipt; (c) printing of the transmitted Electronic Document by the recipient; (d) the storage and archiving of the Electronic Document by sender and recipient; and (e) the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.
 - 22. *Engineer*—The individual or entity named as such in the Agreement.
 - 23. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.
 - 24. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.
 - a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained

pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.

- b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.
 - c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.
- 25. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and binding decrees, resolutions, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
 - 26. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
 - 27. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date, or by a time prior to Substantial Completion of all the Work.
 - 28. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.
 - 29. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.
 - 30. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.
 - 31. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising Contractor's plan to accomplish the Work within the Contract Times.
 - 32. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.
 - 33. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative (RPR) includes any assistants or field staff of Resident Project Representative.
 - 34. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.
 - 35. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer's review of the submittals.
 - 36. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.
 - 37. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.
 - 38. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands or areas furnished by Owner which are designated for the use of Contractor.

39. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.
40. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.
41. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals may include Shop Drawings and Samples; schedules; product data; Owner-delegated designs; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or Site quality-control testing and inspections; warranties and certifications; Suppliers' instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.
42. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion of such Work.
43. *Successful Bidder*—The Bidder to which the Owner makes an award of contract.
44. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.
45. *Supplier*—A manufacturer, fabricator, supplier, distributor, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.
46. *Technical Data*
- Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (1) existing subsurface conditions at or adjacent to the Site, or existing physical conditions at or adjacent to the Site including existing surface or subsurface structures (except Underground Facilities) or (2) Hazardous Environmental Conditions at the Site.
 - If no such express identifications of Technical Data have been made with respect to conditions at the Site, then Technical Data is defined, with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.
 - Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.
47. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site, including but not limited to those facilities or systems that produce,

transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water, other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.

48. *Unit Price Work*—Work to be paid for on the basis of unit prices.

49. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.

50. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 Terminology

A. The words and terms discussed in Paragraphs 1.02.B, C, D, and E are not defined terms that require initial capital letters, but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives*: The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.

C. *Day*: The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective*: The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:

1. does not conform to the Contract Documents;
2. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
3. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or Paragraph 15.04).

E. *Furnish, Install, Perform, Provide*

1. The word “furnish,” when used in connection with services, materials, or equipment, means to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
2. The word “install,” when used in connection with services, materials, or equipment, means to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, means to furnish and install said services, materials, or equipment complete and ready for intended use.
4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words “furnish,” “install,” “perform,” or “provide,” then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.
- F. *Contract Price or Contract Times*: References to a change in “Contract Price or Contract Times” or “Contract Times or Contract Price” or similar, indicate that such change applies to (1) Contract Price, (2) Contract Times, or (3) both Contract Price and Contract Times, as warranted, even if the term “or both” is not expressed.
- G. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Performance and Payment Bonds; Evidence of Insurance*

- A. *Performance and Payment Bonds*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner the performance bond and payment bond (if the Contract requires Contractor to furnish such bonds).
- B. *Evidence of Contractor’s Insurance*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each additional insured (as identified in the Contract), the certificates, endorsements, and other evidence of insurance required to be provided by Contractor in accordance with Article 6, except to the extent the Supplementary Conditions expressly establish other dates for delivery of specific insurance policies.
- C. *Evidence of Owner’s Insurance*: After receipt of the signed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each additional insured (as identified in the Contract), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

2.02 *Copies of Documents*

- A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.
- B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

- A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Contract (or as otherwise required by the Contract Documents), Contractor shall submit to Engineer for timely review:
 1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;
 2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

- A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work, and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other Submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.
- B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *Acceptance of Schedules*

- A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review the schedules submitted in accordance with Paragraph 2.03.A. No progress payment will be made to Contractor until acceptable schedules are submitted to Engineer.
 1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.
 2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
 3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.
 4. If a schedule is not acceptable, Contractor will have an additional 10 days to revise and resubmit the schedule.

2.06 *Electronic Transmittals*

- A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may send, and shall accept, Electronic Documents transmitted by Electronic Means.
- B. If the Contract does not establish protocols for Electronic Means, then Owner, Engineer, and Contractor shall jointly develop such protocols.
- C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

- A. The Contract Documents are complementary; what is required by one Contract Document is as binding as if required by all.

- B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents.
- C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic versions of the Contract Documents (including any printed copies derived from such electronic versions) and the printed record version, the printed record version will govern.
- D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.
- E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.
- F. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.
- G. Nothing in the Contract Documents creates:
 - 1. any contractual relationship between Owner or Engineer and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or
 - 2. any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

3.02 *Reference Standards*

A. *Standards Specifications, Codes, Laws and Regulations*

- 1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, means the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
- 2. No provision of any such standard specification, manual, reference standard, or code, and no instruction of a Supplier, will be effective to change the duties or responsibilities of Owner, Contractor, or Engineer from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner or Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

- 1. *Contractor's Verification of Figures and Field Measurements:* Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.
- 2. *Contractor's Review of Contract Documents:* If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the

Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:
 - a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or
 - b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Contract Documents*

- A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer in writing all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work.
- B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.
- C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly notify Owner and Contractor in writing that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 *Reuse of Documents*

- A. Contractor and its Subcontractors and Suppliers shall not:
 1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media versions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or

2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.
- B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein precludes Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

- A. The Contract Times will commence to run on the 30th day after the Effective Date of the Contract or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the 60th day after the day of Bid opening or the 30th day after the Effective Date of the Contract, whichever date is earlier.

4.02 *Starting the Work*

- A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work may be done at the Site prior to such date.

4.03 *Reference Points*

- A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.04 *Progress Schedule*

- A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.
1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.
 2. Proposed adjustments in the Progress Schedule that will change the Contract Times must be submitted in accordance with the requirements of Article 11.
- B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work will be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

- A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times.
- B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and

interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.

- C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Such an adjustment will be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:
 - 1. Severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
 - 2. Abnormal weather conditions;
 - 3. Acts or failures to act of third-party utility owners or other third-party entities (other than those third-party utility owners or other third-party entities performing other work at or adjacent to the Site as arranged by or under contract with Owner, as contemplated in Article 8); and
 - 4. Acts of war or terrorism.
- D. Contractor's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:
 - 1. Contractor's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.
 - 2. Contractor shall not be entitled to an adjustment in Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor. Such a concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled.
 - 3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11.
- E. Each Contractor request or Change Proposal seeking an increase in Contract Times or Contract Price must be supplemented by supporting data that sets forth in detail the following:
 - 1. The circumstances that form the basis for the requested adjustment;
 - 2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;
 - 3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;
 - 4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and
 - 5. The impact on Contract Price, in accordance with the provisions of Paragraph 11.07.

Contractor shall also furnish such additional supporting documentation as Owner or Engineer may require including, where appropriate, a revised progress schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work.

- F. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5, together with the provisions of Paragraphs 4.05.D and 4.05.E.

- G. Paragraph 8.03 addresses delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

ARTICLE 5—SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

- A. Owner shall furnish the Site. Owner shall notify Contractor in writing of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.
- B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.
- C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*

- 1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.
- 2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.13, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or in a court of competent jurisdiction; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

- B. ***Removal of Debris During Performance of the Work:*** During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris will conform to applicable Laws and Regulations.

- C. *Cleaning*: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.
- D. *Loading of Structures*: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

- A. *Reports and Drawings*: The Supplementary Conditions identify:
 - 1. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data;
 - 2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data; and
 - 3. Technical Data contained in such reports and drawings.
- B. *Underground Facilities*: Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05, and not in the drawings referred to in Paragraph 5.03.A. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.
- C. *Reliance by Contractor on Technical Data*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b.
- D. *Limitations of Other Data and Documents*: Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:
 - 1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;
 - 2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings;
 - 3. the contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or
 - 4. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

5.04 *Differing Subsurface or Physical Conditions*

- A. *Notice by Contractor*: If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site:
 - 1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;
 - 2. is of such a nature as to require a change in the Drawings or Specifications;

3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

- B. *Engineer's Review:* After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine whether it is necessary for Owner to obtain additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.
- C. *Owner's Statement to Contractor Regarding Site Condition:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.
- D. *Early Resumption of Work:* If at any time Engineer determines that Work in connection with the subsurface or physical condition in question may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the condition in question has been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.
- E. *Possible Price and Times Adjustments*
 1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:
 - a. Such condition must fall within any one or more of the categories described in Paragraph 5.04.A;
 - b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,
 - c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E.
 2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:
 - a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise;
 - b. The existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract

Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or

- c. Contractor failed to give the written notice required by Paragraph 5.04.A.
- 3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
- 4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.
- F. *Underground Facilities; Hazardous Environmental Conditions*: Paragraph 5.05 governs rights and responsibilities regarding the presence or location of Underground Facilities. Paragraph 5.06 governs rights and responsibilities regarding Hazardous Environmental Conditions. The provisions of Paragraphs 5.03 and 5.04 are not applicable to the presence or location of Underground Facilities, or to Hazardous Environmental Conditions.

5.05 *Underground Facilities*

- A. *Contractor's Responsibilities*: Unless it is otherwise expressly provided in the Supplementary Conditions, the cost of all of the following are included in the Contract Price, and Contractor shall have full responsibility for:
 - 1. reviewing and checking all information and data regarding existing Underground Facilities at the Site;
 - 2. complying with applicable state and local utility damage prevention Laws and Regulations;
 - 3. verifying the actual location of those Underground Facilities shown or indicated in the Contract Documents as being within the area affected by the Work, by exposing such Underground Facilities during the course of construction;
 - 4. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and
 - 5. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.
- B. *Notice by Contractor*: If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated on the Drawings, or was not shown or indicated on the Drawings with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing regarding such Underground Facility.
- C. *Engineer's Review*: Engineer will:
 - 1. promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy;
 - 2. identify and communicate with the owner of the Underground Facility; prepare recommendations to Owner (and if necessary issue any preliminary instructions to Contractor) regarding the Contractor's resumption of Work in connection with the Underground Facility in question;
 - 3. obtain any pertinent cost or schedule information from Contractor; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and
 - 4. advise Owner in writing of Engineer's findings, conclusions, and recommendations.

During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

- D. *Owner's Statement to Contractor Regarding Underground Facility:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.
- E. *Early Resumption of Work:* If at any time Engineer determines that Work in connection with the Underground Facility may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the Underground Facility in question and conditions affected by its presence have been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.
- F. *Possible Price and Times Adjustments*
 - 1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, to the extent that any existing Underground Facility at the Site that was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:
 - a. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;
 - b. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E; and
 - c. Contractor gave the notice required in Paragraph 5.05.B.
 - 2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.
 - 3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.
 - 4. The information and data shown or indicated on the Drawings with respect to existing Underground Facilities at the Site is based on information and data (a) furnished by the owners of such Underground Facilities, or by others, (b) obtained from available records, or (c) gathered in an investigation conducted in accordance with the current edition of ASCE 38, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, by the American Society of Civil Engineers. If such information or data is incorrect or incomplete, Contractor's remedies are limited to those set forth in this Paragraph 5.05.F.

5.06 *Hazardous Environmental Conditions at Site*

- A. *Reports and Drawings:* The Supplementary Conditions identify:
 - 1. those reports known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site;
 - 2. drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and
 - 3. Technical Data contained in such reports and drawings.
- B. *Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such

reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;
 2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
 3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.
- C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.
- D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.
- E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.
- F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.
- G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, as a result of such Work stoppage, such special conditions under which Work is agreed to be resumed by Contractor, or any costs or expenses incurred in response to the Hazardous Environmental Condition, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off. Entitlement to any such adjustment is subject to the provisions of Paragraphs 4.05.D, 4.05.E, 11.07, and 11.08.
- H. If, after receipt of such written notice, Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special

conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

- I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court, arbitration, or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.I obligates Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J obligates Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

- A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of Contractor's obligations under the Contract. These bonds must remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the terms of a prescribed bond form, the Supplementary Conditions, or other provisions of the Contract.
- B. Contractor shall also furnish such other bonds (if any) as are required by the Supplementary Conditions or other provisions of the Contract.
- C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Owner prior to execution of the Contract, except as provided otherwise by Laws or Regulations, and must be issued and signed by a surety named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Department Circular 570 (as amended and supplemented) by the Bureau of the Fiscal Service, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

- D. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue bonds in the required amounts.
- E. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer in writing and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which must comply with the bond and surety requirements above.
- F. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16.
- G. Upon request to Owner from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Owner shall provide a copy of the payment bond to such person or entity.
- H. Upon request to Contractor from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Contractor shall provide a copy of the payment bond to such person or entity.

6.02 *Insurance—General Provisions*

- A. Owner and Contractor shall obtain and maintain insurance as required in this article and in the Supplementary Conditions.
- B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized in the state or jurisdiction in which the Project is located to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.
- C. Alternative forms of insurance coverage, including but not limited to self-insurance and "Occupational Accident and Excess Employer's Indemnity Policies," are not sufficient to meet the insurance requirements of this Contract, unless expressly allowed in the Supplementary Conditions.
- D. Contractor shall deliver to Owner, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Contractor has obtained and is maintaining the policies and coverages required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, full disclosure of all relevant exclusions, and evidence of insurance required to be purchased and maintained by Subcontractors or Suppliers. In any documentation furnished under this provision, Contractor, Subcontractors, and Suppliers may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those applicable to this Contract.
- E. Owner shall deliver to Contractor, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Owner has obtained and is maintaining the policies and coverages required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, and full disclosure of all relevant exclusions. In any documentation furnished under this provision, Owner may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those relevant to this Contract.
- F. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to

identify a deficiency in compliance from the evidence provided, will not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.

- G. In addition to the liability insurance required to be provided by Contractor, the Owner, at Owner's option, may purchase and maintain Owner's own liability insurance. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.
- H. Contractor shall require:
 - 1. Subcontractors to purchase and maintain worker's compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project, and to name as additional insureds Owner and Engineer (and any other individuals or entities identified in the Supplementary Conditions as additional insureds on Contractor's liability policies) on each Subcontractor's commercial general liability insurance policy; and
 - 2. Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.
- I. If either party does not purchase or maintain the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.
- J. If Contractor has failed to obtain and maintain required insurance, Contractor's entitlement to enter or remain at the Site will end immediately, and Owner may impose an appropriate set-off against payment for any associated costs (including but not limited to the cost of purchasing necessary insurance coverage), and exercise Owner's termination rights under Article 16.
- K. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect (but is in no way obligated) to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price will be adjusted accordingly.
- L. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary.
- M. The insurance and insurance limits required herein will not be deemed as a limitation on Contractor's liability, or that of its Subcontractors or Suppliers, under the indemnities granted to Owner and other individuals and entities in the Contract or otherwise.
- N. All the policies of insurance required to be purchased and maintained under this Contract will contain a provision or endorsement that the coverage afforded will not be canceled, or renewal refused, until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured and Engineer.

6.03 *Contractor's Insurance*

- A. *Required Insurance:* Contractor shall purchase and maintain Worker's Compensation, Commercial General Liability, and other insurance pursuant to the specific requirements of the Supplementary Conditions.
- B. *General Provisions:* The policies of insurance required by this Paragraph 6.03 as supplemented must:
 - 1. include at least the specific coverages required;
 - 2. be written for not less than the limits provided, or those required by Laws or Regulations, whichever is greater;

3. remain in effect at least until the Work is complete (as set forth in Paragraph 15.06.D), and longer if expressly required elsewhere in this Contract, and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract;
 4. apply with respect to the performance of the Work, whether such performance is by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable; and
 5. include all necessary endorsements to support the stated requirements.
- C. *Additional Insureds*: The Contractor's commercial general liability, automobile liability, employer's liability, umbrella or excess, pollution liability, and unmanned aerial vehicle liability policies, if required by this Contract, must:
1. include and list as additional insureds Owner and Engineer, and any individuals or entities identified as additional insureds in the Supplementary Conditions;
 2. include coverage for the respective officers, directors, members, partners, employees, and consultants of all such additional insureds;
 3. afford primary coverage to these additional insureds for all claims covered thereby (including as applicable those arising from both ongoing and completed operations);
 4. not seek contribution from insurance maintained by the additional insured; and
 5. as to commercial general liability insurance, apply to additional insureds with respect to liability caused in whole or in part by Contractor's acts or omissions, or the acts and omissions of those working on Contractor's behalf, in the performance of Contractor's operations.

6.04 *Builder's Risk and Other Property Insurance*

- A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the Work's full insurable replacement cost (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). The specific requirements applicable to the builder's risk insurance are set forth in the Supplementary Conditions.
- B. *Property Insurance for Facilities of Owner Where Work Will Occur*: Owner is responsible for obtaining and maintaining property insurance covering each existing structure, building, or facility in which any part of the Work will occur, or to which any part of the Work will attach or be adjoined. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, providing coverage consistent with that required for the builder's risk insurance, and will be maintained until the Work is complete, as set forth in Paragraph 15.06.D.
- C. *Property Insurance for Substantially Complete Facilities*: Promptly after Substantial Completion, and before actual occupancy or use of the substantially completed Work, Owner will obtain property insurance for such substantially completed Work, and maintain such property insurance at least until the Work is complete, as set forth in Paragraph 15.06.D. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, and provide coverage consistent with that required for the builder's risk insurance. The builder's risk insurance may terminate upon written confirmation of Owner's procurement of such property insurance.
- D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide advance notice of such occupancy or use to the builder's risk insurer, and obtain an

endorsement consenting to the continuation of coverage prior to commencing such partial occupancy or use.

- E. *Insurance of Other Property; Additional Insurance:* If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, then the entity or individual owning such property item will be responsible for insuring it. If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.04, it may do so at Contractor's expense.

6.05 *Property Losses; Subrogation*

- A. The builder's risk insurance policy purchased and maintained in accordance with Paragraph 6.04 (or an installation floater policy if authorized by the Supplementary Conditions), will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors.
1. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils, risks, or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all individuals or entities identified in the Supplementary Conditions as builder's risk or installation floater insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused.
 2. None of the above waivers extends to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.
- B. Any property insurance policy maintained by Owner covering any loss, damage, or consequential loss to Owner's existing structures, buildings, or facilities in which any part of the Work will occur, or to which any part of the Work will attach or adjoin; to adjacent structures, buildings, or facilities of Owner; or to part or all of the completed or substantially completed Work, during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06, will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them, and that the insured is allowed to waive the insurer's rights of subrogation in a written contract executed prior to the loss, damage, or consequential loss.
1. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from fire or any of the perils, risks, or causes of loss covered by such policies.
- C. The waivers in this Paragraph 6.05 include the waiver of rights due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other insured peril, risk, or cause of loss.
- D. Contractor shall be responsible for assuring that each Subcontract contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or

resulting from fire or other peril, risk, or cause of loss covered by builder's risk insurance, installation floater, and any other property insurance applicable to the Work.

6.06 *Receipt and Application of Property Insurance Proceeds*

- A. Any insured loss under the builder's risk and other policies of property insurance required by Paragraph 6.04 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.
- B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.04 shall maintain such proceeds in a segregated account, and distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.
- C. If no other special agreement is reached, Contractor shall repair or replace the damaged Work, using allocated insurance proceeds.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.01 *Contractor's Means and Methods of Construction*

- A. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.
- B. If the Contract Documents note, or Contractor determines, that professional engineering or other design services are needed to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety, then Contractor shall cause such services to be provided by a properly licensed design professional, at Contractor's expense. Such services are not Owner-delegated professional design services under this Contract, and neither Owner nor Engineer has any responsibility with respect to (1) Contractor's determination of the need for such services, (2) the qualifications or licensing of the design professionals retained or employed by Contractor, (3) the performance of such services, or (4) any errors, omissions, or defects in such services.

7.02 *Supervision and Superintendence*

- A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents.
- B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who will not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.03 *Labor; Working Hours*

- A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall maintain good discipline and order at the Site.
- B. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of Contractor's employees; of Suppliers and Subcontractors, and their employees; and of any other individuals or entities performing or furnishing any of the Work, just as Contractor is responsible for Contractor's own acts and omissions.

- C. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site will be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.04 *Services, Materials, and Equipment*

- A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.
- B. All materials and equipment incorporated into the Work must be new and of good quality, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications will expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.
- C. All materials and equipment must be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.05 *"Or Equals"*

- A. *Contractor's Request; Governing Criteria:* Whenever an item of equipment or material is specified or described in the Contract Documents by using the names of one or more proprietary items or specific Suppliers, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material, or items from other proposed Suppliers, under the circumstances described below.
 - 1. If Engineer in its sole discretion determines that an item of equipment or material proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer will deem it an "or equal" item. For the purposes of this paragraph, a proposed item of equipment or material will be considered functionally equal to an item so named if:
 - a. in the exercise of reasonable judgment Engineer determines that the proposed item:
 - 1) is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
 - 2) will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;
 - 3) has a proven record of performance and availability of responsive service; and
 - 4) is not objectionable to Owner.
 - b. Contractor certifies that, if the proposed item is approved and incorporated into the Work:
 - 1) there will be no increase in cost to the Owner or increase in Contract Times; and
 - 2) the item will conform substantially to the detailed requirements of the item named in the Contract Documents.

- B. *Contractor's Expense*: Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.
- C. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal," which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.
- D. *Effect of Engineer's Determination*: Neither approval nor denial of an "or-equal" request will result in any change in Contract Price. The Engineer's denial of an "or-equal" request will be final and binding, and may not be reversed through an appeal under any provision of the Contract.
- E. *Treatment as a Substitution Request*: If Engineer determines that an item of equipment or material proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer consider the item a proposed substitute pursuant to Paragraph 7.06.

7.06 Substitutes

- A. *Contractor's Request; Governing Criteria*: Unless the specification or description of an item of equipment or material required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material under the circumstances described below. To the extent possible such requests must be made before commencement of related construction at the Site.
 - 1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of equipment or material from anyone other than Contractor.
 - 2. The requirements for review by Engineer will be as set forth in Paragraph 7.06.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.
 - 3. Contractor shall make written application to Engineer for review of a proposed substitute item of equipment or material that Contractor seeks to furnish or use. The application:
 - a. will certify that the proposed substitute item will:
 - 1) perform adequately the functions and achieve the results called for by the general design;
 - 2) be similar in substance to the item specified; and
 - 3) be suited to the same use as the item specified.
 - b. will state:
 - 1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times;
 - 2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and
 - 3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.

- c. will identify:
 - 1) all variations of the proposed substitute item from the item specified; and
 - 2) available engineering, sales, maintenance, repair, and replacement services.
 - d. will contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.
- B. *Engineer's Evaluation and Determination:* Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.
- C. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.
- D. *Reimbursement of Engineer's Cost:* Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.
- E. *Contractor's Expense:* Contractor shall provide all data in support of any proposed substitute at Contractor's expense.
- F. *Effect of Engineer's Determination:* If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request will be final and binding, and may not be reversed through an appeal under any provision of the Contract. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.06.D, by timely submittal of a Change Proposal.

7.07 Concerning Subcontractors and Suppliers

- A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner. The Contractor's retention of a Subcontractor or Supplier for the performance of parts of the Work will not relieve Contractor's obligation to Owner to perform and complete the Work in accordance with the Contract Documents.
- B. Contractor shall retain specific Subcontractors and Suppliers for the performance of designated parts of the Work if required by the Contract to do so.
- C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor or Supplier to furnish or perform any of the Work against which Contractor has reasonable objection.
- D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 5 days.

- E. Owner may require the replacement of any Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors or Suppliers for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor or Supplier so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor or Supplier.
- F. If Owner requires the replacement of any Subcontractor or Supplier retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.
- G. No acceptance by Owner of any such Subcontractor or Supplier, whether initially or as a replacement, will constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.
- H. On a monthly basis, Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.
- I. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors and Suppliers.
- J. The divisions and sections of the Specifications and the identifications of any Drawings do not control Contractor in dividing the Work among Subcontractors or Suppliers, or in delineating the Work to be performed by any specific trade.
- K. All Work performed for Contractor by a Subcontractor or Supplier must be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract for the benefit of Owner and Engineer.
- L. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor for Work performed for Contractor by the Subcontractor or Supplier.
- M. Contractor shall restrict all Subcontractors and Suppliers from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed in this Contract.

7.08 *Patent Fees and Royalties*

- A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If an invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights will be disclosed in the Contract Documents.
- B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

- C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.09 *Permits*

- A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits, licenses, and certificates of occupancy. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

7.10 *Taxes*

- A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.11 *Laws and Regulations*

- A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.
- B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It is not Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this does not relieve Contractor of its obligations under Paragraph 3.03.
- C. Owner or Contractor may give written notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such written notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.12 *Record Documents*

- A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available

to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.13 *Safety and Protection*

- A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations.
- B. Contractor shall designate a qualified and experienced safety representative whose duties and responsibilities are the prevention of Work-related accidents and the maintenance and supervision of safety precautions and programs.
- C. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:
 - 1. all persons on the Site or who may be affected by the Work;
 - 2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
 - 3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
- D. All damage, injury, or loss to any property referred to in Paragraph 7.13.C.2 or 7.13.C.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).
- E. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.
- F. Contractor shall notify Owner; the owners of adjacent property; the owners of Underground Facilities and other utilities (if the identity of such owners is known to Contractor); and other contractors and utility owners performing work at or adjacent to the Site, in writing, when Contractor knows that prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.
- G. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. Any Owner's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.
- H. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.
- I. Contractor's duties and responsibilities for safety and protection will continue until all the Work is completed, Engineer has issued a written notice to Owner and Contractor in accordance with Paragraph 15.06.C that the Work is acceptable, and Contractor has left the Site (except as otherwise expressly provided in connection with Substantial Completion).
- J. Contractor's duties and responsibilities for safety and protection will resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.14 *Hazard Communication Programs*

- A. Contractor shall be responsible for coordinating any exchange of safety data sheets (formerly known as material safety data sheets) or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 *Emergencies*

- A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused by an emergency, or are required as a result of Contractor's response to an emergency. If Engineer determines that a change in the Contract Documents is required because of an emergency or Contractor's response, a Work Change Directive or Change Order will be issued.

7.16 *Submittals*

A. *Shop Drawing and Sample Requirements*

1. Before submitting a Shop Drawing or Sample, Contractor shall:
 - a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
 - b. determine and verify:
 - 1) all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal;
 - 2) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
 - 3) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto;
 - c. confirm that the Submittal is complete with respect to all related data included in the Submittal.
2. Each Shop Drawing or Sample must bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that Submittal, and that Contractor approves the Submittal.
3. With each Shop Drawing or Sample, Contractor shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Contract Documents. This notice must be set forth in a written communication separate from the Submittal; and, in addition, in the case of a Shop Drawing by a specific notation made on the Shop Drawing itself.

- B. *Submittal Procedures for Shop Drawings and Samples:* Contractor shall label and submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals.

1. *Shop Drawings*

- a. Contractor shall submit the number of copies required in the Specifications.
- b. Data shown on the Shop Drawings must be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to

show Engineer the services, materials, and equipment Contractor proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.C.

2. *Samples*

- a. Contractor shall submit the number of Samples required in the Specifications.
 - b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the Submittal for the limited purposes required by Paragraph 7.16.C.
3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Engineer's Review of Shop Drawings and Samples*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if the items covered by the Submittals will, after installation or incorporation in the Work, comply with the requirements of the Contract Documents, and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction, or to safety precautions or programs incident thereto.
3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
4. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the requirements of the Contract Documents in a Field Order or other appropriate Contract modification.
5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for complying with the requirements of Paragraphs 7.16.A and B.
6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, will not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.
7. Neither Engineer's receipt, review, acceptance, or approval of a Shop Drawing or Sample will result in such item becoming a Contract Document.
8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.C.4.

D. *Resubmittal Procedures for Shop Drawings and Samples*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.
2. Contractor shall furnish required Shop Drawing and Sample submittals with sufficient information and accuracy to obtain required approval of an item with no more than two

resubmittals. Engineer will record Engineer's time for reviewing a third or subsequent resubmittal of a Shop Drawing or Sample, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges.

3. If Contractor requests a change of a previously approved Shop Drawing or Sample, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

E. *Submittals Other than Shop Drawings, Samples, and Owner-Delegated Designs*

1. The following provisions apply to all Submittals other than Shop Drawings, Samples, and Owner-delegated designs:
 - a. Contractor shall submit all such Submittals to the Engineer in accordance with the Schedule of Submittals and pursuant to the applicable terms of the Contract Documents.
 - b. Engineer will provide timely review of all such Submittals in accordance with the Schedule of Submittals and return such Submittals with a notation of either Accepted or Not Accepted. Any such Submittal that is not returned within the time established in the Schedule of Submittals will be deemed accepted.
 - c. Engineer's review will be only to determine if the Submittal is acceptable under the requirements of the Contract Documents as to general form and content of the Submittal.
 - d. If any such Submittal is not accepted, Contractor shall confer with Engineer regarding the reason for the non-acceptance, and resubmit an acceptable document.
2. Procedures for the submittal and acceptance of the Progress Schedule, the Schedule of Submittals, and the Schedule of Values are set forth in Paragraphs 2.03, 2.04, and 2.05.

- F. Owner-delegated Designs:** Submittals pursuant to Owner-delegated designs are governed by the provisions of Paragraph 7.19.

7.17 *Contractor's General Warranty and Guarantee*

- A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer is entitled to rely on Contractor's warranty and guarantee.
- B. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 15.08. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.17 is limited only by applicable Laws and Regulations restricting actions to enforce such rights; provided, however, that after the end of the correction period under Paragraph 15.08:
 1. Owner shall give Contractor written notice of any defective Work within 60 days of the discovery that such Work is defective; and
 2. Such notice will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the notice.
- C. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
 1. abuse, or improper modification, maintenance, or operation, by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
 2. normal wear and tear under normal usage.

- D. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents is absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents, a release of Contractor's obligation to perform the Work in accordance with the Contract Documents, or a release of Owner's warranty and guarantee rights under this Paragraph 7.17:
1. Observations by Engineer;
 2. Recommendation by Engineer or payment by Owner of any progress or final payment;
 3. The issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
 4. Use or occupancy of the Work or any part thereof by Owner;
 5. Any review and approval of a Shop Drawing or Sample submittal;
 6. The issuance of a notice of acceptability by Engineer;
 7. The end of the correction period established in Paragraph 15.08;
 8. Any inspection, test, or approval by others; or
 9. Any correction of defective Work by Owner.
- E. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract will govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 Indemnification

- A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from losses, damages, costs, and judgments (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising from third-party claims or actions relating to or resulting from the performance or furnishing of the Work, provided that any such claim, action, loss, cost, judgment or damage is attributable to bodily injury, sickness, disease, or death, or to damage to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom, but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable.
- B. In any and all claims against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A will not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.19 Delegation of Professional Design Services

- A. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that Contractor must furnish to Engineer with respect to the Owner-delegated design.

- B. Contractor shall cause such Owner-delegated professional design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and Submittals prepared by such design professional. Such design professional must issue all certifications of design required by Laws and Regulations.
- C. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Engineer, then such Shop Drawing or other Submittal must bear the written approval of Contractor's design professional when submitted by Contractor to Engineer.
- D. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under an Owner-delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.
- E. Pursuant to this Paragraph 7.19, Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:
 - 1. Checking for conformance with the requirements of this Paragraph 7.19;
 - 2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and
 - 3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.
- F. Contractor shall not be responsible for the adequacy of performance or design criteria specified by Owner or Engineer.
- G. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.

ARTICLE 8—OTHER WORK AT THE SITE

8.01 *Other Work*

- A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.
- B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any third-party utility work that Owner has arranged to take place at or adjacent to the Site, Owner shall provide such information to Contractor.
- C. Contractor shall afford proper and safe access to the Site to each contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work.
- D. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.

- E. If the proper execution or results of any part of Contractor's Work depends upon work performed by others, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.
- F. The provisions of this article are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay, disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.05.C.3.

8.02 *Coordination*

- A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:
 - 1. The identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;
 - 2. An itemization of the specific matters to be covered by such authority and responsibility; and
 - 3. The extent of such authority and responsibilities.
- B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 *Legal Relationships*

- A. If, in the course of performing other work for Owner at or adjacent to the Site, the Owner's employees, any other contractor working for Owner, or any utility owner that Owner has arranged to perform work, causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment will take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract, and any remedies available to Contractor under Laws or Regulations concerning utility action or inaction. When applicable, any such equitable adjustment in Contract Price will be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times or Contract Price is subject to the provisions of Paragraphs 4.05.D and 4.05.E.
- B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site.
 - 1. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this Paragraph 8.03.B.
 - 2. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable

direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due Contractor.

- C. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.01 *Communications to Contractor*

- A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

9.02 *Replacement of Engineer*

- A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer's status under the Contract Documents will be that of the former Engineer.

9.03 *Furnish Data*

- A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

9.04 *Pay When Due*

- A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

9.05 *Lands and Easements; Reports, Tests, and Drawings*

- A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.
- B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.
- C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 *Insurance*

- A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.

9.07 *Change Orders*

- A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.

9.08 *Inspections, Tests, and Approvals*

- A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.09 *Limitations on Owner's Responsibilities*

- A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

9.10 *Undisclosed Hazardous Environmental Condition*

- A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.11 *Evidence of Financial Arrangements*

- A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract (including obligations under proposed changes in the Work).

9.12 *Safety Programs*

- A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed.
- B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *Owner's Representative*

- A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract.

10.02 *Visits to Site*

- A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe, as an experienced and qualified design professional, the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.
- B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.07. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 *Resident Project Representative*

- A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in the Supplementary Conditions and in Paragraph 10.07.
- B. If Owner designates an individual or entity who is not Engineer's consultant, agent, or employee to represent Owner at the Site, then the responsibilities and authority of such individual or entity will be as provided in the Supplementary Conditions.

10.04 *Engineer's Authority*

- A. Engineer has the authority to reject Work in accordance with Article 14.
- B. Engineer's authority as to Submittals is set forth in Paragraph 7.16.
- C. Engineer's authority as to design drawings, calculations, specifications, certifications and other Submittals from Contractor in response to Owner's delegation (if any) to Contractor of professional design services, is set forth in Paragraph 7.19.
- D. Engineer's authority as to changes in the Work is set forth in Article 11.
- E. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.05 *Determinations for Unit Price Work*

- A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.06 *Decisions on Requirements of Contract Documents and Acceptability of Work*

- A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.07 *Limitations on Engineer's Authority and Responsibilities*

- A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, will create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.
- B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.
- C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.
- D. Engineer's review of the final Application for Payment and accompanying documentation, and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Contractor under Paragraph 15.06.A, will only be to determine generally that their content

complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.

- E. The limitations upon authority and responsibility set forth in this Paragraph 10.07 also apply to the Resident Project Representative, if any.

10.08 *Compliance with Safety Program*

- A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs of which Engineer has been informed.

ARTICLE 11—CHANGES TO THE CONTRACT

11.01 *Amending and Supplementing the Contract*

- A. The Contract may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.
- B. If an amendment or supplement to the Contract includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order.
- C. All changes to the Contract that involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, must be supported by Engineer's recommendation. Owner and Contractor may amend other terms and conditions of the Contract without the recommendation of the Engineer.

11.02 *Change Orders*

- A. Owner and Contractor shall execute appropriate Change Orders covering:
 - 1. Changes in Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;
 - 2. Changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;
 - 3. Changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.05, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters; and
 - 4. Changes that embody the substance of any final and binding results under: Paragraph 11.03.B, resolving the impact of a Work Change Directive; Paragraph 11.09, concerning Change Proposals; Article 12, Claims; Paragraph 13.02.D, final adjustments resulting from allowances; Paragraph 13.03.D, final adjustments relating to determination of quantities for Unit Price Work; and similar provisions.
- B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of Paragraph 11.02.A, it will be deemed to be of full force and effect, as if fully executed.

11.03 *Work Change Directives*

- A. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the

terms of the Contract Documents governing adjustments, expressly including Paragraph 11.07 regarding change of Contract Price.

B. If Owner has issued a Work Change Directive and:

1. Contractor believes that an adjustment in Contract Times or Contract Price is necessary, then Contractor shall submit any Change Proposal seeking such an adjustment no later than 30 days after the completion of the Work set out in the Work Change Directive.
2. Owner believes that an adjustment in Contract Times or Contract Price is necessary, then Owner shall submit any Claim seeking such an adjustment no later than 60 days after issuance of the Work Change Directive.

11.04 *Field Orders*

- A. Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly.
- B. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.05 *Owner-Authorized Changes in the Work*

- A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Changes involving the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.
- B. Such changes in the Work may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work must be performed under the applicable conditions of the Contract Documents.
- C. Nothing in this Paragraph 11.05 obligates Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.06 *Unauthorized Changes in the Work*

- A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.C.2.

11.07 *Change of Contract Price*

- A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12.
- B. An adjustment in the Contract Price will be determined as follows:
 1. Where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03);

2. Where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.07.C.2); or
 3. Where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.07.C).
- C. *Contractor's Fee*: When applicable, the Contractor's fee for overhead and profit will be determined as follows:
1. A mutually acceptable fixed fee; or
 2. If a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
 - a. For costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee will be 15 percent;
 - b. For costs incurred under Paragraph 13.01.B.3, the Contractor's fee will be 5 percent;
 - c. Where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.07.C.2.a and 11.07.C.2.b is that the Contractor's fee will be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted Work the maximum total fee to be paid by Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the Work;
 - d. No fee will be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;
 - e. The amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in Cost of the Work will be the amount of the actual net decrease in Cost of the Work and a deduction of an additional amount equal to 5 percent of such actual net decrease in Cost of the Work; and
 - f. When both additions and credits are involved in any one change or Change Proposal, the adjustment in Contractor's fee will be computed by determining the sum of the costs in each of the cost categories in Paragraph 13.01.B (specifically, payroll costs, Paragraph 13.01.B.1; incorporated materials and equipment costs, Paragraph 13.01.B.2; Subcontract costs, Paragraph 13.01.B.3; special consultants costs, Paragraph 13.01.B.4; and other costs, Paragraph 13.01.B.5) and applying to each such cost category sum the appropriate fee from Paragraphs 11.07.C.2.a through 11.07.C.2.e, inclusive.

11.08 *Change of Contract Times*

- A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment in the Contract Times must comply with the provisions of Article 12.
- B. Delay, disruption, and interference in the Work, and any related changes in Contract Times, are addressed in and governed by Paragraph 4.05.

11.09 *Change Proposals*

- A. *Purpose and Content*: Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; contest an initial decision by Engineer

concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; challenge a set-off against payment due; or seek other relief under the Contract. The Change Proposal will specify any proposed change in Contract Times or Contract Price, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents. Each Change Proposal will address only one issue, or a set of closely related issues.

B. *Change Proposal Procedures*

1. *Submittal*: Contractor shall submit each Change Proposal to Engineer within 30 days after the start of the event giving rise thereto, or after such initial decision.
2. *Supporting Data*: The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal.
 - a. Change Proposals based on or related to delay, interruption, or interference must comply with the provisions of Paragraphs 4.05.D and 4.05.E.
 - b. Change proposals related to a change of Contract Price must include full and detailed accounts of materials incorporated into the Work and labor and equipment used for the subject Work.

The supporting data must be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event.

3. *Engineer's Initial Review*: Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal. If in its discretion Engineer concludes that additional supporting data is needed before conducting a full review and making a decision regarding the Change Proposal, then Engineer may request that Contractor submit such additional supporting data by a date specified by Engineer, prior to Engineer beginning its full review of the Change Proposal.
 4. *Engineer's Full Review and Action on the Change Proposal*: Upon receipt of Contractor's supporting data (including any additional data requested by Engineer), Engineer will conduct a full review of each Change Proposal and, within 30 days after such receipt of the Contractor's supporting data, either approve the Change Proposal in whole, deny it in whole, or approve it in part and deny it in part. Such actions must be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.
 5. *Binding Decision*: Engineer's decision is final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.
- C. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties in writing that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice will be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.
- D. *Post-Completion*: Contractor shall not submit any Change Proposals after Engineer issues a written recommendation of final payment pursuant to Paragraph 15.06.B.

11.10 *Notification to Surety*

- A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not

limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

ARTICLE 12—CLAIMS

12.01 Claims

- A. *Claims Process*: The following disputes between Owner and Contractor are subject to the Claims process set forth in this article:
 - 1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;
 - 2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents;
 - 3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters; and
 - 4. Subject to the waiver provisions of Paragraph 15.07, any dispute arising after Engineer has issued a written recommendation of final payment pursuant to Paragraph 15.06.B.
- B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim rests with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.
- C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim will be stated in writing and submitted to the other party, with a copy to Engineer.
- D. *Mediation*
 - 1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate will stay the Claim submittal and response process.
 - 2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process will resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process will resume as of the date of the conclusion of the mediation, as determined by the mediator.
 - 3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.
- E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action will be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.
- F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time

thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim will be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.

- G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim will be incorporated in a Change Order or other written document to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

ARTICLE 13—COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 *Cost of the Work*

- A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:
1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or
 2. When needed to determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.
- B. *Costs Included*: Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work will be in amounts no higher than those commonly incurred in the locality of the Project, will not include any of the costs itemized in Paragraph 13.01.C, and will include only the following items:
1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor in advance of the subject Work. Such employees include, without limitation, superintendents, foremen, safety managers, safety representatives, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work will be apportioned on the basis of their time spent on the Work. Payroll costs include, but are not limited to, salaries and wages plus the cost of fringe benefits, which include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, will be included in the above to the extent authorized by Owner.
 2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts will accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment will accrue to Owner, and Contractor shall make provisions so that they may be obtained.
 3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, which will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work

plus a fee, the Subcontractor's Cost of the Work and fee will be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.

4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed or retained for services specifically related to the Work.
5. Other costs consisting of the following:
 - a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
 - b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.
 - 1) In establishing included costs for materials such as scaffolding, plating, or sheeting, consideration will be given to the actual or the estimated life of the material for use on other projects; or rental rates may be established on the basis of purchase or salvage value of such items, whichever is less. Contractor will not be eligible for compensation for such items in an amount that exceeds the purchase cost of such item.
 - c. *Construction Equipment Rental*
 - 1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner as to price (including any surcharge or special rates applicable to overtime use of the construction equipment or machinery), and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs will be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts must cease when the use thereof is no longer necessary for the Work.
 - 2) Costs for equipment and machinery owned by Contractor or a Contractor-related entity will be paid at a rate shown for such equipment in the equipment rental rate book specified in the Supplementary Conditions. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.
 - 3) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed Work.
 - d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
 - e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
 - f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of builder's risk or other property insurance established in accordance with Paragraph 6.04), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly

employed by any of them or for whose acts any of them may be liable. Such losses include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses will be included in the Cost of the Work for the purpose of determining Contractor's fee.

- g. The cost of utilities, fuel, and sanitary facilities at the Site.
- h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.
- i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

C. *Costs Excluded:* The term Cost of the Work does not include any of the following items:

- 1. Payroll costs and other compensation of Contractor's officers, executives, principals, general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.
- 2. The cost of purchasing, renting, or furnishing small tools and hand tools.
- 3. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.
- 4. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
- 5. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
- 6. Expenses incurred in preparing and advancing Claims.
- 7. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. *Contractor's Fee*

- 1. When the Work as a whole is performed on the basis of cost-plus-a-fee, then:
 - a. Contractor's fee for the Work set forth in the Contract Documents as of the Effective Date of the Contract will be determined as set forth in the Agreement.
 - b. for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work, Contractor's fee will be determined as follows:
 - 1) When the fee for the Work as a whole is a percentage of the Cost of the Work, the fee will automatically adjust as the Cost of the Work changes.
 - 2) When the fee for the Work as a whole is a fixed fee, the fee for any additions or deletions will be determined in accordance with Paragraph 11.07.C.2.
- 2. When the Work as a whole is performed on the basis of a stipulated sum, or any other basis other than cost-plus-a-fee, then Contractor's fee for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work will be determined in accordance with Paragraph 11.07.C.2.

- E. *Documentation and Audit*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor and pertinent Subcontractors will establish and maintain records of the costs in accordance with generally accepted accounting practices. Subject to prior written notice, Owner will be afforded reasonable access, during normal business hours, to all Contractor's accounts, records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to the Cost of the Work and Contractor's fee. Contractor shall preserve all such documents for a period of three years after the final payment by Owner. Pertinent Subcontractors will afford such access to Owner, and preserve such documents, to the same extent required of Contractor.

13.02 Allowances

- A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.
- B. *Cash Allowances*: Contractor agrees that:
1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
 2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment for any of the foregoing will be valid.
- C. *Owner's Contingency Allowance*: Contractor agrees that an Owner's contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.
- D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor for Work covered by allowances, and the Contract Price will be correspondingly adjusted.

13.03 Unit Price Work

- A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.
- C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.
- D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, and the final adjustment of Contract Price will be set forth in a Change Order, subject to the provisions of the following paragraph.

E. *Adjustments in Unit Price*

1. Contractor or Owner shall be entitled to an adjustment in the unit price with respect to an item of Unit Price Work if:
 - a. the quantity of the item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and
 - b. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.
2. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.
3. Adjusted unit prices will apply to all units of that item.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

14.01 *Access to Work*

- A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply with such procedures and programs as applicable.

14.02 *Tests, Inspections, and Approvals*

- A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.
- B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work will be governed by the provisions of Paragraph 14.05.
- C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.
- D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:
 1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;
 2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;
 3. by manufacturers of equipment furnished under the Contract Documents;
 4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and

5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

Such inspections and tests will be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

- E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.
- F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering will be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 *Defective Work*

- A. *Contractor's Obligation:* It is Contractor's obligation to assure that the Work is not defective.
- B. *Engineer's Authority:* Engineer has the authority to determine whether Work is defective, and to reject defective Work.
- C. *Notice of Defects:* Prompt written notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.
- D. *Correction, or Removal and Replacement:* Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.
- E. *Preservation of Warranties:* When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.
- F. *Costs and Damages:* In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs, losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 *Acceptance of Defective Work*

- A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work will be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 *Uncovering Work*

- A. Engineer has the authority to require additional inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.
- B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.
- C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.
 - 1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.
 - 2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 *Owner May Stop the Work*

- A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work will not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

14.07 *Owner May Correct Defective Work*

- A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace defective Work as required by Engineer, then Owner may, after 7 days' written notice to Contractor, correct or remedy any such deficiency.
- B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.
- C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.
- D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15—PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 *Progress Payments*

- A. *Basis for Progress Payments:* The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments for Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.
- B. *Applications for Payments*
 - 1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents.
 - 2. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment must also be accompanied by: (a) a bill of sale, invoice, copies of subcontract or purchase order payments, or other documentation establishing full payment by Contractor for the materials and equipment; (b) at Owner's request, documentation warranting that Owner has received the materials and equipment free and clear of all Liens; and (c) evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.
 - 3. Beginning with the second Application for Payment, each Application must include an affidavit of Contractor stating that all previous progress payments received by Contractor have been applied to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
 - 4. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.
- C. *Review of Applications*
 - 1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
 - 2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:
 - a. the Work has progressed to the point indicated;
 - b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and
 - c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
 - a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or
 - b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.
4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
 - a. to supervise, direct, or control the Work;
 - b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto;
 - c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work;
 - d. to make any examination to ascertain how or for what purposes Contractor has used the money paid by Owner; or
 - e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.
5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.
6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:
 - a. the Work is defective, requiring correction or replacement;
 - b. the Contract Price has been reduced by Change Orders;
 - c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
 - d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or
 - e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

D. *Payment Becomes Due*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

E. *Reductions in Payment by Owner*

1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:
 - a. Claims have been made against Owner based on Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages resulting from Contractor's conduct in the performance or furnishing of the

Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;

- b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;
 - c. Contractor has failed to provide and maintain required bonds or insurance;
 - d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;
 - e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;
 - f. The Work is defective, requiring correction or replacement;
 - g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
 - h. The Contract Price has been reduced by Change Orders;
 - i. An event has occurred that would constitute a default by Contractor and therefore justify a termination for cause;
 - j. Liquidated or other damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;
 - k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens; or
 - l. Other items entitle Owner to a set-off against the amount recommended.
2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed will be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.
3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld will be treated as an amount due as determined by Paragraph 15.01.D.1 and subject to interest as provided in the Agreement.

15.02 *Contractor's Warranty of Title*

- A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than 7 days after the time of payment by Owner.

15.03 *Substantial Completion*

- A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.

- B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.
- C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which will fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have 7 days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.
- D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.
- E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.
- F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

15.04 *Partial Use or Occupancy*

- A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:
 - 1. At any time, Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through 15.03.E for that part of the Work.
 - 2. At any time, Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.
 - 3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer

will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.04 regarding builder's risk or other property insurance.

15.05 *Final Inspection*

- A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

15.06 *Final Payment*

A. *Application for Payment*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.12), and other documents, Contractor may make application for final payment.
2. The final Application for Payment must be accompanied (except as previously delivered) by:
 - a. all documentation called for in the Contract Documents;
 - b. consent of the surety, if any, to final payment;
 - c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.
 - d. a list of all duly pending Change Proposals and Claims; and
 - e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.
3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.

- B. *Engineer's Review of Final Application and Recommendation of Payment:* If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract have been fulfilled, Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the final Application for Payment to Owner for payment. Such recommendation will account for any set-offs against payment that are

necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

- C. *Notice of Acceptability*: In support of its recommendation of payment of the final Application for Payment, Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to stated limitations in the notice and to the provisions of Paragraph 15.07.
- D. *Completion of Work*: The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment and issuance of notice of the acceptability of the Work.
- E. *Final Payment Becomes Due*: Upon receipt from Engineer of the final Application for Payment and accompanying documentation, Owner shall set off against the amount recommended by Engineer for final payment any further sum to which Owner is entitled, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions of this Contract with respect to progress payments. Owner shall pay the resulting balance due to Contractor within 30 days of Owner's receipt of the final Application for Payment from Engineer.

15.07 *Waiver of Claims*

- A. By making final payment, Owner waives its claim or right to liquidated damages or other damages for late completion by Contractor, except as set forth in an outstanding Claim, appeal under the provisions of Article 17, set-off, or express reservation of rights by Owner. Owner reserves all other claims or rights after final payment.
- B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted as a Claim, or appealed under the provisions of Article 17.

15.08 *Correction Period*

- A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the Supplementary Conditions or the terms of any applicable special guarantee required by the Contract Documents), Owner gives Contractor written notice that any Work has been found to be defective, or that Contractor's repair of any damages to the Site or adjacent areas has been found to be defective, then after receipt of such notice of defect Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:
 - 1. correct the defective repairs to the Site or such adjacent areas;
 - 2. correct such defective Work;
 - 3. remove the defective Work from the Project and replace it with Work that is not defective, if the defective Work has been rejected by Owner, and
 - 4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting from the corrective measures.
- B. Owner shall give any such notice of defect within 60 days of the discovery that such Work or repairs is defective. If such notice is given within such 60 days but after the end of the correction period, the notice will be deemed a notice of defective Work under Paragraph 7.17.B.
- C. If, after receipt of a notice of defect within 60 days and within the correction period, Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal

and replacement (including but not limited to all costs of repair or replacement of work of others). Contractor's failure to pay such costs, losses, and damages within 10 days of invoice from Owner will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the failure to pay.

- D. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.
- E. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.
- F. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph are not to be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

- A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times directly attributable to any such suspension. Any Change Proposal seeking such adjustments must be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 *Owner May Terminate for Cause*

- A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:
 - 1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment, or failure to adhere to the Progress Schedule);
 - 2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;
 - 3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or
 - 4. Contractor's repeated disregard of the authority of Owner or Engineer.
- B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) 10 days' written notice that Owner is considering a declaration that Contractor is in default and termination of the Contract, Owner may proceed to:
 - 1. declare Contractor to be in default, and give Contractor (and any surety) written notice that the Contract is terminated; and
 - 2. enforce the rights available to Owner under any applicable performance bond.
- C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.

- D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within 7 days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.
- E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.
- F. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.
- G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond will govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 Owner May Terminate for Convenience

- A. Upon 7 days' written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):
 - 1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
 - 2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and
 - 3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.
- B. Contractor shall not be paid for any loss of anticipated profits or revenue, post-termination overhead costs, or other economic loss arising out of or resulting from such termination.

16.04 Contractor May Stop Work or Terminate

- A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon 7 days' written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.
- B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, 7 days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this paragraph are

not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17—FINAL RESOLUTION OF DISPUTES

17.01 *Methods and Procedures*

- A. *Disputes Subject to Final Resolution:* The following disputed matters are subject to final resolution under the provisions of this article:
 - 1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full, pursuant to Article 12; and
 - 2. Disputes between Owner and Contractor concerning the Work, or obligations under the Contract Documents, that arise after final payment has been made.
- B. *Final Resolution of Disputes:* For any dispute subject to resolution under this article, Owner or Contractor may:
 - 1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions;
 - 2. agree with the other party to submit the dispute to another dispute resolution process; or
 - 3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

ARTICLE 18—MISCELLANEOUS

18.01 *Giving Notice*

- A. Whenever any provision of the Contract requires the giving of written notice to Owner, Engineer, or Contractor, it will be deemed to have been validly given only if delivered:
 - 1. in person, by a commercial courier service or otherwise, to the recipient's place of business;
 - 2. by registered or certified mail, postage prepaid, to the recipient's place of business; or
 - 3. by e-mail to the recipient, with the words "Formal Notice" or similar in the e-mail's subject line.

18.02 *Computation of Times*

- A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

18.03 *Cumulative Remedies*

- A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. The provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

18.04 *Limitation of Damages*

- A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 *No Waiver*

- A. A party's non-enforcement of any provision will not constitute a waiver of that provision, nor will it affect the enforceability of that provision or of the remainder of this Contract.

18.06 *Survival of Obligations*

- A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or termination of the Contract or of the services of Contractor.

18.07 *Controlling Law*

- A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 *Assignment of Contract*

- A. Unless expressly agreed to elsewhere in the Contract, no assignment by a party to this Contract of any rights under or interests in the Contract will be binding on the other party without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract.

18.09 *Successors and Assigns*

- A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

18.10 *Headings*

- A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

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SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT

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SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT

These Supplementary Conditions amend or supplement EJCDC® C-700, Standard General Conditions of the Construction Contract (2018). The General Conditions remain in full force and effect except as amended.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added—for example, "Paragraph SC-4.05."

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

SC-1.01.A Modify Section 1.01.A with the following:

Delete paragraph 1.01.A.5 and insert the following in lieu thereof:

5. Bidder - Any individual, partnership, corporation, joint venture, or other combination thereof who submits a Bid to Owner for the Work contemplated, acting directly or through an authorized representative. As used in the Contract Documents, masculine pronouns refer to both masculine and feminine genders.

Delete paragraph 1.01.A.16 and insert the following in lieu thereof:

16. Contractor – Person or entity identified as such in the Agreement and the Contractor's authorized representative who is referred to throughout the Contract Documents as if singular in number.

Delete paragraph 1.01.A.22 and insert the following in lieu thereof:

22. Engineer – Person or entity identified as such in the Agreement and the Engineer's authorized representative who is referred to throughout the Contract Documents as if singular in number.

Delete paragraph 1.01.A.30 and insert the following in lieu thereof:

30. Owner – The individual, entity, public body or authority identified as such in the Agreement and the Owner's authorized representatives who are referred to throughout the Contract Documents as if singular in number.

Add the following statement to the end of paragraph 1.01.A.42:

Substantial completion shall still require the Contractor to complete the punch list items unless waived by Owner.

Add the following subparagraphs immediately after subparagraph 1.01.A.50:

51. *Award* – The formal acceptance of the Bid by Owner.
52. *Bid Guarantee (Bid Bond)* – The security furnished with a Bid to guarantee that the Bidder will enter into the contract if Bidder's Bid is accepted by Owner.
53. *Calendar Day* – Any day of the week or month, no day being excepted.
54. *Competitive Sealed Proposal* – Procurement method that the Owner may use to request information from a prospective Bidder in which evaluation criteria will be used to select the Contractor for the project based on the best value instead of the lowest bidder. May be referred to as "Bid(s)" in the Bidding Documents.
55. *Design Engineer* – **Garver, LLC**

- 56. *Equipment (Construction)* – All machinery and equipment, together with the necessary supplies for upkeep and maintenance, including tools and apparatus necessary for the proper construction and acceptable completion of the Work contemplated. (Installation)
– All material or articles used in equipping a facility or apparatus required to fulfill a functional design.
- 57. *Execution* – Field or site performance, workmanship, installation, erection, application, field fabrication, quality control, and protection of installed products on the site.
- 58. *Final Completion* – The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion, expressed in writing, of Owner and Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended, all agreed to punch list items are complete and agreed to by the Owner, and is complete as agreed to by the Owner in writing. As a condition for Final Completion, the final inspection shall have been completed by the Owner and Engineer with a written acceptance of the work being complete, in writing by the Owner to the Contractor. As conditions for Final Completion, the specified Correction Period shall begin with all specified warranties being in place and functional. The terms “contractually complete”, and “date of final completion” and/or “Final Acceptance”, as applied to all or part of the Work refer to Final Completion of such Work.
- 59. *Materials* – All materials incorporated into the Project, including equipment and all other materials consumed or to be consumed in the performance of the Work contemplated.
- 60. *Owner’s Representative* – The authorized representative of Owner who is assigned to the site or any part thereof.
- 61. *Product Data* – Type of Shop Drawing comprised of standard illustrations, schedules, performance charts, instructions, brochures, diagrams, catalog cuts, and other information assembled by or for the Contractor and submitted by the Contractor to illustrate materials or equipment for some portion of the Work.
- 62. *Products* – Materials, equipment, systems, shop fabrications, mixtures, and source controls.
- 63. *Utility* – Any public or private fixed works for the transportation of fluids, gases, electricity, signals, or communications.

ARTICLE 2—PRELIMINARY MATTERS

2.02 *Copies of Documents*

SC-2.02 Delete Paragraph 2.02.A in its entirety and insert the following new paragraph in its place:

- A. Owner shall furnish to Contractor _____ **printed copies** of conformed Contract Documents incorporating and integrating all Addenda and any amendments negotiated prior to the Effective Date of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies of the conformed Contract Documents will be furnished upon request at the cost of reproduction.

2.03 *Before Starting Construction*

SC-2.03.A Add the following to Paragraph 2.03.A:

- 4. A preliminary Schedule of Payments showing projected cash flow.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

SC-2.04.A Delete Paragraph 2.04.A and insert the following in lieu thereof:

- A. Before the Contract Times start to run, but after Notice to Proceed is given, a conference attended by Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other Submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.

2.05 *Acceptance of Schedules*

SC-2.05.A Add the following subparagraph to Paragraph 2.05.A:

5. Contractor's schedule of payments will be acceptable if it provides a reasonable projection of payments in relationship to the progress schedule and schedule of values.

2.06 *Electronic Transmittals*

SC-2.06 Delete Paragraphs 2.06.B and 2.06.C in their entirety and insert the following in their place:

- B. *Electronic Documents Protocol:* The parties shall conform to the following provisions in Paragraphs 2.06.B and 2.06.C, together referred to as the Electronic Documents Protocol ("EDP" or "Protocol") for exchange of electronic transmittals.

1. *Basic Requirements*

- a. To the fullest extent practical, the parties agree to and will transmit and accept Electronic Documents in an electronic or digital format using the procedures described in this Protocol. Use of the Electronic Documents and any information contained therein is subject to the requirements of this Protocol and other provisions of the Contract.
- b. The contents of the information in any Electronic Document will be the responsibility of the transmitting party.
- c. Electronic Documents as exchanged by this Protocol may be used in the same manner as the printed versions of the same documents that are exchanged using non-electronic format and methods, subject to the same governing requirements, limitations, and restrictions, set forth in the Contract Documents.
- d. Except as otherwise explicitly stated herein, the terms of this Protocol will be incorporated into any other agreement or subcontract between a party and any third party for any portion of the Work on the Project, or any Project-related services, where that third party is, either directly or indirectly, required to exchange Electronic Documents with a party or with Engineer. Nothing herein will modify the requirements of the Contract regarding communications between and among the parties and their subcontractors and consultants.
- e. When transmitting Electronic Documents, the transmitting party makes no representations as to long term compatibility, usability, or readability of the items resulting from the receiving party's use of software application packages, operating systems, or computer hardware differing from those established in this Protocol.
- f. Nothing herein negates any obligation 1) in the Contract to create, provide, or maintain an original printed record version of Drawings and Specifications, signed and sealed according to applicable Laws and Regulations; 2) to comply with any applicable Law or Regulation governing the signing and sealing of design documents or the signing and electronic transmission of any other documents; or 3) to comply with the notice requirements of Paragraph 18.01 of the General Conditions.

2. *System Infrastructure for Electronic Document Exchange*

- a. Each party will provide hardware, operating system(s) software, internet, e-mail, and large file transfer functions ("System Infrastructure") at its own cost and sufficient for complying with the EDP requirements. With the exception of minimum standards set forth in this EDP, and any explicit system requirements specified by attachment to this EDP, it is the obligation of each party to determine, for itself, its own System Infrastructure.
 - 1) The maximum size of an email attachment for exchange of Electronic Documents under this EDP is **20 MB**. Attachments larger than that may be exchanged using large file transfer functions or physical media.
 - 2) Each Party assumes full and complete responsibility for any and all of its own costs, delays, deficiencies, and errors associated with converting, translating, updating, verifying, licensing, or otherwise enabling its System Infrastructure, including operating systems and software, for use with respect to this EDP.
- b. Each party is responsible for its own system operations, security, back-up, archiving, audits, printing resources, and other Information Technology ("IT") for maintaining operations of its System Infrastructure during the Project, including coordination with the party's individual(s) or entity responsible for managing its System Infrastructure and capable of addressing routine communications and other IT issues affecting the exchange of Electronic Documents.
- c. Each party will operate and maintain industry-standard, industry-accepted, ISO-standard, commercial-grade security software and systems that are intended to protect the other party from: software viruses and other malicious software like worms, trojans, adware; data breaches; loss of confidentiality; and other threats in the transmission to or storage of information from the other parties, including transmission of Electronic Documents by physical media such as CD/DVD/flash drive/hard drive. To the extent that a party maintains and operates such security software and systems, it shall not be liable to the other party for any breach of system security.
- d. In the case of disputes, conflicts, or modifications to the EDP required to address issues affecting System Infrastructure, the parties shall cooperatively resolve the issues; but, failing resolution, the Owner is authorized to make and require reasonable and necessary changes to the EDP to effectuate its original intent. If the changes cause additional cost or time to Contractor, not reasonably anticipated under the original EDP, Contractor may seek an adjustment in price or time under the appropriate process in the Contract.
- e. Each party is responsible for its own back-up and archive of documents sent and received during the term of the contract under this EDP, unless this EDP establishes a Project document archive, either as part of a mandatory Project website or other communications protocol, upon which the parties may rely for document archiving during the specified term of operation of such Project document archive. Further, each party remains solely responsible for its own post-Project back-up and archive of Project documents after the term of the Contract, or after termination of the Project document archive, if one is established, for as long as required by the Contract and as each party deems necessary for its own purposes.
- f. If a receiving party receives an obviously corrupted, damaged, or unreadable Electronic Document, the receiving party will advise the sending party of the incomplete transmission.
- g. The parties will bring any non-conforming Electronic Documents into compliance with the EDP. The parties will attempt to complete a successful transmission of the Electronic Document or use an alternative delivery method to complete the communication.

- h. The Engineer will operate a Project information management system (also referred to in this EDP as “Project Website”) for use of Owner, Engineer and Contractor during the Project for exchange and storage of Project-related communications and information. Except as otherwise provided in this EDP or the General Conditions, use of the Project Website by the parties as described in this Paragraph will be mandatory for exchange of Project documents, communications, submittals, and other Project-related information. The following conditions and standards will govern use of the Project Website:
 - 1) Describe the period of time during which the Project Website will be operated and be available for reliance by the parties;
 - 2) Provide any minimum system infrastructure, software licensing and security standards for access to and use of the Project Website;
 - 3) Describe the types and extent of services to be provided at the Project Website (such as large file transfer, email, communication and document archives, etc.); and
 - 4) Include any other Project Website attributes that may be pertinent to Contractor’s use of the facility and pricing of such use.

C. *Software Requirements for Electronic Document Exchange; Limitations*

- 1. Each party will acquire the software and software licenses necessary to create and transmit Electronic Documents and to read and to use any Electronic Documents received from the other party (and if relevant from third parties), using the software formats required in this section of the EDP.
 - a. Prior to using any updated version of the software required in this section for sending Electronic Documents to the other party, the originating party will first notify and receive concurrence from the other party for use of the updated version or adjust its transmission to comply with this EDP.
- 2. The parties agree not to intentionally edit, reverse engineer, decrypt, remove security or encryption features, or convert to another format for modification purposes any Electronic Document or information contained therein that was transmitted in a software data format, including Portable Document Format (PDF), intended by sender not to be modified, unless the receiving party obtains the permission of the sending party or is citing or quoting excerpts of the Electronic Document for Project purposes.

SC-2.06 Supplement Paragraph 2.06 of the General Conditions by adding the following paragraph:

D. *Requests by Contractor for Electronic Documents in Other Formats*

- 1. Release of any Electronic Document versions of the Project documents in formats other than those identified in the Electronic Documents Protocol (if any) or elsewhere in the Contract will be at the sole discretion of the Owner.
- 2. To extent determined by Owner, in its sole discretion, to be prudent and necessary, release of Electronic Documents versions of Project documents and other Project information requested by Contractor (“Request”) in formats other than those identified in the Electronic Documents Protocol (if any) or elsewhere in the Contract will be subject to the provisions of the Owner’s response to the Request, and to the following conditions to which Contractor agrees:
 - a. The content included in the Electronic Documents created by Engineer and covered by the Request was prepared by Engineer as an internal working document for Engineer’s purposes solely, and is being provided to Contractor on an “AS IS” basis without any warranties of any kind, including, but not limited to any implied warranties of fitness for any purpose. As such, Contractor is advised and acknowledges that the content may not be suitable for Contractor’s application, or

may require substantial modification and independent verification by Contractor. The content may include limited resolution of models, not-to-scale schematic representations and symbols, use of notes to convey design concepts in lieu of accurate graphics, approximations, graphical simplifications, undocumented intermediate revisions, and other devices that may affect subsequent reuse.

- b. Electronic Documents containing text, graphics, metadata, or other types of data that are provided by Engineer to Contractor under the request are only for convenience of Contractor. Any conclusion or information obtained or derived from such data will be at the Contractor's sole risk and the Contractor waives any claims against Engineer or Owner arising from use of data in Electronic Documents covered by the Request.
 - c. Contractor shall indemnify and hold harmless Owner and Engineer and their subconsultants from all claims, damages, losses, and expenses, including attorneys' fees and defense costs arising out of or resulting from Contractor's use, adaptation, or distribution of any Electronic Documents provided under the Request.
 - d. Contractor agrees not to sell, copy, transfer, forward, give away or otherwise distribute this information (in source or modified file format) to any third party without the direct written authorization of Engineer, unless such distribution is specifically identified in the Request and is limited to Contractor's subcontractors. Contractor warrants that subsequent use by Contractor's subcontractors complies with all terms of the Contract Documents and Owner's response to Request.
3. In the event that Owner elects to provide or directs the Engineer to provide to Contractor any Contractor-requested Electronic Document versions of Project information that is not explicitly identified in the Contract Documents as being available to Contractor, the Owner shall be reimbursed by Contractor on an hourly basis (at \$[number] per hour) for any engineering costs necessary to create or otherwise prepare the data in a manner deemed appropriate by Engineer.

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

SC-3.01 Add the following sentence and subparagraphs to Paragraph 3.01.A:

The Contract Document higher in precedence shall control and supersede the Contract Documents lower in precedence in accordance with the following listing arranged from the highest to the lowest in precedence:

1. Addenda, if any; Supplemental Agreements; and Change Order(s); the one dated later having precedence over another dated earlier.
2. Agreement.
3. General Requirements (DIVISION 01).
4. Other Specifications (DIVISION 02 and other DIVISIONS following it).
5. Drawings.
6. Standard Details.
7. **[Special Provisions and City Specifications.]**
8. Supplementary Conditions.
9. General Conditions.

3.02 *Reference Standards*

SC-3.02 Add the following language at the end of article 3.02.A.1:

If there is any conflict between the provisions of the Contract Documents and any such reference provisions, the language of the Contract Documents will take precedence over that of any standard specification, manual or code.

SC-3.03.B.1 Add the following new paragraph after article 3.03.B.1.b:

- c. Should Drawings disagree in themselves or with Specifications and are not clarified by addendum, the better quality or greater amount of work or materials shall be estimated upon and, unless otherwise ordered by Engineering in writing, shall be performed and furnished. Figures given on Drawings govern scale measurements, and large-scale details govern small scale drawings.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

SC-4.01.A Delete the last sentence of Paragraph 4.01.A and replace with the following:

In no event will the Contract Times commence to run later than the 90th day after the day of Bid opening or the 30th day after the Effective Date of the Contract, whichever date is earlier.

4.03 *Reference Points*

SC-4.03.A Add the following three paragraphs at the end of Paragraph 4.03.A:

1. Construction staking is the responsibility of the Contractor. The Engineer will provide horizontal and vertical control throughout the length of the project. Horizontal control shall consist of referencing all Centerline P.C.'s and P.T.'s and establishing a control point approximately every 1000' along the centerline stationing. Vertical control shall consist of the establishment of accessible benchmarks at each end of the project and at a minimum of every 500' throughout the project as measured along the centerline. The remainder of the staking shall be the responsibility of the Contractor and shall be subject to inspection by the Engineer. The right of inspection is understood by the parties hereto as being for the purpose of ensuring that the plans and specifications are complied with and not to control the details of the work.
2. The contractor shall notify the Engineer at least seventy-two (72) hours in advance when control points will be needed.
3. The furnishing of the control points does not relieve the Contractor of the responsibility of checking to ensure that the new improvements are constructed to the lines and grades shown on the plans. Should any of the control be removed or otherwise disturbed through carelessness of the Contractor, they shall be replaced at the expense of the Contractor.

4.04 *Progress Schedule*

SC-4.04 Add the following subparagraph to Paragraph 4.04.A:

3. If, in the opinion of Engineer, Contractor falls behind the accepted Construction Schedule due to actions or neglect of Contractor or Contractor's agents, servants, employees, officers, subcontractors, directors, or any party contracting to perform part or all of the Work or to supply any equipment or materials, Contractor shall take steps, including, but not limited to, increasing the number of personnel, shifts, and/or overtime operations, days of work, and/or amount of construction equipment until such time as the Work is back on schedule. Contractor shall also submit for review not later than the time of submittal of the next request for partial payment, such supplementary schedule or schedules as may be necessary to demonstrate the

manner in which the acceptable rate of progress will be regained, all without additional cost to Owner.

4.05 *Delays in Contractor's Progress*

SC-4.05 Amend Paragraph 4.05.C by adding the following subparagraphs:

5. *Weather-Related Delays*

- a. If "abnormal weather conditions" as set forth in Paragraph 4.05.C.2 of the General Conditions are the basis for a request for an equitable adjustment in the Contract Times, such request must be documented by data substantiating each of the following: 1) that weather conditions were abnormal for the period of time in which the delay occurred, 2) that such weather conditions could not have been reasonably anticipated, and 3) that such weather conditions had an adverse effect on the Work as scheduled.
- b. The existence of abnormal weather conditions will be determined on a month-by-month basis in accordance with the following:
 - 1) Every workday on which one or more of the following conditions exist will be considered a "bad weather day":
 - i) Total precipitation (as rain equivalent) occurring between 7:00 p.m. on the preceding day (regardless of whether such preceding day is a workday) through 7:00 p.m. on the workday in question equals or exceeds **0.10 inches** of precipitation (as rain equivalent, based on the snow/rain conversion indicated in the table entitled Foreseeable Bad Weather Days; such table is hereby incorporated in this SC-4.05.C by reference.
 - ii) Ambient outdoor air temperature at 11:00 a.m. is equal to or less than the following low temperature threshold: **32** degrees Fahrenheit.
 - 2) Determination of actual bad weather days during performance of the Work will be based on the weather records measured and recorded by the closest **NOAA** weather monitoring station with precipitation and air temperature data.
 - 3) Contractor shall anticipate the number of foreseeable bad weather days per month indicated in the table in Exhibit A—Foreseeable Bad Weather Days.
 - 4) In each month, every bad weather day exceeding the number of foreseeable bad weather days established in the table in Exhibit A—Foreseeable Bad Weather Days will be considered as "abnormal weather conditions." The existence of abnormal weather conditions will not relieve Contractor of the obligation to demonstrate and document that delays caused by abnormal weather are specific to the planned work activities or that such activities thus delayed were on Contractor's then-current Progress Schedule's critical path for the Project.

ARTICLE 5—SITE, SUBSURFACE AND PHYSICAL CONDITIONS, HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

SC-5.01 Add the following Paragraph 5.01.D immediately following Paragraph 5.01.C:

- D. Any Work performed in public rights-of-way, in addition to conforming to the Contract Documents, shall be done in accordance with the requirements of the permit issued by the public agency in whose right-of-way the Work is located.

5.02 *Use of Site and Other Areas*

SC-5.02.B Add the following language at the end of Paragraph 5.02.B:

All trees, stumps, slashings, brush or other debris removed from the Project Site or right-of-way as a preliminary to the construction of the work or its appurtenances shall be removed from the property and disposed of in a manner approved by the Owner. All excess spoil materials, excluding any items deemed reusable (salvageable) by the Owner, shall be the property of the Contractor. The responsibility of locating suitable disposal sites for removal items on this project will be solely a function of the Contractor. The Owner will in no way be responsible for the actions of the Contractor if he disposes of excess material and debris in locations that are not approved. No extra compensation will be made for the removal and hauling of this material; all costs shall be included in the various items listed in the bid proposal.

5.03 *Subsurface and Physical Conditions*

SC-5.03.A Add the following sentence to the end of Paragraph 5.03.A.3:

The data given herein and shown on the drawings is as accurate as could be obtained; its accuracy is not guaranteed.

SC-5.03.C In Paragraph 5.03.C, delete the words "Technical Data expressly identified in the Supplementary Conditions" and insert "Technical Data, which is limited to data provided in the reports and drawings listed in the Supplementary Conditions" in lieu thereof. Add the following subparagraph to 5.03.D:

5. any Contractor interpretation of the character and condition of the materials between test hole locations.

SC-5.03.D Add the following new paragraphs immediately after Paragraph 5.03.D:

- E. The following table lists the reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data, and specifically identifies the Technical Data in the report upon which Contractor may rely:

Report Title	Date of Report	Technical Data
None		

- F. The following table lists the drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data, and specifically identifies the Technical Data upon which Contractor may rely:

Drawings Title	Date of Drawings	Technical Data
Plans for Wastewater Treatment System Improvements, City of Moore/Moore Public Works Authority, Moore, Oklahoma by Eagle Consultants, Inc.	March 19, 2010	

- G. Contractor may examine copies of reports and drawings identified in SC-5.03.E and SC-5.03.F by downloading a copy of the documents from the Garver online plan room used for this project.

5.05 *Underground Facilities*

SC-5.05.A Add the following subparagraphs to Paragraph 5.05.A:

6. Generally, service connections are not indicated on the Drawings. Contractor shall be responsible for discovery of existing underground installations, in advance of excavating or trenching, by contacting all local utilities and by prospecting through hydro-excavation or potholing.
7. All information relative to Underground Facilities shall be recorded and incorporated into the record documents required by paragraph 7.12.
8. Contractor will be held responsible for any unauthorized interruption in the operation of Underground Facilities as a result of Contractor's operations. Unless the owner of the damaged facility elects to perform the repair and restoration work, Contractor shall repair and fully restore any damaged Underground Facility to a condition at least equal to that which existed just prior to the time of damage. All repair and restoration work shall be done to the satisfaction of the facility owner and Engineer.
9. Contractor shall arrange for any inspection of repaired or reconditioned Utility facilities required by authorities having jurisdiction. All inspection fees shall be paid by Contractor. If the facility owner elects to perform the repair and restoration work, Contractor shall render all assistance required. Contractor shall be responsible for all just and reasonable expenses incurred by the facility owners for such work.

5.06 *Hazardous Environmental Conditions*

SC-5.06 Add the following new paragraphs immediately after Paragraph 5.06.A.3:

4. The following table lists the reports known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and the Technical Data (if any) upon which Contractor may rely:

Report Title	Date of Report	Technical Data
None		

5. The following table lists the drawings known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and Technical Data (if any) contained in such Drawings upon which Contractor may rely:

Drawings Title	Date of Drawings	Technical Data
None		

ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

SC-6.01 Add the following paragraphs immediately after Paragraph 6.01.A:

1. *Required Performance Bond Form:* The performance bond that Contractor furnishes will be in the form of EJCDC® C-610, Performance Bond (2010, 2013, or 2018 edition).
2. *Required Payment Bond Form:* The payment bond that Contractor furnishes will be in the form of EJCDC® C-615, Payment Bond (2010, 2013, or 2018 edition).

SC-6.01 Add the following paragraphs immediately after Paragraph 6.01.B:

1. The correction period specified as one year after the date of Substantial Completion in Paragraph 15.08.A of the General Conditions is hereby revised to be two (2) years after Substantial Completion.
2. After Substantial Completion, Contractor shall furnish a warranty bond issued in the form of EJCDC® C-612, Warranty Bond (2018). The warranty bond must be in a bond amount of twenty-five (25) percent of the final Contract Price. The warranty bond period will extend to a date two (2) years after Substantial Completion of the Work. Contractor shall deliver the fully executed warranty bond to Owner prior to or with the final application for payment, and in any event no later than 11 months after Substantial Completion.
3. The warranty bond must be issued by the same surety that issues the performance bond required under Paragraph 6.01.A of the General Conditions.

6.02 *Insurance—General Provisions*

SC-6.02 Add the following paragraph immediately after Paragraph 6.02.B:

1. Contractor may obtain worker's compensation insurance from an insurance company that has not been rated by A.M. Best, provided that such company (a) is domiciled in the state in which the Project is located, (b) is certified or authorized as a worker's compensation insurance provider by the appropriate state agency, and (c) has been accepted to provide worker's compensation insurance for similar projects by the state within the last 12 months.

SC-6.02.N Delete "10 days" in the first sentence of Paragraph 6.02.N and insert "30 days" in lieu thereof.

SC-6.02 Add the following Paragraphs 6.02.O and 6.02.P immediately after Paragraph 6.02.N:

- O. *Indemnification:* For the consideration included in the bid price, Contractor and his subcontractors shall pay to indemnify and save harmless the City, its agents, guests, consultants (including the Engineer), invitees, employees, from all suits, actions, claims, demands, damages, losses, expenses, including attorney's fees, costs and judgements of every kind and description to which the City, its agents, guests, consultants, invitees, or employees may be subjected to by reason of injury to persons or death or property damage, resulting from or growing out of any act of commission, omission, negligence or fault of the Contractor and his subcontractors, their agents or employees, committed in connection with this contract, Contractor's performance hereof, or any work performed hereunder. Contractor and his subcontractors shall indemnify and save harmless the City, its agents, or employees and consultants (including the Engineer), from and against all claims, demands, actions, suits, damages, losses, expenses, costs including attorney's fees, and judgements of every kind and description arising from, based upon, or growing out of the violation of any federal, state, county, or city law, bylaw, ordinance or regulation by the Contractor, its agents, trainees, invitees, servants, and employees.
- P. Contractor shall deliver all certificates of insurance required by the Contract Documents to Owner with executed Agreement.

6.03 *Contractor's Insurance*

SC-6.03.A Delete Paragraph 6.03.A and replace with the following, in lieu thereof:

Required Insurance: Contractor shall purchase and maintain, in a company or companies licensed to do business in the State of the project, and to which the Owner has no reasonable objection, Worker's Compensation, Commercial General Liability, and other insurance pursuant to the specific requirements of the Supplementary Conditions. The commercial liability insurance form of policy may be used in lieu of comprehensive general liability form. The limits of liability for the insurance required by Article 6.03 of the General Conditions shall

provide coverage for not less than the following amounts or greater where required by laws and regulators.

SC-6.03.B Add the following subparagraphs to Paragraph 6.03.B:

6. Contain a cross liability or severability of interest clause or endorsement. Insurance covering the specified additional insureds shall be primary insurance, and all other insurance carried by the additional insureds shall be excess insurance; and
 7. With respect to workers' compensation and employer's liability, comprehensive automobile liability, commercial general liability, and umbrella liability insurance, Contractor shall require Contractor's insurance carriers to waive all rights of subrogation against Owner, Engineer, Engineer's Consultants, and their respective officers, directors, partners, employees, and agents.
- E. *Workers' Compensation and Employer's Liability:* Contractor shall purchase and maintain workers' compensation and employer's liability insurance, including, as applicable, United States Longshoreman and Harbor Workers' Compensation Act, Jones Act, stop-gap employer's liability coverage for monopolistic states, and foreign voluntary workers' compensation (from available sources, notwithstanding the jurisdictional requirement of Paragraph 6.02.B of the General Conditions).

Workers' Compensation and Related Policies	Policy limits of not less than:
Workers' Compensation	
State	\$500,000
Applicable Federal (e.g., Longshoreman's)	\$500,000
Foreign voluntary workers' compensation (employer's responsibility coverage), if applicable	\$Statutory
Jones Act (if applicable)	
Bodily injury by accident—each accident	\$N/A
Bodily injury by disease—aggregate	\$N/A
Employer's Liability	
Each accident	\$1,000,000
Each employee	\$1,000,000
Policy limit	\$2,000,000

- F. *Commercial General Liability—Claims Covered:* Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against claims for:
1. damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees,
 2. damages insured by reasonably available personal injury liability coverage, and
 3. damages because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.
- G. *Commercial General Liability—Form and Content:* Contractor's commercial liability policy must be written on a 1996 (or later) Insurance Services Organization, Inc. (ISO) commercial general liability form (occurrence form) and include the following coverages and endorsements:
1. Products and completed operations coverage.
 - a. Such insurance must be maintained for three years after final payment.

- b. Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.
 2. Blanket contractual liability coverage, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.
 3. Severability of interests and no insured-versus-insured or cross-liability exclusions.
 4. Underground, explosion, and collapse coverage.
 5. Personal injury coverage.
 6. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together). If Contractor demonstrates to Owner that the specified ISO endorsements are not commercially available, then Contractor may satisfy this requirement by providing equivalent endorsements.
 7. For design professional additional insureds, ISO Endorsement CG 20 32 07 04 "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.
- H. **Commercial General Liability—Excluded Content:** The commercial general liability insurance policy, including its coverages, endorsements, and incorporated provisions, must not include any of the following:
 1. Any modification of the standard definition of "insured contract" (except to delete the railroad protective liability exclusion if Contractor is required to indemnify a railroad or others with respect to Work within 50 feet of railroad property).
 2. Any exclusion for water intrusion or water damage.
 3. Any provisions resulting in the erosion of insurance limits by defense costs other than those already incorporated in ISO form CG 00 01.
 4. Any exclusion of coverage relating to earth subsidence or movement.
 5. Any exclusion for the insured's vicarious liability, strict liability, or statutory liability (other than worker's compensation).
 6. Any limitation or exclusion based on the nature of Contractor's work.
 7. Any professional liability exclusion broader in effect than the most recent edition of ISO form CG 22 79.
- I. **Commercial General Liability—Minimum Policy Limits**

Commercial General Liability	Policy limits of not less than:
General Aggregate	\$ 5,000,000
Products—Completed Operations Aggregate	\$ 5,000,000
Personal and Advertising Injury	\$ 5,000,000
Bodily Injury and Property Damage—Each Occurrence	\$ 5,000,000

- J. **Automobile Liability:** Contractor shall purchase and maintain automobile liability insurance for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy must be written on an occurrence basis.

Automobile Liability	Policy limits of not less than:
Bodily Injury	

Automobile Liability	Policy limits of not less than:
Each Person	\$1,000,000
Each Accident	\$2,000,000
Property Damage	
Each Accident	\$1,000,000
[or]	
Combined Single Limit	
Combined Single Limit (Bodily Injury and Property Damage)	\$ 5,000,000

- K. *Umbrella or Excess Liability:* Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the Paragraphs above. The coverage afforded must be at least as broad as that of each and every one of the underlying policies.

Excess or Umbrella Liability	Policy limits of not less than:
Each Occurrence	\$5,000,000
General Aggregate	\$5,000,000

- L. *Using Umbrella or Excess Liability Insurance to Meet CGL and Other Policy Limit Requirements:* Contractor may meet the policy limits specified for employer's liability, commercial general liability, and automobile liability through the primary policies alone, or through combinations of the primary insurance policy's policy limits and partial attribution of the policy limits of an umbrella or excess liability policy that is at least as broad in coverage as that of the underlying policy, as specified herein.
- M. *Contractor's Pollution Liability Insurance:* Contractor shall purchase and maintain a policy covering third-party injury and property damage, including cleanup costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance must be maintained for no less than three years after final completion.

Contractor's Pollution Liability	Policy limits of not less than:
Each Occurrence/Claim	\$1,000,000
General Aggregate	\$2,000,000

- N. *Contractor's Professional Liability Insurance:* If Contractor will provide or furnish professional services under this *Contract*, through a delegation of professional design services or otherwise, then Contractor shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance must cover negligent acts, errors, or omissions in the performance of professional design or related services by the insured or others for whom the insured is legally liable. The insurance must be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. The retroactive date on the policy must pre-date the commencement of furnishing services on the Project.

Contractor's Professional Liability	Policy limits of not less than:
Each Claim	\$N/A
Annual Aggregate	\$N/A

- O. *Railroad Protective Liability Insurance:* Prior to commencing any Work within 50 feet of railroad-owned and controlled property, Contractor shall (1) endorse its commercial general liability policy with ISO CG 24 17, removing the contractual liability exclusion for work within 50 feet of a railroad, (2) purchase and maintain railroad protective liability insurance meeting

the following requirements, (3) furnish a copy of the endorsement to Owner, and (4) submit a copy of the railroad protective policy and other railroad-required documentation to the railroad, and notify Owner of such submittal.

Railroad Protective Liability Insurance	Policy limits of not less than:
Each Claim	\$N/A
Aggregate	\$N/A

- P. *Unmanned Aerial Vehicle Liability Insurance:* If Contractor uses unmanned aerial vehicles (UAV—commonly referred to as drones) at the Site or in support of any aspect of the Work, Contractor shall obtain UAV liability insurance in the amounts stated; name Owner, Engineer, and all individuals and entities identified in the Supplementary Conditions as additional insureds; and provide a certificate to Owner confirming Contractor's compliance with this requirement. Such insurance will provide coverage for property damage, bodily injury or death, and invasion of privacy.

Unmanned Aerial Vehicle Liability Insurance	Policy limits of not less than:
Each Claim	\$ 1,000,000
General Aggregate	\$ 2,000,000

- Q. *Other Required Insurance:* **[Here list additional types and amounts of insurance that Contractor is required to carry.]**

6.04 *Builder's Risk and Other Property Insurance*

SC-6.04 Delete Paragraph 6.04.A and insert the following in its place:

- A. Owner shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the Work's full insurable replacement cost (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). The specific requirements applicable to the builder's risk insurance are set forth in the Supplementary Conditions.

SC-6.04 Supplement Paragraph 6.04 of the General Conditions with the following provisions:

- F. *Builder's Risk Requirements:* The builder's risk insurance must:
1. be written on a builder's risk "all risk" policy form that at a minimum includes insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment stored and in transit, and must not exclude the coverage of the following risks: fire; windstorm; hail; flood; earthquake, volcanic activity, and other earth movement; lightning; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; and water damage (other than that caused by flood).
 - a. Such policy will include an exception that results in coverage for ensuing losses from physical damage or loss with respect to any defective workmanship, methods, design, or materials exclusions.
 - b. If insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake, volcanic activity, and other earth movement; or flood, are not commercially available under builder's risk policies, by endorsement

or otherwise, such insurance will be provided through other insurance policies acceptable to Owner and Contractor.

2. cover, as insured property, at least the following: (a) the Work and all materials, supplies, machinery, apparatus, equipment, fixtures, and other property of a similar nature that are to be incorporated into or used in the preparation, fabrication, construction, erection, or completion of the Work, including Owner-furnished or assigned property; (b) spare parts inventory required within the scope of the Contract; and (c) temporary works which are not intended to form part of the permanent constructed Work but which are intended to provide working access to the Site, or to the Work under construction, or which are intended to provide temporary support for the Work under construction, including scaffolding, form work, fences, shoring, falsework, and temporary structures.
3. cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of contractors, engineers, and architects).
4. extend to cover damage or loss to insured property while in temporary storage at the Site or in a storage location outside the Site (but not including property stored at the premises of a manufacturer or Supplier).
5. extend to cover damage or loss to insured property while in transit.
6. allow for the waiver of the insurer's subrogation rights, as set forth in this Contract.
7. allow for partial occupancy or use by Owner by endorsement, and without cancellation or lapse of coverage.
8. include performance/hot testing and start-up, if applicable.
9. be maintained in effect until the Work is complete, as set forth in Paragraph 15.06.D of the General Conditions, or until written confirmation of Owner's procurement of property insurance following Substantial Completion, whichever occurs first.
10. include as named insureds the Owner, Contractor, Subcontractors (of every tier), and any other individuals or entities required by this Contract to be insured under such builder's risk policy. For purposes of Paragraphs 6.04, 6.05, and 6.06 of the General Conditions, and this and all other corresponding Supplementary Conditions, the parties required to be insured will be referred to collectively as "insureds."

SC-6.04 Supplement Paragraph 6.04 of the General Conditions with the following provision:

- G. *Coverage for Completion Delays:* The builder's risk policy will include, for the benefit of Owner, loss of revenue and soft cost coverage for losses arising from delays in completion that result from covered physical losses or damage. Such coverage will include, without limitation, fixed expenses and debt service for a minimum of 12 months with a maximum deductible of 30 days, compensation for loss of net revenues, rental costs, and attorneys' fees and engineering or other consultants' fees, if not otherwise covered.

SC-6.04 Supplement Paragraph 6.04 of the General Conditions with the following provisions:

- H. *Builder's Risk and Other Property Insurance Deductibles:* The purchaser of any required builder's risk, installation floater, or other property insurance will be responsible for costs not covered because of the application of a policy deductible.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.03 Labor; Working Hours

SC-7.03 Add the following new subparagraphs immediately after Paragraph 7.03.C:

1. The Contractor may undertake work only between 7:00 a.m. and 6:00 p.m. on Monday through Saturday except in the case of urgent necessity in the interest of Public Safety.

2. Owner's legal holidays are: New Year's Day (January 1); Dr. Martin Luther King Jr.'s Birthday (3rd Monday in January); President's Day (3rd Monday in February); Memorial Day (last Monday in May); Independence Day (July 4); Labor Day (1st Monday in September); Columbus Day (2nd Monday in October); Veterans Day (November 11) Thanksgiving Day (4th Thursday in November); Day after Thanksgiving (Friday following Thanksgiving); Christmas Eve (December 24); and Christmas Day (December 25). If a holiday falls on a Saturday or Sunday, the observed day shall be the Friday preceding the Saturday or the Monday following the Sunday.

7.04 *Services, Materials, and Equipment*

SC-7.04 Add the following new paragraph immediately after Paragraph 7.04.C:

- D. Before ordering materials or doing any work, the contractor shall in all cases verify measurements at the site or premises and check same against the Drawings. No extra charge or compensation will be allowed on the account of differences between actual dimensions and measurements shown on the Drawings. Any differences found shall be submitted to the Owner for resolution before proceeding with the work.

7.05 *"Or Equals"*

SC-7.05.A Delete the last sentence in Paragraph 7.05.A and replace with the following, in lieu thereof:

If the specification or description contains the words, "or equal" or "or equal allowed", or "or equal item is permitted", Contractor may request that Engineer authorize the use of other items of material or equipment, or items from other proposed suppliers under the circumstances described below. Unless these words are specifically written in the description of such item, no substitution is allowed per this Contract. If the item's description is followed by words reading that "no like", "no equivalent", or "no or equal" item is permitted, then no substitution of like items or like manufacturers is allowed as part of this Contract.

SC-7.05.C Amend the next to the last sentence of Article 7.05.C as follows:

Delete the phrase at the end of the sentence "an approved Shop Drawing." and add the phrase, "an Addendum."

7.06 *Substitutes*

SC-7.06.A Delete the first sentence in Paragraph 7.06.A and replace with the following, in lieu thereof:

Unless the specification or description of an item of material or equipment required to be furnished under the Contract Documents contains or is followed by words reading that, "or equal" or "or equal allowed", or "or equal item is permitted", then no substitution of like items is permitted. If the item's description includes the words "no substitution is permitted", "no like", "no equivalent", or "no or equal" item is permitted, then no substitution of like items or like manufacturers is allowed as part of this Contract. If the words, "or equal is permitted", "or equal", or "like items are permitted", Contractor may request that Engineer authorize the use of other items of material or equipment under the circumstances described below.

7.07 *Concerning Subcontractors and Suppliers*

SC-7.07.D Delete Paragraph 7.07.D and replace with the following in lieu thereof, and add subparagraph 7.07.D.1:

- D. Contractor shall submit to the Owner a list of certain Subcontractors, Suppliers, or other individuals or entities for acceptance by Owner as stipulated in the Bidding Documents. Owner's acceptance (either in writing or by failing to make written objection thereto within two weeks of submittal of the list) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation.
 1. Subcontracting: Contractor shall perform with Contractor's own organization work amounting to not less than 51 percent of the combined value of all items of the Work covered by the Contract.

SC-7.07.F Delete Paragraph 7.07.F and replace with the following, in lieu thereof:

- F. If Owner requires the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work, then Contractor shall not be entitled to an adjustment in Contract Price or Contract Times, or both, with respect to the replacement.

7.09 *Permits*

SC-7.09.A Add the following subparagraph immediately after Paragraph 7.09.A:

1. The Owner will provide right-of-way for the purpose of construction without cost to the Contractor by securing permits in areas of public dedication or by obtaining easements across privately owned property. It shall be the responsibility of the Contractor, prior to the initiation of construction on easements through private property, to inform the property owner of his intent to begin construction. Before beginning construction in areas of public dedication, the Contractor shall inform the agency having jurisdiction in the area prior to the initiation of the work. The Contractor shall pay for all fees and permits, as called for above, except for Building Permits which will be paid for by the Owner.

7.10 *Taxes*

SC-7.10 Add a new paragraph immediately after Paragraph 7.10.A:

- B. Owner is exempt from payment of sales and compensating use taxes of the State of Oklahoma of cities and counties thereof on all materials to be incorporated into the Work.
 1. Owner will furnish the required certificates of tax exemption to Contractor for use in the purchase of supplies and materials to be incorporated into the Work.
 2. Owner's exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Contractor, or to supplies or materials not incorporated into the Work.

7.11 *Laws and Regulations*

SC-7.11 Delete Paragraph 7.11.A and replace with the following in lieu thereof:

- A. Contractor shall give all notices required by and comply with all Laws and Regulations applicable to furnishing and performance of the Work and shall cause all Contractor's agents, employees, Subcontractors, and Suppliers to observe and comply with all such laws, ordinances, and regulations.

7.12 *Record Documents*

SC-7.12 Add the following Paragraph 7.12.B immediately following Paragraph 7.11.A:

- B. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.

7.13 *Safety and Protection*

SC-7.13.G Insert the following after the second sentence of Paragraph 7.13.G:

The following Owner safety programs are applicable to the Work: **None.**

SC-7.13 Add the following Paragraphs 7.13.K and 7.13.L immediately after Paragraph 7.13.J:

- K. The Contractor shall comply with all Occupational Safety and Health Act (OSHA) Standards and any other Federal, State, or Local rules and regulations applicable to construction and/or maintenance activities in the State of Oklahoma. City Safety Personnel or any supervisor may, but are not required to, order that the work be stopped if a condition of immediate danger is found to exist. Nothing contained herein shall be construed to shift responsibility or risk of loss for injuries or damage sustained as a result of a violation of this Article from the Contractor to

the Owner. The Contractor shall remain solely and exclusively responsible for compliance with all safety requirements and for the safety of all persons and property at the project site. The parties hereto expressly agree that the obligation to comply with applicable safety provisions is a material provision of this Contract and a duty of the Contractor. The Owner reserves the right to require demonstration of compliance upon reasonable request. In the event the Contractor is unable to demonstrate compliance with the safety provisions of this Contract, the parties agree that such failure is deemed to be a material breach of this Agreement; and the Contractor agrees that upon such breach, all work pursuant to the Contract shall terminate until demonstration to the Owner that the safety provisions of the Agreement have been complied with. In no event shall action or failure to act on the part of the Owner be construed as a duty to enforce the safety provisions of this Agreement nor shall it be construed to create liability for the City for any act or failure to act in respect to the safety provisions of this Agreement.

- L. *Safety Equipment:* The Contractor shall be responsible for the safety equipment to be used by its employees and/or all of its subcontractors working on the Owner's property. This equipment will include, but may not be limited to, hard hats, safety belts or harnesses, eye, face, hand, ear or hearing protection. Sport or athletic type shoes are not considered suitable work shoes on any construction site.

7.16 *Submittals*

SC-7.16.E Delete Paragraph 7.16E.1.b and replace with the following, in lieu thereof:

- b. Engineer will provide timely review of all such Submittals in accordance with the Schedule of Submittals and return such Submittals with a notation of either Furnish as Submitted, Furnish as Noted, Furnish as Corrected, Partial Resubmit, Revise and Resubmit, or Rejected.

ARTICLE 8—OTHER WORK AT THE SITE

8.02 *Coordination*

SC-8.03 Delete the first sentence in Paragraph 8.03.A and replace with the following in lieu thereof:

If, in the course of performing other work at or adjacent to the Site for Owner, the Owner's employees, any other contractor working for Owner, or any utility owner causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction then Contractor *may* be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.02 *Replacement of Engineer*

SC-9.02.A Delete the following text in the first sentence of Paragraph 9.02.A:

"provided Contractor makes no reasonable objection to the replacement Engineer."

ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.03 *Resident Project Representative*

SC-10.03 Add the following new paragraphs immediately after Paragraph 10.03.B:

- C. The Resident Project Representative (RPR) will be Engineer's representative at the Site. RPR's dealings in matters pertaining to the Work in general will be with Engineer and

Contractor. RPR's dealings with Subcontractors will only be through or with the full knowledge or approval of Contractor. The RPR will:

1. *Conferences and Meetings:* Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings (but not including Contractor's safety meetings), and as appropriate prepare and circulate copies of minutes thereof.
2. *Safety Compliance:* Comply with Site safety programs, as they apply to RPR, and if required to do so by such safety programs, receive safety training specifically related to RPR's own personal safety while at the Site.
3. *Liaison*
 - a. Serve as Engineer's liaison with Contractor. Working principally through Contractor's authorized representative or designee, assist in providing information regarding the provisions and intent of the Contract Documents.
 - b. Assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on-Site operations.
 - c. Assist in obtaining from Owner additional details or information, when required for Contractor's proper execution of the Work.
4. *Review of Work; Defective Work*
 - a. Conduct on-Site observations of the Work to assist Engineer in determining, to the extent set forth in Paragraph 10.02, if the Work is in general proceeding in accordance with the Contract Documents.
 - b. Observe whether any Work in place appears to be defective.
 - c. Observe whether any Work in place should be uncovered for observation, or requires special testing, inspection or approval.
5. *Inspections and Tests*
 - a. Observe Contractor-arranged inspections required by Laws and Regulations, including but not limited to those performed by public or other agencies having jurisdiction over the Work.
 - b. Accompany visiting inspectors representing public or other agencies having jurisdiction over the Work.
6. *Payment Requests:* Review Applications for Payment with Contractor.
7. *Completion*
 - a. Participate in Engineer's visits regarding Substantial Completion.
 - b. Assist in the preparation of a punch list of items to be completed or corrected.
 - c. Participate in Engineer's visit to the Site in the company of Owner and Contractor regarding completion of the Work, and prepare a final punch list of items to be completed or corrected by Contractor.
 - d. Observe whether items on the final punch list have been completed or corrected.

D. The RPR will not:

1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including "or-equal" items).
2. Exceed limitations of Engineer's authority as set forth in the Contract Documents.
3. Undertake any of the responsibilities of Contractor, Subcontractors, or Suppliers.

4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of construction.
5. Advise on, issue directions regarding, or assume control over security or safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor.
6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.
7. Authorize Owner to occupy the Project in whole or in part.

ARTICLE 11—CHANGES TO THE CONTRACT

11.05 *Owner-Authorized Changes in the Work*

SC-11.05.A Add the following language at the end of Paragraph 11.05.A:

It is further agreed that the quantities of work to be done at unit prices and materials to be furnished may be increased or diminished as may be considered necessary, in the opinion of the Engineer, to complete the work fully as planned and contemplated and that all quantities of work, whether increased or decreased, are to be performed at the unit prices set forth except as provided for in the Specifications. The Owner reserves the right to increase or decrease the amount of work to be done by any amount not to be exceeded by twenty-five percent (25%) of the original contract amount. In the event the increase pertains to items not originally bid, the Contractor shall submit a bid in writing to the Engineer for approval. It is further agreed that lump sum prices may be increased to cover additional work ordered by the Engineer but not shown on the plans or required by the specifications, in accordance with the provisions of the General Conditions; similarly, they may be decreased to cover deletion or work so ordered. The Owner reserves the right to reject the Contractor's bid on such Extra Work and secure such work to be done other than by said Contractor.

11.08 *Change of Contract Times*

SC-11.08 Add the following Paragraphs 11.08.C and 11.05.D:

C. Use of Float:

1. A claim for an adjustment of Contract Times (or Milestones), otherwise allowable under the Contract Documents, shall be granted only when the time lost or gained exceeds the float for the activity at the time of the event giving rise to the claim. Float, the amount of time between the early start date and the late start date, or the early finish date and the late finish date, is jointly owned by both Owner and Contractor whether expressly disclosed or implied in any manner.
2. Contractor shall not use float suppression techniques (including, but not limited to, preferential sequencing caused by late starts of follow-up trades, unreasonably small crews, extended durations, or imposed dates) in information provided to Engineer.

- D. The Contract Time includes weather day allowances as listed in Exhibit A. Extension of contract time will be allowed for each month's days that are in excess of each month's anticipated weather days as identified as identified in Exhibit A.

ARTICLE 12—CLAIMS

No modifications.

ARTICLE 13—COST OF WORK; ALLOWANCES, UNIT PRICE WORK

13.01 *Cost of the Work*

SC-13.01 Supplement Paragraph 13.01.B.5.c.(2) by adding the following sentences:

The equipment rental rate book that governs the included costs for the rental of machinery and equipment owned by Contractor (or a related entity) under the Cost of the Work provisions of this Contract is the most current edition of the cost guide, entitled "Rental Rate Blue Book," and revisions thereto. Attachments (e.g. tractor with ripper and dozer or tractor with loader and backhoe) will be included in the hourly rental rate only when deemed essential to the Work as determined by Engineer. The total established rental rate per hour shall be rounded to the nearest \$0.10. Rental rates shall not be adjusted for regional differences. No compensation shall be allowed for shop tools having a daily rental rate less than \$10.00 as set forth in the cost guide. If deemed necessary by Engineer to use equipment not listed in the aforementioned publications, a suitable rental rate for such equipment will be mutually established by Contractor and Engineer. Contractor may furnish any cost data that might establish a suitable rental rate for such equipment. Rental payment will be made for the actual time that such equipment is in operation on the Work and for 20 percent of the actual standby time on the Work.

SC-13.01 Supplement Paragraph 13.01.C.2 by adding the following definition of small tools and hand tools:

- a. For purposes of this paragraph, "small tools and hand tools" means any tool or equipment whose current price if it were purchased new at retail would be less than \$500.

13.03 *Unit Price Work*

SC-13.03 Delete Paragraph 13.03.E in its entirety and insert the following in its place:

E. *Adjustments in Unit Price*

1. Contractor or Owner shall be entitled to an adjustment in the unit price with respect to an item of Unit Price Work if:
 - a. the extended price of a particular item of Unit Price Work amounts to five (5) percent or more of the Contract Price (based on estimated quantities at the time of Contract formation) and the variation in the quantity of that particular item of Unit Price Work actually furnished or performed by Contractor differs by more than twenty (20) percent from the estimated quantity of such item indicated in the Agreement; and
 - b. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.
2. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.
3. Adjusted unit prices will apply to all units of that item.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

14.02 *Tests, Inspections, and Approvals*

SC-14.02.A Delete Paragraph 14.02.A and replace with the following in lieu thereof:

- A. Contractor shall give the Owner's Representative timely notice of readiness of the Work for all required inspections, tests or approvals. The site must be ready for testing upon the

Contractor's notification to the Owner's Representative. Should the site not be properly prepared for testing upon the arrival of the testing agent, any costs which are incurred will be borne solely by the Contractor. The Owner may withhold payment until the payment of the related outstanding expenses are resolved.

SC-14.02.B Amend the first sentence of Paragraph 14.02.B as follows:

Replace "Owner" with "Contractor" to designate the payor of independent testing laboratory services. Replace "except that" with "including but not limited to the following".

14.05 *Uncovering Work*

SC-14.05.C Amend the first sentence of Paragraph 14.05.C.2 as follows:

Delete the word "shall" and replace with the word "may".

ARTICLE 15—PAYMENTS TO CONTRACTOR, SET OFFS; COMPLETIONS; CORRECTION PERIOD

15.01 *Progress Payments*

SC-15.01.B Delete "At least twenty days before the date established for each progress payment (but not more than once a month)" in the first sentence of paragraph 15.01.B and insert "On the last day of each calendar month" in lieu thereof and add the following subparagraphs at the end of 15.01.B:

5. Schedules and Data: During the progress of the Work, each Application for Payment shall be accompanied by Contractor's updated schedule of operations, or progress report, with such shop drawings schedules, procurement schedules, value of material on hand included in application, and other data as reasonably required by Engineer.
6. Payment for material delivered to the work site or stored under Owner's control will be based on the vendors' paid invoices or the bill of lading showing date of delivery and the work site where the delivery took place, a copy of which shall be furnished by Contractor to Engineer with each request for progress payment. Only those materials which have been incorporated into the Project or are stored under Owner's control may be included in the progress payment as material stored.
7. In addition to the amounts which Owner may retain as provided elsewhere in the Contract Documents, Owner may withhold a sufficient amount or amounts from any payment otherwise due Contractor as in Owner's judgment may be necessary to cover:
 - a. Payments which may be due and payable for properly filed claims against Contractor or any Subcontractor for labor or materials furnished in or about the performance of the Contract.
 - b. Estimated or actual costs for correcting defective work not remedied.
 - c. Amounts claimed by Owner as forfeiture due to delays or other offsets. Owner may apply such withheld amount or amounts to the payment of such claim at Owner's discretion. In doing so, Owner shall be deemed the agent of Contractor and any payments so made by Owner shall be considered as a payment made under the Contract by Owner to Contractor, and Owner shall not be liable to Contractor for such payment made in good faith. Such payments may be made without prior judicial determination of the claim or claims. Owner shall render to Contractor a proper account of any such funds disbursed in or on behalf of Contractor.
8. Contractor shall disburse money paid to him, including any interest Contractor receives, to Subcontractors and Suppliers within 15 days after Contractor receives the money, in direct proportion to the Subcontractors' and Suppliers' basis in the total Contract between Contractor and Owner. Any money which is payable to a Subcontractor pursuant to this section accrues interest at the legal rate. Contractor may withhold 10 percent from the

amount of any partial payment under a subcontract which is made before 50 percent of the Work has been completed under the subcontract. Thereafter Contractor shall pay any additional funds if, in the opinion of Contractor, satisfactory progress is being made in the work under the subcontract, and the payment must be equal to that paid by Owner to Contractor for the Work performed by the Subcontractor.

- a. The Contractor may retain the amount withheld under the subcontract until the subcontract is satisfactorily completed.
- b. The amount withheld under the subcontract is due within 15 days after the acceptance of the subcontract work by Contractor.
- c. Whenever Contractor receives a payment of interest earned on the amount withheld from the Contract, Contractor shall within 15 days pay to each Subcontractor that portion of the interest received from the state which is attributable to the amount of money withheld from the Subcontractor.

SC-15.01.B.1 After the first sentence of Paragraph 15.01.B.1. add the following sentence:

Supporting documentation shall include copies of requisitions or invoices from subcontractors and material suppliers, and any other data the Engineer or Owner may reasonably require.

SC-15.01.B.2 Delete Paragraph 15.01.B.2 and replace with the following in lieu thereof:

2. The Owner will not make payment on materials and equipment not incorporated into the work.

SC-15.01.C Amend Paragraph 15.01.C.1 to read as follows:

“within 20 days after receipt of the Application for Payment...”

SC-15.01.D Delete paragraph 15.01.D.1 and insert the following paragraph in lieu thereof:

1. Sixty (60) days after presentation of the Application for Payment to Owner with Engineer’s recommendation, the amount recommended less amounts due to Owner and other amounts which are authorized to be reserved or retained by state law will (subject to the provisions of paragraph 15.01) become due and when due will be paid by Owner to Contractor.

15.03 *Substantial Completion*

SC-15.03.A Add the following subparagraphs immediately after paragraph 15.03.A:

1. A phase of the Work shall be Substantially Complete when the Work associated with that phase can **[insert substantially complete description of project]** to the quality and in the quantity in accordance with the Contract Documents. All **[insert items applicable]** associated with a phase of the work shall be installed and operational, or temporary arrangements satisfactory to Owner shall have been made. All performance testing need not be completed prior to the date of Substantial Completion.
2. For the work to be considered substantially complete, all portions of the work must be operational and ready for Owner’s continuous use.

SC-15.03.B Add the following new subparagraph 15.03.B.1 to Paragraph 15.03.B:

1. If some or all of the Work has been determined not to be at a point of Substantial Completion and will require re-inspection or re-testing by Engineer, the cost of such re-inspection or re-testing, including the cost of time, travel and living expenses, will be paid by Contractor to Owner. If Contractor does not pay, or the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under this Article 15.

15.06 *Final Payment*

SC-15.06.A Add the following new Paragraph 15.06.A.2.f immediately after Paragraph 15.06.A.2.e:

- f. The final application for payment shall be accompanied by the following items in addition to those required above:
 - 1) Project Record Documents (to requirements of the Contract Documents)
 - 2) Operating Maintenance Data, Instructions to Owner's personnel (to requirements of the Contract Documents)
 - 3) Warranties and Bonds.
 - 4) Keys.
 - 5) Evidence of Payment and Release of Liens (to requirements of Contract Documents)

SC-15.06.E In the last sentence of Paragraph 15.06.E, delete the number "30" and replace with the number "60".

15.08 *Correction Period*

SC-15.08.A Delete "*Substantial Completion*" and insert "*final acceptance*" in lieu thereof.

SC-15.08 Add the following paragraphs immediately after paragraph 15.08.F:

- G. Contractor's obligation under this paragraph includes also providing a correction period from the substantial completion of any early completion items until the project's final completion and the beginning and completion of the 1-year completion's period as defined in paragraph 15.08.A.
- H. Remedying Defects: If, at any time before expiration of the correction period under 15.08.A, Owner determines that the goods are defective, Contractor shall either correct the defects or remove the goods and replace them with non-defective goods.
- I. Owner May Remedy: If Contractor fails to take action as required by Owner in accordance with paragraph 15.08.B, Owner may, after ten days' written notice to Contractor, remedy any such deficiency, instead of requiring removal or replacement. In an emergency where delay would cause serious risk of loss or damage, Owner may take such action without notice to or waiting for action by Contractor.
- J. Correction Period: Contractor's responsibility for remedying defects will extend for a period of one (1) year after date of final acceptance, or for such longer period of time as may be prescribed by law or by provisions of manufacturer's warranty or guarantee in conformance with the Contract Documents.

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

SC-16.01.A Delete paragraph 16.01.A and insert the following in lieu thereof:

- A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. At the discretion of the Owner, the Contractor may be entitled to an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension. Any Change Proposal seeking such adjustments shall be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 *Owner May Terminate for Cause*

SC-16.02 Delete paragraphs 16.02.A through 16.02.D and insert the following in lieu thereof:

- A. If Contractor refuses or fails to prosecute the Work or any separable part thereof with such diligence as will ensure the completion of the Work within the Contract Times, or any extension thereof, or fails or refuses to complete such Work within such extension, or if Contractor should be adjudged bankrupt, or if Contractor should make assignment for the benefit of Contractor's creditors, or if Contractor files a petition to take advantage of any debtor's act, or if a receiver should be appointed on account of Contractor's insolvency, or if Contractor or any Subcontractor should violate any provision of the Contract, or if Contractor should persistently refuse or should fail to supply enough properly skilled workmen or proper materials to complete the Work in the time specified, or if Contractor should fail to make prompt payment to Subcontractors or for materials or labor, or if Contractor should disregard laws, ordinances, or instructions given by Owner, Engineer, or Owner's Operating Agent or disregard in any substantial way any provisions of the Contract Documents; Owner may without prejudice to any other right or remedy, serve written notice upon Contractor and Contractor's surety of Owner's intention to terminate the Contract. Such notice will contain the reasons for Owner's intention to terminate the Contract and unless such violations shall cease and satisfactory arrangements for the corrections thereof have been accepted by Owner in writing within 10 days after the service of such notice, the Contract shall upon the expiration of said 10 days cease and terminate. In the event of such termination, the Owner shall immediately serve written notice upon the Surety and Contractor, and Contractor shall be liable for all costs necessary to complete the Work.
- B. The Surety shall, after receipt of notification from Owner of termination of the Contract, take over and perform the Work, utilizing a contractor which qualified under the prequalification criteria and which is acceptable to Engineer. The Surety shall, within 10 days after receipt of the notice of termination, provide Owner with written notice of Surety's intent to take over and complete the Work in accordance with the Contract Documents, and shall commence the Work within 10 days thereafter.
- C. If the Surety does not reply to the notice of termination, or fails to perform the Work in compliance with the Contract Documents, or provides the Owner with written notice that Surety does not intend to take over and perform the Work to completion, Owner may without prejudice on the part of the Surety, take over the Work and prosecute the same to completion by any method Owner may deem advisable for the account at the expense of Contractor, and the Surety shall be liable to Owner for any excess cost or other damage occasioned Owner thereby. In such event Owner may, without liability for so doing, take possession of and utilize in completing the Work such materials, appliances, plant, and other property belonging to Contractor that may be on the work sites and be necessary therefor. Contractor shall turn over to Owner's Operating Agent all materials and equipment in Contractor's possession that is to be incorporated into the Project, and shall make arrangements with Owner to turn over any materials or equipment in which Owner has made payment or partial payment but is not in Owner's possession.
- D. Upon completion of the Work, if the unpaid balance of the Contract Price exceeds the direct and indirect cost of completing the Work, including, but not limited to, all costs incurred by Owner from professional services and attorneys' fees and all costs generated to insure or bond the Work of substituted contractors or subcontractors used to complete the Work, such excess shall be paid to Contractor. If such costs exceed the unpaid balance, Contractor shall pay the difference to Owner within 30 days upon demand; on failure of Contractor to pay, the Surety shall promptly pay the difference to Owner upon written notice of Contractor's failure of payment. Such difference or any portion thereof not paid by the Contractor or the Surety within the 30 days following the date of mailing of the demand for payment, shall earn interest at the rate of 10 percent per annum or the maximum rate authorized by state law, whichever is lower.

16.04 *Contractor May Stop Work or Terminate*

SC-16.04 Delete paragraph 16.04 in its entirety.

ARTICLE 17—FINAL RESOLUTIONS OF DISPUTES

17.02 *Arbitration*

SC-17.02 Add the following new paragraph immediately after Paragraph 17.01.

17.02 *Arbitration*

- A. All matters subject to final resolution under this Article will be settled by arbitration administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules (subject to the conditions and limitations of this Paragraph SC-17.02). Any controversy or claim in the amount of \$100,000 or less will be settled in accordance with the American Arbitration Association's supplemental rules for Fixed Time and Cost Construction Arbitration. This agreement to arbitrate will be specifically enforceable under the prevailing law of any court having jurisdiction.
- B. The demand for arbitration will be filed in writing with the other party to the Contract and with the selected arbitration administrator, and a copy will be sent to Engineer for information. The demand for arbitration will be made within the specific time required in Article 17, or if no specified time is applicable within a reasonable time after the matter in question has arisen, and in no event will any such demand be made after the date when institution of legal or equitable proceedings based on such matter in question would be barred by the applicable statute of limitations.
- C. The arbitrator(s) must be licensed engineers, contractors, attorneys, or construction managers. Hearings will take place pursuant to the standard procedures of the Construction Arbitration Rules that contemplate in-person hearings. The arbitrators will have no authority to award punitive or other damages not measured by the prevailing party's actual damages, except as may be required by statute or the Contract. Any award in an arbitration initiated under this clause will be limited to monetary damages and include no injunction or direction to any party other than the direction to pay a monetary amount.
- D. The Arbitrators will have the authority to allocate the costs of the arbitration process among the parties, but will only have the authority to allocate attorneys' fees if a specific Law or Regulation or this Contract permits them to do so.
- E. The award of the arbitrators must be accompanied by a reasoned written opinion and a concise breakdown of the award. The written opinion will cite the Contract provisions deemed applicable and relied on in making the award.
- F. The parties agree that failure or refusal of a party to pay its required share of the deposits for arbitrator compensation or administrative charges will constitute a waiver by that party to present evidence or cross-examine witness. In such event, the other party shall be required to present evidence and legal argument as the arbitrator(s) may require for the making of an award. Such waiver will not allow for a default judgment against the non-paying party in the absence of evidence presented as provided for above.
- G. No arbitration arising out of or relating to the Contract will include by consolidation, joinder, or in any other manner any other individual or entity (including Engineer, and Engineer's consultants and the officers, directors, partners, agents, employees or consultants of any of them) who is not a party to this Contract unless:
 - 1. the inclusion of such other individual or entity will allow complete relief to be afforded among those who are already parties to the arbitration;

2. such other individual or entity is substantially involved in a question of law or fact which is common to those who are already parties to the arbitration, and which will arise in such proceedings;
 3. such other individual or entity is subject to arbitration under a contract with either Owner or Contractor, or consents to being joined in the arbitration; and
 4. the consolidation or joinder is in compliance with the arbitration administrator's procedural rules.
- H. The award will be final. Judgment may be entered upon it in any court having jurisdiction thereof, and it will not be subject to modification or appeal, subject to provisions of the Laws and Regulations relating to vacating or modifying an arbitral award.
- I. Except as may be required by Laws or Regulations, neither party nor an arbitrator may disclose the existence, content, or results of any arbitration hereunder without the prior written consent of both parties, with the exception of any disclosure required by Laws and Regulations or the Contract. To the extent any disclosure is allowed pursuant to the exception, the disclosure must be strictly and narrowly limited to maintain confidentiality to the extent possible.

17.03 Attorneys' Fees

SC-17.03 Add the following new paragraph immediately after Paragraph 17.02. [Note: If there is no Paragraph 17.02, because neither arbitration nor any other dispute resolution process has been specified here in the Supplementary Conditions, then revise this to state "Add the following new Paragraph immediately after Paragraph 17.01" and revise the numbering accordingly].

17.03 Attorneys' Fees

- A. For any matter subject to final resolution under this Article, the prevailing party shall be entitled to an award of its attorneys' fees incurred in the final resolution proceedings, in an equitable amount to be determined in the discretion of the court, arbitrator, arbitration panel, or other arbiter of the matter subject to final resolution, taking into account the parties' initial demand or defense positions in comparison with the final result.

ARTICLE 18—MISCELLANEOUS

SC-18.11 Add the following new paragraph after Paragraph 18.10:

18.11 Roadways

- A. No public road shall be entirely closed overnight. It shall be the responsibility of the Contractor to build and maintain asphalt pavement by-passes and detours, if necessary, and to properly light, barricade, and mark all by-passes and detours that might be required on or across the road involved in the work included in this contract.
- B. The Contractor shall make every effort to complete construction and allow immediate access to adjacent property at all driveway entrances. Owners or tenants of improvements where access and/or entrance drives are located shall be notified at least twenty-four (24) hours prior to the time the construction will started at their driveways or entrances and informed as to the length of time driveways will be closed, which period shall not exceed six (6) hours.
- C. The Contractor shall be responsible for all road and entrance reconstruction, and repairs and maintenance of same, for a period of two (2) years from the date of acceptance. In the event the repairs and maintenance are made immediately to the satisfaction of the Owner, and it becomes necessary for the Owner to make such repairs, the Contractor shall reimburse the Owner for the cost of such repairs.

- D. The Contractor shall, at all times, keep a sufficient width of the roadway clear of dirt and other material to allow the free flow of traffic. The Contractor shall assume any and all responsibility for damage, personal or otherwise, that may be caused by the construction along public roadways or private driveways.

SC-18.12 Add the following new paragraph after Paragraph 18.11:

18.12 *Barricades, Lights, and Watchmen*

- A. Where the work is carried on in or adjacent to any street, alley or public place, the Contractor shall, at his own cost and expense, furnish and erect such barricades, fences, lights, and danger signals, shall provide such watchmen, and shall provide such other precautionary measures for the protection of persons or property and of the work as necessary. Barricades shall be painted in a color that will be visible at night. From sunset to sunrise the Contractor shall furnish and maintain at least one light at each barricade and a sufficient number of barricades shall be erected to keep vehicles from being driven on or into any work under construction. The Contractor shall furnish watchmen in sufficient numbers to protect the work.
- B. The Contractor will be held responsible for all damage to the work due to failure of barricades, signs, lights, and watchmen to protect it, and whenever evidence is found of such damage, the Owner may order the damaged portion immediately removed and replaced by the Contractor at his cost and expense. The Contractor's responsibility for the maintenance of barricades, signs, lights and for providing watchmen shall not cease until the project shall have been accepted by the Owner.
- C. The Contractor shall use only battery powered lights, enclosed lanterns or other lights satisfactory to the Owner. Smudge Pots or other lights which have an open flame will not be permitted.
- D. The Contractor will be required to furnish all barricades, lights, signs, and flagmen where it becomes necessary to reroute traffic during the time construction is in progress in the City streets or highways. The detour will be determined by the Engineers and approved by the Owner and, as applicable, the Oklahoma Department of Transportation.

SC-18.13 Add the following new paragraph after Paragraph 18.12:

18.13 *Fences, Drainage Channels and Crop Damage*

- A. The Contractor shall not be held liable for unavoidable crop damage to crops provided such damage occurs within the construction easement provided.
- B. Where surface drainage channels are disturbed or blocked during construction, they shall be restored to their original condition or grade and cross section after work of construction is completed.
- C. Boundary fences or other improvements removed to permit the prosecution of the work shall be replaced in the same location or relocated to their positions prior to City temporary removal or relocation for franchise utility work, and left in a condition as good or better than that in which they were found. No compensation will be provided for removal and replacement of fences. All costs associated with the fence removal and replacement shall be in the lump sum bid for right-of-way preparation.

SC-18.14 Add the following new paragraph after Paragraph 18.13:

18.14 *Protection of Trees*

- A. No trees shall be removed or cut except upon the specific authority of the Owner. Trees adjacent to the work shall be protected from all damage by the Contractor's construction operations. See Appendix "A" for the City's Tree Preservation Ordinance.

SC-18.15 Add the following new paragraph after Paragraph 18.14:

18.15 *Cleanup*

- A. During Construction - The Contractor shall at all times keep the job site as free from all material, debris and rubbish as is practical and shall remove same from any portion of the job site, when it becomes objectionable or interferes with the project in the opinion of the Owner's Representative.
- B. Final - Upon completion of the work, the Contractor shall remove from the site all materials, debris, tools and equipment belonging to him, and leave the site with an appearance acceptable to the Owner. The Contractor shall thoroughly clean all equipment and materials installed by him and shall deliver over such materials and equipment in a bright, clean polished and new appearing condition.

SC-18.16 Add the following new paragraph after Paragraph 18.15:

18.16 *Minimum Wage Rates*

- A. The specified wage rates are minimum rates only, and the Owner will not consider any claims for additional compensation made by the Contractor of any wage range in excess of the applicable rate contained in this contract. All disputes in regard to payment of wages in excess of those specified in this contract shall be adjusted by the Contractor.

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EXHIBIT A—FORESEEABLE BAD WEATHER DAYS

Month	Number of Foreseeable Bad Weather Days in Month Based on Precipitation as Rain Equivalent (inches) (1) and Temperature
January	8
February	9
March	6
April	5
May	8
June	7
July	7
August	4
September	4
October	5
November	4
December	5
Notes: 1. Two inches of sleet equal one inch of rain. Five inches of wet, heavy snow equal one inch of rain. Fifteen inches of “dry” powder snow equals one inch of rain.	

RELEASE

FROM: Contractor's Name _____
Address _____
TO: Owner's Name _____
Address _____

DATE OF CONTRACT:

Upon receipt of the final payment and in consideration of that amount, the undersigned does hereby release the Owner and its agents from any and all claims arising under or by virtue of this Contract or modification thereof occurring from the undersigned's performance in connection with the _____ project.

Contractor's Signature

Title

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

Notary Public

My Commission Expires:

CONTRACTOR'S AFFIDAVIT

FROM: Contractor's Name _____

Address _____

TO: Owner's Name _____

Address _____

DATE OF CONTRACT: _____

I hereby certify that all claims for material, labor, and supplies entered into contingent and incident to the construction or used in the course of the performance of the work on the _____ project have been fully satisfied.

Contractor's Signature

Title

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

Notary Public

My Commission Expires:

The Surety Company consents to the release of the retained percentage on this project with the understanding that should any unforeseen contingencies arise having a right of action on the bond that the Surety Company will not waive liability through the consent to the release of the retained percentage.

Dated _____
Surety Company

By _____
Resident Agent, State of Oklahoma

PART 4
CWSRF DOCUMENTATIONS

Bidder's Statement about: **Equal Opportunity Clause (ORF-211)**

Mark **one**:

☐ I have participated in previous contract(s) or subcontract(s) subject to the equal opportunity clause under Executive Orders 11246 and 11375 or preceding Executive Orders 10925 and 11114. I have filed all reports due under the requirements contained in 40 CFR, Part C, 8.11.

☐ I have not participated in previous contract(s) subject to the equal opportunity clause under Executive Orders 11246 and 11375 or preceding Executive Orders 10925 and 11114.

☐ I will obtain a similar statement from any proposed subcontractor(s), when appropriate.

Bidder's Statement about: **Non-Segregated Facilities (ORF-212)**

☐ I hereby certify that I do not and will not maintain any facilities provided for my employees in a segregated manner, or permit my employees to perform their services at any location under my control where segregated facilities are maintained; and that I will obtain a similar certification prior to the award of any subcontract exceeding \$10,000 which is not exempted from the equal opportunity clause.

Bidder's Statement about: **Bonds**

☐ I hereby certify that I will obtain and provide a Bid Bond along with my Bid.

☐ I hereby certify that, in the event of being awarded a Contract, I will provide a Performance Bond for 100% of the contract amount.

☐ I hereby certify that, in the event of being awarded a Contract, I will provide a Statutory/Payment Bond for 100% of the contract amount.

☐ I hereby certify that, in the event of being awarded a Contract, I will provide a Maintenance Bond for at least 1 year after construction completion, and 100% of the contract amount

Bidder's Statement about: **Sam.gov registration**

Mark **one**:

☐

I have registered in SAM.gov and my status is “active”.

☐

I am not currently registered in SAM.gov, but I will be registered and holding an “active” status prior to the beginning of any construction.

☐

I certify that I will actively review the SAM.gov status of all of the subcontractors in this work to verify they are registered and their status is “active”.

Bidder's Statement about: **Davis Bacon Act and Build America Buy America**

☐

I hereby certify that all of my employees will be paid according to the Davis Bacon Act.

☐

I hereby certify that I will comply with the **Build America Buy America requirement.**

Name and Title of Prospective Prime Contractor's Representative

Signature of Prospective Prime Contractor's Representative

Name and address of Prospective Prime Contractor

BIDDERS LIST**To be completed by Project Owner** for all bidding Prime Contractors & Subcontractors.(List of **all firms** that bid or quote on **Prime Contracts** and **Subcontracts** on the project, including Services and Supplies)

Project Name: _____ CWSRF Loan Number: ORF-__-____-CW

Company Name:	
Address:	
Contact Name:	
Phone:	
Email:	
Quote/Bid Amount (\$)	
Date:	
Utilized: Y ☐ N ☐	If utilized and >\$10,000, ORF-212a form is required (all subcontractors and suppliers).
DBE: Y ☐ N ☐ If yes , MBE or WBE? _____	Check one: Construction ☐ Equipment ☐ Services ☐ Supplies ☐ ORF 6100-3 form is required for all DBEs that bid/quote, even if not utilized. Submit with Bidders List. If utilized submit the following with Bidders List: • A copy of the companies MBE or WBE certificate is required. • ORF 6100-4 form is also required.

Company Name:	
Address:	
Contact Name:	
Phone:	
Email:	
Quote/Bid Amount (\$)	
Date:	
Utilized: Y ☐ N ☐	If utilized and >\$10,000, ORF-212a form is required (all subcontractors and suppliers).
DBE: Y ☐ N ☐ If yes , MBE or WBE? _____	Check one: Construction ☐ Equipment ☐ Services ☐ Supplies ☐ ORF 6100-3 form is required for all DBEs that bid/quote, even if not utilized. Submit with Bidders List. If utilized submit the following with Bidders List: • A copy of the companies MBE or WBE certificate is required. • ORF 6100-4 form is also required.

Company Name:	
Address:	
Contact Name:	
Phone:	
Email:	
Quote/Bid Amount (\$)	
Date:	
Utilized: Y ☐ N ☐	If utilized and >\$10,000, ORF-212a form is required (all subcontractors and suppliers).
DBE: Y ☐ N ☐ If yes , MBE or WBE? _____	Check one: Construction ☐ Equipment ☐ Services ☐ Supplies ☐ ORF 6100-3 form is required for all DBEs that bid/quote, even if not utilized. Submit with Bidders List. If utilized submit the following with Bidders List: • A copy of the companies MBE or WBE certificate is required. • ORF 6100-4 form is also required.

*Copy this form if additional pages are required.

BIDDER'S AMERICAN IRON AND STEEL CERTIFICATION

I, the Bidder, _____, authorized
Contractor's Authorized Representative
 representative of _____, hereby certify that I am aware of
Contractor
 the requirement per Section 436(a)-(f) of the Consolidated Appropriations Act of 2014, as
 amended, by which all applicable products made primarily out of iron and steel used in
 this project must be manufactured in the United States, and that the bid prepared for
 _____ has been prepared accordingly, as it is
Project
 funded through the Clean Water State Revolving Fund (loan number ORF-____-____-
 CW). I, the Bidder, am aware that none of the funds appropriated or otherwise made
 available by the Consolidated Appropriation Act of 2014 (Appropriations Act) shall be used
 for the construction, alteration, maintenance, or repair of a treatment works unless all of
 the iron and steel products used in the project are produced in the United States. I, the
 Bidder, furthermore certify the following:

1. The bidder understands the term "iron and steel products" applies to the following materials made primarily of iron or steel, and used for the construction, alteration, maintenance, or repair of publicly owned treatment works; lined or unlined pipes and fittings, manhole covers and other municipal castings, hydrants, tanks, flanges, pipe clamps and restraints, valves, structural steel, reinforced precast concrete, and other construction materials as defined by the U.S. Environmental Protection Agency (EPA). For additional guidance, visit http://water.epa.gov/grants_funding/aisrequirement.cfm
2. The bidder further states that this requirement applies to all portions of the project that are subcontracted.
3. This "Bidder's American Iron and Steel Certification" is to be submitted by the bidder as part of its bid.

4. Iron and steel of unknown origin are considered to have been produced or manufactured outside the United States.
5. Consistent with the terms of the Owner's bid solicitation and the provisions of Use of American Iron and Steel Section 436, the bidder certifies that this bid reflects the bidder's best, good faith effort to identify domestic sources of iron and steel goods in the bid solicitation where such American-made goods are available on the schedule and consistent with the deadlines prescribed in or required by the bid solicitation.
6. The bidder certifies that all iron and steel products contained in the bid solicitation that are American-made have been so identified, and if this bid is accepted, the bidder agrees that it will provide reasonable, sufficient, and timely verification to the Owner of the U.S. production of each component so identified.
7. The bidder certifies that for any iron and steel products that are not American-made and are so identified in this bid, the bidder has included in or attached to this bid one or both of the following, as applicable:
 - a. Identification of and citation to a categorical waiver published by EPA in the Federal Register that is applicable to such component or components, and an analysis that supports its applicability to the component or components; If the Administrator of EPA receives a request for a waiver under this section, the Administrator shall make available to the public on an informal basis a copy of the request and information available to the Administrator concerning the request, and shall allow for informal public input on the request for at least 15 days prior to making a finding based on the request. The Administrator shall make the request and accompanying information available by electronic means, including on the official public Internet Website of EPA.
 - b. Verifiable documentation sufficient to the Owner, as required in the bid solicitation or otherwise, that the bidder has sought to secure American-produced goods but has determined that such goods are not available on the schedule and consistent with the deadlines prescribed in the bid solicitation, with assurance adequate for the bidder under the applicable conditions stated in the bid solicitation or otherwise.
8. The bidder certifies that for any such product or products that are not so available, the bidder has also provided in or attached to this bid certification, including but not

limited to the verifiable documentation and a full description of the bidder's efforts to secure any such American-produced iron and steel goods, that the bidder believes are sufficient to provide and as far as possible constitute the detailed justification required for a waiver under Use of American Iron and Steel with respect to such product or products.

9. If use of a non-compliant iron and/or steel product is permanently incorporated into a project, one or more of the following can occur:
 - a. Request a waiver where appropriate.
 - b. Require the removal of the non-domestic item.
 - c. Payment withholding of all or part of the project.
10. The bidder further agrees that, if this bid is accepted, it will assist the Owner in amending, supplementing, or further supporting such information as required by the Owner to request and, as applicable, implement the terms of a waiver with respect to any such product or products. The EPA strongly recommends the use of a step certification, similar to the one used by the Federal Highway Administration. The final manufacturer can also certify that the manufacturing process occurred in the United States.

Contractor's Authorized Representative
Signature

____/____/____
Date

BIDDER'S BUILD AMERICA BUY AMERICA CERTIFICATION

I, the Bidder, _____, authorized representative
Contractor's Authorized Representative
 of _____, hereby certify that funds for this project must comply
Contractor
 with all federal requirements applicable to the assistance received (including those imposed by the Infrastructure Investment and Jobs Act ("IIJA"), Public Law No. 117-58) which the Bidder understands includes, but is not limited to, the following requirements: that all of the iron and steel, manufactured products, and construction materials used in the project are to be produced in the United States ("Build America, Buy America [BABA] Requirements") unless (i) the Bidder has requested and obtained a waiver from the cognizant Agency pertaining to the project or the project is otherwise covered by a general applicability waiver; or (ii) all of the contributing Agencies have otherwise advised the Bidder in writing that the BABA Requirements are not applicable to the project.

The Bidder is aware that all iron and steel, manufactured projects, and construction materials used for this project must be produced in the United States per BABA requirements, and that the bid prepared for _____ has
Project
 been prepared accordingly, as it is funded through the Clean Water State Revolving Fund (loan number ORF-____-____-CW). and furthermore certifies as follows.

1. The Bidder understands the term "iron and steel, manufactured products, and construction materials" applies to all projects for the construction, alteration, maintenance, or repair of publically owned treatment works or public water systems. The Bidder understands the term "iron and steel, manufactured products, and construction materials" refers to the following:

- a. To establish standards defining the term “all manufacturing processes” in the case of construction materials, Office of Management and Budget (“OMB”) must first determine to which materials the standards will apply.
 - b. The IIJA finds that “construction materials” include an article, material, or supply—other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives—that is or consists primarily of: Non-ferrous metals, plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables), glass (including optic glass), lumber, and drywall.
2. The Bidder further states that this requirement applies to all portions of the project that are subcontracted.
3. This “Bidder’s Build America Buy America Certification” is to be submitted by the Bidder as a part of this bid and proposal.
4. Iron and steel, manufactured products, and construction materials of unknown origin are considered to have been produced or manufactured outside the United States.
5. Identification of American-produced Iron and Steel, Manufactured Products, and Construction Materials: Consistent with the terms of the Owner’s bid solicitation and the provisions of BABA, the Bidder certifies that this bid reflects the Bidder’s best, good faith effort to identify domestic sources of iron and steel, manufactured products, and construction materials in the bid solicitation where such American-made goods are available on the schedule and consistent with the deadlines prescribed in or required by the bid solicitation.
6. Verification of U.S. Production: The Bidder certifies that all iron and steel, manufactured products, and construction materials contained in the bid solicitation that are American-made have been so identified, and if this bid is accepted, the Bidder agrees that it will provide reasonable, sufficient, and timely verification to the Owner of the U.S. production of each component so identified.

7. Documentation Regarding Non-American-made Iron and Steel Goods: The Bidder certifies that for any iron and steel, manufactured products, and construction material that are not American-made and are so identified in this bid, the Bidder has included in or attached to this bid one or both of the following, as applicable:
 - a. Identification of and citation to a categorical waiver published by the U.S. Environmental Protection Agency ("EPA") in the Federal Register that is applicable to such component or components, and an analysis that supports its applicability to the component or components. If the Administrator of EPA receives a request for a waiver under this section, the Administrator shall make available to the public on an informal basis a copy of the request and information available to the Administrator concerning the request and shall allow for informal public input on the request for at least 15 days prior to making a finding based on the request. The Administrator shall make the request and accompanying information available by electronic means, including on the official public Internet Website of EPA.
 - b. Verifiable documentation sufficient to the Owner, as required in the bid solicitation or otherwise, that the Bidder has sought to secure American-produced goods but has determined that such goods are not available on the schedule and consistent with the deadlines prescribed in the bid solicitation, with assurance adequate for the Bidder under the applicable conditions stated in the bid solicitation or otherwise.
8. Information and Detailed Justification Regarding Non-American-produced Iron and Steel, Manufactured products, and Construction Materials: The Bidder certifies that for any such product or products that are not so available, the Bidder has also provided in or attached to this bid certification, including but not limited to the verifiable documentation and a full description of the Bidder's efforts to secure any such American-produced iron and steel, manufactured products, and construction materials, that the Bidder believes are sufficient to provide and as far as possible constitute the detailed justification required for a waiver under Use of American Iron and Steel with respect to such product or products.

9. If use of a noncompliant iron and steel, manufactured products, and construction materials is permanently incorporated into a project, one or more of the following can occur: 1) Request a waiver where appropriate. 2) Require the removal of the non-domestic item. 3) Payment for all or part of the project will be withheld.
10. The Bidder further agrees that, if this bid is accepted, it will assist the Owner in amending, supplementing, or further supporting such information as required by the Owner to request and, as applicable, implement the terms of a waiver with respect to any such product or products. EPA strongly recommends the use of a step certification, similar to the one used by the Federal Highway Administration. The final manufacturer can also certify that the manufacturing process occurred in the United States.

Contractor's Authorized Representative Signature

____/____/_____
Date

Build America, Buy America Act (BABA) FAQs for Manufacturers

U.S. Environmental Protection Agency

June 2025

The purpose of this document is to assist product manufacturers, suppliers, and distributors with understanding the Build America, Buy America Act (BABA)¹ requirements. This document consists of a series of frequently asked questions (FAQs) with responses based on Office of Management and Budget (OMB) guidance^{2,3}, U.S. Environmental Protection Agency (EPA) implementation procedures,⁴ and other resources. This document does not address domestic sourcing requirements associated with federal procurement or financial assistance from other federal agencies.⁵ For current information on BABA implementation at the EPA, visit the [EPA's BABA website](#).

Q1. Does my product need to meet the BABA requirements?

Your product needs to meet the BABA requirements for being considered “produced in the United States” if it is an iron or steel product, construction material, or manufactured product, and you want to supply it to infrastructure projects receiving any form of federal financial assistance (e.g., grants, loans, cooperative agreements, and rebates). See Q2-Q7 to understand if your product is considered an iron or steel product, construction material, or manufactured product and what “produced in the United States” means for each of these product categories.

Infrastructure projects are defined very broadly to include any activity related to the construction, alteration, maintenance, or repair of any structures, facilities, or equipment that serve a public function. Infrastructure projects include but are not limited to roads, highways, and bridges; public transportation; dams, ports, harbors, and other maritime facilities; intercity passenger and freight railroads; freight and intermodal facilities; airports; water systems, including drinking water and wastewater systems; electrical transmission facilities and systems; utilities; broadband infrastructure; buildings and real property (except for private homes for personal use); and energy generation, transportation, and distribution including electric vehicle charging. In addition, a project serves a public function if it is publicly owned and operated, privately operated on behalf of the public, or is a place of public accommodation. [More than 70 EPA programs](#) fund infrastructure projects that can only use iron or steel products, construction materials, or manufactured products that are “produced in the United States.”

Your product may NOT need to meet the BABA requirements if any of the following are true:

- Your product is not directly incorporated into a federally funded infrastructure project (e.g., your product is a component or subcomponent of another product).
- Your product is brought to the project site and removed at or before the completion of the infrastructure project (e.g., temporary scaffolding).

¹ [Build America, Buy America Act \(BABA\)](#). Pub. L. No. 117-58, §§ 70901-52.

² [2 CFR 184](#). Buy America Preferences for Infrastructure Projects.

³ [M-24-02](#). Implementation Guidance on Application of Buy America Preference in Federal Financial Assistance Programs for Infrastructure.

⁴ [Build America, Buy America \(BABA\) EPA Programs](#).

⁵ See [MadeinAmerica.gov](#) for information on BABA implementation at other agencies.

- Your product is equipment or furnishing that is used at or within the finished infrastructure project but is not an integral part of the project (e.g., movable chair, desk, portable computer equipment).
- Your product is vegetation, biodegradable materials, or soil.
- Your product is a cement or cementitious material, aggregate (e.g., stone, sand, gravel), or aggregate binding agent or additive unless it has been combined with other materials and processed into a specific form and shape (e.g., precast concrete).
- The EPA has approved a waiver that applies to your product or to the project to which you are supplying your product. See Q12 for more information on waivers.

Q2. Is my product considered an iron or steel product?

For BABA purposes, your product is considered an iron or steel product if it consists wholly or predominantly of iron or steel or a combination of both. This means that the cost of the iron and steel content exceeds 50 percent of the total cost of all components. The cost of iron and steel is the cost of the iron or steel mill products (e.g., bar, billet, slab, wire, plate, or sheet), castings, or forgings utilized in the manufacture of the product and a good faith estimate of the cost of iron or steel components. Components are items incorporated directly into an iron or steel product. Additional products may qualify as an iron or steel product if they are being supplied to water infrastructure projects that must comply with the American Iron and Steel (AIS) requirements.⁶

Q3. What does it mean to be “produced in the United States” for iron or steel products?

For BABA purposes, iron or steel products are considered “produced in the United States” if all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States. If an iron or steel product was manufactured by re-heating imported ferrous sources such as billets or ingots, it is not considered “produced in the United States.” The [EPA’s Minor \(Ferrous\) Components Waiver](#) allows up to five percent of the total material cost of an iron or steel product to include miscellaneous minor iron or steel components that are nondomestic or of unknown origin.

Q4. Is my product considered a construction material?

For BABA purposes, your product is considered a construction material if it consists of only one of the following items: non-ferrous metals; plastic and polymer-based products (e.g., polyvinylchloride, composite building materials, and polymers used in fiber optic cables); glass (including optic glass); fiber optic cable (including drop cable); optical fiber; lumber; engineered wood; and drywall. Minor additions to a construction material, including binding agents or additions described in the standard for that construction material (see Q5) do not change its categorization as a construction material. If your product combines more than one of the listed construction materials or combines one of the listed construction materials with other materials, then it is considered a manufactured product for BABA purposes.

⁶ See the [EPA’s AIS website](#) for more information on AIS implementation at the EPA.

Q5. What does it mean to be “produced in the United States” for construction materials?

For BABA purposes, construction materials are considered “produced in the United States” if all manufacturing process occurred in the United States. The following list includes each construction material followed by a standard for the material to be considered “produced in the United States.”

- Non-ferrous metals. All manufacturing processes, from initial smelting or melting through final shaping, coating, and assembly, occurred in the United States.
- Plastic and polymer-based products. All manufacturing processes, from initial combination of constituent plastic or polymer-based inputs, or, where applicable, constituent composite materials, until the item is in its final form, occurred in the United States.
- Glass. All manufacturing processes, from initial batching and melting of raw materials through annealing, cooling, and cutting, occurred in the United States.
- Fiber optic cable (including drop cable). All manufacturing processes, from the initial ribboning (if applicable), through buffering, fiber stranding and jacketing, occurred in the United States. All manufacturing processes also include the standards for glass and optical fiber, but not for non-ferrous metals, plastic and polymer-based products, or any others.
- Optical fiber. All manufacturing processes, from the initial preform fabrication stage through the completion of the draw, occurred in the United States.
- Lumber. All manufacturing processes, from initial debarking through treatment and planing, occurred in the United States.
- Drywall. All manufacturing processes, from initial blending of mined or synthetic gypsum plaster and additives through cutting and drying of sandwiched panels, occurred in the United States.
- Engineered wood. All manufacturing processes from the initial combination of constituent materials until the wood product is in its final form, occurred in the United States.

Q6. Is my product considered a manufactured product?

For BABA purposes, your product is considered a manufactured product if it does not meet the definition of an iron or steel product (see Q2) or a construction material (see Q4) and is not an exempted material (see Q1). Manufactured products are defined as articles, materials, or supplies that have been processed into a specific form and shape or have been combined with other articles, materials, or supplies to create a product with different properties than the individual articles, materials, or supplies.

Q7. What does it mean to be “produced in the United States” for manufactured products?

For BABA purposes, manufactured products are considered “produced in the United States” if the final product was manufactured in the United States and components of domestic origin constitute greater than 55 percent of the total cost of all components. Components are items incorporated directly into the final manufactured product. The cost of a component includes transportation costs, any applicable duties, and allocable overhead costs. The cost of a component does NOT include any costs associated with manufacture of the final manufactured product. More information on determining the cost of components for manufactured products can be found in OMB’s guidance at [2 CFR 184.5](#).

Q8. How do I demonstrate that my product meets the BABA requirements?

To demonstrate that your product meets the BABA requirements, the product manufacturer should provide a self-certification letter attesting that the product(s) supplied to the infrastructure project meet the BABA requirements. The entity receiving the federal financial assistance is ultimately responsible for ensuring BABA compliance and must collect and maintain compliance documentation such as these self-certification letters for all products that are incorporated into their infrastructure project. They may work through a contractor to collect manufacturer self-certification letters. See Q9 for more information on what should be included in manufacturer self-certification letters.

Q9. What should be included in a manufacturer self-certification letter?

Manufacturer self-certification letters should be product-specific and project-specific. They should identify the project by name, location, and/or contract/project number and identify the product(s) actually supplied to the project. They should also contain a statement attesting that the product(s) meet the BABA requirements for the specific product category (i.e., iron or steel products, construction materials, manufactured products), and the location(s) of manufacturing (city and state). Finally, the letter should be on company letterhead and signed by a qualified manufacturer representative. To view manufacturer self-certification letter templates, visit the resources page of the [EPA's BABA website](#).

Q10. Does the EPA certify products or manage a list of products that meet the BABA requirements?

The EPA does not certify products that meet the BABA requirements. The EPA relies on a system of manufacturer self-certification letters described in Q8 and Q9.

The EPA does not manage a list of products that meet the BABA requirements. Products that meet the BABA requirements should be identified as such on your website and/or in your sales materials. These products may be more readily considered for incorporation into infrastructure projects receiving federal financial assistance.

Q11. What if my product is shipped as a kit?

For BABA purposes, if your product is considered a manufactured product but is brought to the project site as separate components intended for final assembly or installation onsite, it can still be treated and evaluated as a single manufactured product. Delivering the product as a kit rather than a fully assembled product must be standard business practice in the industry and you must be meaningfully involved in the manufacturing process of a component of the kit. This treatment is limited to discrete products that perform a unified function and does not apply to more wide-ranging systems of interconnected products (e.g., heating, ventilation, and air conditions systems for an entire building). When calculating the cost of components for a product shipped as a kit, do not include the cost of transportation to the project site.

Q12. Can I obtain a waiver if my product does not meet the BABA requirements?

The EPA does not have the authority to waive the BABA requirements for individual manufacturers. The EPA only has authority to waive the BABA requirements for certain products or projects if: (1) applying the BABA requirements would be inconsistent with public interest; (2) products that meet the BABA requirements are not available in sufficient and reasonably available quantities or of a satisfactory quality; or (3) the inclusion of products that meet the BABA requirements will increase the cost of the overall infrastructure project by more than 25 percent.

The EPA only accepts project-specific waiver requests if they are submitted by the entity receiving the federal financial assistance (or their authorized representative) and only after the entity has conducted market research to justify the need for the waiver. The EPA does not accept waiver requests submitted by product manufacturers, suppliers, or distributors. Project-specific waivers do not waive the BABA requirements for other EPA-funded projects. Similarly, waivers issued by other federal agencies do not waive the BABA requirements for EPA-funded projects.⁷

The EPA has program-wide and agency-wide waivers that may apply to your product or to the project to which you are supplying your product (e.g., the [EPA's De Minimis Waiver](#)). If you believe this is the case, the entity receiving the EPA's federal financial assistance should contact their project officer and provide a rationale for applying the waiver. Note that waivers have specific applicability conditions and other requirements, which must be followed.

To view a list of the EPA's approved general applicability and project-specific waivers, visit the approved waivers page of the [EPA's BABA website](#).

Q13. What if my product does not meet the BABA requirements and is not covered by a waiver?

If your product does not meet the BABA requirements and is not covered by a waiver, it cannot be incorporated into infrastructure projects receiving federal financial assistance. If the EPA finds that a manufacturer has knowingly misrepresented their product's adherence to the BABA requirements in a self-certification letter, the case would be referred to the EPA's Office of Inspector General (OIG), who may pursue civil or criminal penalties.

At all levels where fraud, waste, abuse, or any violation of the law is suspected, the EPA's OIG should be contacted immediately. The EPA's OIG can be reached at 1-888-546-8740 or OIG_Hotline@epa.gov. For more information, visit the [EPA's OIG website](#).

Q14. Where can I find more information on BABA implementation at the EPA?

For more information on BABA implementation at the EPA, please visit the [EPA's BABA website](#), which includes links to relevant OMB guidance (e.g., [2 CFR 184](#) and [M-24-02](#)), manufacturer self-

⁷ See [MadeinAmerica.gov](https://www.madeinamerica.gov) to view a list BABA waivers issued by other federal agencies.

certification letter templates, approved waivers, waivers open for public comment, and program-specific implementation procedures.

Q15. Who can I contact for more information on BABA?

For general questions, please email EPA_BABA_Waiver@epa.gov. If the question is regarding a specific project or program, please email the EPA office funding the project:

- For the Office of Water (OW), please email BABA-OW@epa.gov
- For the Office of Land and Emergency Management (OLEM), please email BABA-OLEM@epa.gov
- For the Office of Research and Development (ORD), please email BABA-ORD@epa.gov
- For the Office of Transportation and Air Quality (OTAQ), please email BABA-OTAQ@epa.gov
- For the Climate Pollution Reduction Grants, please email BABA-CPRG@epa.gov
- For the Office of International and Tribal Affairs (OITA), please email GAP@epa.gov
- For the Greenhouse Gas Reduction Fund (GGRF), please contact BABA-GGRF@epa.gov

The following information is provided as a sample letter of certification for **BABA** compliance for Non-Ferrous **Construction Materials**. **Documentation must be provided on company letterhead.**

Date

Company Name

Company Address

City, State Zip

Subject: Build America, Buy America Act Certification for Project XXXXXXXXXXXX (must state the water/wastewater system name, location, and/or project/contract title, that is specific and recognizable enough to easily associate it with this particular project)

I, (company representative), certify that the non-ferrous construction materials shipped/provided to the subject project are in full compliance with the Buy America, Build America Act requirement as mandated in the Infrastructure Investment and Jobs Act (IIJA) Pub. L. No. 117-58, §§ 70901-52 and in EPA's State Revolving Fund Programs (if applicable). Each manufacturing process required for the manufacture of the construction material and the inputs of the construction material occurred in the United States, per [OMB Guidance 2 CFR 184.6](#). Detailed standard provided below.

Items, Products and/or Materials and relevant Product Service Code (PSC) and North American Industry Classification System (NAICS) code:

1. XXXX
2. XXXX
3. XXXX

Such product manufacturing process(es) took place at the following location(s): (City and State)

1. XXXX
2. XXXX
3. XXXX

If any of the above compliance statements change, we will immediately notify the subject project prime contractor.

Signature of company representative

Printed name of company representative

Professional title of company representative

Email address

Phone number

§ 184.6 Construction material standards.

- (a) The Buy America Preference applies to the following construction materials incorporated into infrastructure projects. Each construction material is followed by a standard for the material to be considered “produced in the United States.”
- (1) ***Non-ferrous metals.*** All manufacturing processes, from initial smelting or melting through final shaping, coating, and assembly, occurred in the United States.
 - (2) ***Plastic and polymer-based products.*** All manufacturing processes, from initial combination of constituent plastic or polymer-based inputs, or, where applicable, constituent composite materials, until the item is in its final form, occurred in the United States.
 - (3) ***Glass.*** All manufacturing processes, from initial batching and melting of raw materials through annealing, cooling, and cutting, occurred in the United States.
 - (4) ***Fiber optic cable (including drop cable).*** All manufacturing processes, from the initial ribboning (if applicable), through buffering, fiber stranding and jacketing, occurred in the United States. All manufacturing processes also include the standards for glass and optical fiber, but not for non-ferrous metals, plastic and polymer-based products, or any others.
 - (5) ***Optical fiber.*** All manufacturing processes, from the initial preform fabrication stage through the completion of the draw, occurred in the United States.
 - (6) ***Lumber.*** All manufacturing processes, from initial debarking through treatment and planing, occurred in the United States.
 - (7) ***Drywall.*** All manufacturing processes, from initial blending of mined or synthetic gypsum plaster and additives through cutting and drying of sandwiched panels, occurred in the United States.
 - (8) ***Engineered wood.*** All manufacturing processes from the initial combination of constituent materials until the wood product is in its final form, occurred in the United States.

The following information is provided as a sample letter of certification for **BABA** compliance for **Iron/Steel Products**. **Documentation must be provided on company letterhead.**

Date

Company Name

Company Address

City, State Zip

Subject: Build America, Buy America Act Certification for Project XXXXXXXXXXXX (must state the water/wastewater system name, location, and/or project/contract title, that is specific and recognizable enough to easily associate it with this particular project)

I, (company representative), certify that the (initial melting, reheating, refining, forming, rolling, drawing, finishing, fabricating, coating, assembly) of the following products and/or materials shipped/provided to the subject project are in full compliance with the American Iron and Steel Requirement (AIS) (if applicable), and for the iron/steel category of products in the Build America, Buy America Act requirement, as mandated in the Infrastructure Investment and Jobs Act (IIJA) Pub. L. No. 117-58, §§ 70901-52 and in EPA's State Revolving Fund Programs (if applicable).

Items, Products and/or Materials and relevant Product Service Code (PSC) and North American Industry Classification System (NAICS) code:

1. XXXX
2. XXXX
3. XXXX

Such product manufacturing process(es) took place at the following location: (City and State)

Initial Melting location: (City and State)

Bending, Cutting, etc location: (City and State; list out each step taken by a different manufacturer or producer)

If any of the above compliance statements change, we will immediately notify the subject project prime contractor.

Signature of company representative

Printed name of company representative

Professional title of company representative

Email address

Phone number

The following information is provided as a sample letter of certification for **BABA** compliance for **Manufactured Products**. **Documentation must be provided on company letterhead.**

Date

Company Name

Company Address

City, State Zip

Subject: Build America, Buy America Act Certification for Project XXXXXXXXXXXX (must state the water/wastewater system name, location, and/or project/contract title, that is specific and recognizable enough to easily associate it with this particular project)

I, (company representative), certify that the manufactured product(s) shipped/provided to the subject project is/are in full compliance with the Build America, Buy America Act requirement as mandated in the Infrastructure Investment and Jobs Act (IIJA) Pub. L. No. 117-58, §§ 70901-52 and in EPA's State Revolving Fund Programs (if applicable). This/these product(s) meet(s) the 55 percent component cost test, where the cost of components that are mined, produced, or manufactured in the United States is greater than 55 percent of the total cost of all components; and final manufacturing occurred in the United States.

Items, Products and/or Materials and relevant Product Service Code (PSC) and North American Industry Classification System (NAICS) code:

1. XXXX
2. XXXX
3. XXXX

Final product manufacturing process(es) took place at the following location(s): (City and State)

1. XXXX
2. XXXX
3. XXXX

If any of the above compliance statements change, we will immediately notify the subject project prime contractor.

Signature of company representative

Printed name of company representative

Professional title of company representative

Email address

Phone number

Disadvantaged Business Enterprise Program (DBE) Guidance

Important note: All OWRB and EPA forms can be found at www.owrb.ok.gov/forms

The Oklahoma CWSRF receives a portion of their funding from the U.S. Environmental Protection Agency (EPA). The federal funds are used to supplement low interest rate loans to finance wastewater and water quality projects. As a condition of federal grant awards, EPA regulations require that loan recipients and sub-recipients (i.e., prime contractors and subcontractors) make a good-faith effort to award a fair share of work to DBE's who are small business enterprises (SBE's), minority business enterprises (MBE's) and women's business enterprises (WBE's). Additionally, EPA's DBE rule requires loan recipients and sub-recipients adhere to the terms and conditions on Appendix A attached hereto.

To ensure compliance with EPA's DBE requirements, both **Loan Recipients (Project Owners)** and **Prime Contractors must** undertake the good faith efforts to provide opportunities for DBE firms to participate in contracts. EPA regulations require evidence of the demonstration of the six good faith efforts in trying to achieve the DBE participation goals. Oklahoma's negotiated DBE participation goals with EPA can be found on the [OWRB Financial Assistance website](http://www.owrb.ok.gov/financial-assistance). The goals are not a quota. The Oklahoma Department of Transportation has developed a DBE Directory of Certified Firms. This database can be found at this website: <https://okdot.gob2g.com/Default.asp>

Good Faith Efforts: The following good faith efforts apply to the procurement categories involving CWSRF financial assistance funds (See Appendix B: EPA Good Faith Efforts):

1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities. For state and local government recipients, this will include placing DBEs on solicitation lists and soliciting them whenever they are potential sources.
2. Make information on forthcoming opportunities available to DBEs and arrange time frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. This includes, whenever possible, posting solicitations for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.
3. Consider in the contracting process whether firms competing for large contracts could subcontract with DBEs. For state and local government recipients, this will include dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.

4. Encourage contracting with a consortium of DBEs when a contract is too large for one of these firms to handle individually.
5. Use the services and assistance of the Small Business Administration (SBA) and the Minority Business Development Agency of the Department of Commerce.
6. If the prime contractor awards subcontracts, require the prime contractor to take the above steps.

Please submit all information to:

Financial Assistance Division, OWRB
3800 North Classen Blvd, Oklahoma City, OK 73118
Phone: 405.530.8800, FAX: 405.530.8900
<http://www.owrb.ok.gov>

Demonstration of the Six Good Faith Efforts. See **Appendices A & B** for additional bidding instructions and contract administrative provisions.

A: Project Owners are required to create and maintain a bidders list in accordance with Subpart E of Part 33 of EPA's Disadvantaged Business Enterprise Program rule, (§ 33.501(b)). The list must include all firms that bid or quote on prime contracts, or bid or quote subcontracts, on competitively bid CWSRF funded projects. The bidders list must only be kept until the project period for the identified loan has ended. The following information must be obtained from all prime and subcontractors and can be provided on **Bidders List (ORF-249)**:

1. Entity's name with point of contact
2. Entity's mailing address, telephone number, and e-mail address
3. The procurement on which the entity bid or quoted, and when; and
4. Entity's status as an MBE/WBE or non-MBE/WBE

B: Project Owners are required to undertake good faith efforts. Steps 1 through 5 can be utilized during the project planning, design and/or pre-bidding phase, to assure that qualified DBE firms have procurement opportunities in construction, equipment, services, and supplies.

To provide procurement opportunities to DBE Firms, the Project Owner should undertake the following:

- Conduct pre-bid meetings to inform potential bidders/contractors about DBE requirements and provide guidance in undertaking the required good faith efforts.

- Use listings of certified DBEs from the U.S. Small Business Administration (SBA), Oklahoma Department of Transportation (ODOT), etc, to solicit DBE firms as prime contractors whenever they are potential candidates. Project Owners should advertise in minority, local and regional newspapers and in the Dodge report.
- Invite DBE firms, where appropriate, to meetings, conferences etc., to inform them of procurement opportunities and develop, where possible, reasonable contract and delivery schedules that encourage and facilitate participation by DBE's. This includes, whenever possible, a minimum of 30 calendar days for bids or request for proposals.
- Determine if a project can be broken down into smaller components/contracts to allow opportunity for DBE firms to bid both as prime-contractors and as sub-contractors.
- For projects broken down into smaller components (e.g., painting, roofing, excavation, pipe laying, etc.,) ensure that the delivery schedules are reasonable.
- Encourage DBE firms, where appropriate, to apply as a consortium of DBE's, when a contract is too large for one of these firms to handle individually.
- **Require prime contractor** to complete **ORF Form 6100-3 & ORF Form 6100-4** and submit with bid proposal to Project Owner.

C: Project Owners must require the prime contractor to undertake steps 1 through 5 of the Good Faith Efforts in providing DBE firms opportunity for sub-contracts.

Project Owner must provide the **DBE Guidance (ORF-267)** and associated forms to Prime Contractors for utilization of DBE's in the bidding documents.

**APPENDIX A: Project Owner, Prime Contractor and
Sub-Contractor Responsibilities**

EPA's Disadvantaged Business Enterprise Program rule applies to contract procurement actions funded in part by EPA assistance agreements awarded after May 27, 2008. The rule is found at Federal regulation Title 40, Part 33. Specific responsibilities are highlighted below.

Project Owner Responsibilities:

- Include OWRB's DBE guidance (ORF-267) in each contract with a primary contractor.
- Employ the six Good Faith Efforts during prime contractor procurement (§33.301).
- Require prime contractor to comply with the following prime contractor requirements of Title 40 Part 33:
 - a) To employ the six Good Faith Efforts steps in paragraphs (a) through (e) of § 33.301 if the prime contractor awards subcontracts (§ 33.301(f)).
 - b) To provide **ORF form 6100-2 – DBE Subcontractor Participation Form to all DBE subcontractors** (Optional submittal by subcontractors) (§ 33.302(e)).
 - c) To submit **ORF form 6100-3 – DBE Program Subcontractor Performance Form and ORF form 6100-4 – DBE Program Subcontractor Utilization Form with bid package or proposal.** (§ 33.302 (f) and (g)).
 - d) To pay its subcontractor for satisfactory performance no more than 30 days from the prime contractor's receipt of payment from the recipient (§ 33.302(a)).
 - e) To notify recipient in writing by its prime contractor prior to any termination of a DBE subcontractor for convenience by the prime contractor (§ 33.302(b)).
 - f) To employ the six good faith efforts described in § 33.301 if soliciting a replacement subcontractor after a DBE subcontractor fails to complete work under the subcontract for any reason. (§ 33.302(c)).
 - g) To employ the six good faith efforts described in § 33.301 even if the prime contractor has achieved its fair share objectives under subpart D of Part 33. (§33.302(d)).

- h) Provide Project Owner DBE participation achievements with bid proposal – this includes all information necessary for the Owner to complete the **Bidders List (ORF-249)**. The Owner may allow the prime contractor to complete the **Bidders List (ORF-249)**; however, the **Owner is responsible for review and submittal.**
- Maintain records documenting compliance with the requirements of Title 40 Part 33, including **Bidders List (ORF-249)** and documentation of the good faith efforts (§ 33.301(a)) by the Project Owner and prime contractor.

Prime Contractor Responsibilities:

- Employ the six Good Faith Efforts steps in paragraphs (a) through (e) of § 33.301 if the prime contractor awards subcontracts (§ 33.301(f)).
- Provide **ORF form 6100-2 – DBE Program Subcontractor Participation Form** and **ORF form 6100-3 – DBE Program Subcontractor Performance Form** to each DBE subcontractor as part of the bid conference and prior to opening of the contractor's bid or proposal (§ 33.302(e) and (f)). Complete **ORF form 6100-4 – DBE Program Subcontractor Utilization Form** (§ 33.302(g))
- Submit to recipient with bid package or proposal the completed **ORF form 6100-4**, plus an **ORF form 6100-3** for each DBE subcontractor used in the contractor's bid or proposal (§ 33.302(f) and (g)).
- Pay subcontractors for satisfactory performance no more than 30 days from the prime contractor's receipt of payment from the Project Owner (§ 33.302(a)).
- Notify the recipient in writing prior to prime contractor termination of a DBE subcontractor for convenience (§ 33.302(b)).
- Employ the six good faith efforts described in (§ 33.301) if soliciting a replacement subcontractor after a DBE subcontractor fails to complete work under the subcontract for any reason. (§ 33.302(c)).
- Employ the six good faith efforts described in (§ 33.301) even if the prime contractor has achieved its fair share objectives under subpart D of Part 33. (§33.302(d)).
- Provide Project Owner DBE participation achievements with bid proposal. This includes information necessary for Owner's completion of the **Bidders List (ORF-249)**.

- Maintain records documenting its compliance with the requirements of Title 40 Part 33, including **Bidders List (ORF-249)** and documentation of the good faith efforts (§ 33.301(a)) by the Project Owner and prime contractor.

Subcontractor Responsibilities:

- May submit **ORF form 6100-2 – DBE Subcontractor Participation Form** to Debra Bradford, EPA Region 6 DBE Coordinator (§ 33.302(e)). Submitted if concerns with EPA funded project (e.g. termination, late payment, etc.)
- Must complete **ORF form 6100-3 – DBE Program Subcontractor Performance Form**, and submit it to the prime contractor soliciting services from the subcontractor prior to the opening of bids for the prime contract.

Summary of ORF Forms

ORF Form	Requirement	Provided By	Completed By	Submitted To
6100-2: DBE Subcontractor Participation Form	Project Owners required to have prime contractors provide form to Subcontractors	Prime Contractors to DBE Subcontractors	DBE Subcontractors if concerns with EPA funded project (e.g. termination, late payment, etc)	EPA Region 6 DBE Coordinator, Debora Bradford
6100-3: DBE Subcontractor Performance Form	Project Owners required to have prime contractors provide form to Subcontractors	Prime Contractors to DBE Subcontractors	DBE Subcontractors with Prime Contractor's Signature. Completed when bidding on a job.	Project Owners as part of a bid or proposal package
6100-4: DBE Subcontractor Utilization Form	Project Owners required to have prime contractors complete the form	Project Owners to Prime Contractors	Prime Contractors to indicate the utilization of a DBE.	Project Owners as part of bid or proposal

APPENDIX B: TITLE 40 PART 33 SUBPART C—GOOD FAITH EFFORTS

§ 33.102 When do the requirements of this part apply?

The requirements of this part apply to procurement under CWSRF financial assistance agreements performed entirely within the United States, whether by a Project Owner or its prime contractor, for construction, equipment, services, and supplies.

§ 33.106 What assurances must CWSRF financial assistance recipients obtain from their contractors?

The recipient must ensure that each procurement contract it awards contains the term and condition specified in Appendix A to this part concerning compliance with the requirements of this part.

§ 33.206 Is there a list of certified MBEs and WBEs?

The Oklahoma Department of Transportation has developed a DBE Directory of Certified Firms. This database can be found at this website: <https://okdot.gob2g.com/Default.asp>. There may be other DBEs outside of this database.

§ 33.301 What does this subpart require?

A recipient, including one exempted from applying the fair share objective requirements by §33.411, is required to make the following good faith efforts whenever procuring construction, equipment, services and supplies under an CWSRF financial assistance agreement, even if it has achieved its fair share objectives under subpart D of this part:

- a) Ensure DBE's are made aware of contracting opportunities fully practicable through outreach and recruitment activities. For State and Local and Government recipients, this will include placing DBEs on solicitation lists and soliciting them whenever they are potential sources.
- b) Make information on forthcoming opportunities available to DBE's, arrange periods for contracts, and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBE's in the competitive process. This includes, whenever possible, posting solicitations for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.

- c) Consider in the contracting process whether firms competing for large contracts could subcontract with DBE's. For state and local Government recipients, this will include dividing total requirements when economically feasible into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.
- d) Encourage contracting with a consortium of DBE's when a contract is too large for one of these firms to handle individually.
- e) Use the services and assistance of the SBA and the Minority Business Development Agency of the Department of Commerce.
- f) If the prime contractor awards subcontracts, require the prime contractor to take the steps in paragraphs (a) through (e) of this section.

§ 33.302 Are there any additional contract administration requirements?

- a) Project Owners must require its prime contractor to pay its subcontractor for satisfactory performance no more than 30 days from the prime contractor's receipt of payment from the recipient.
- b) Its prime contractor must notify Project Owner in writing prior to any termination of a DBE subcontractor for convenience by the prime contractor.
- c) If a DBE subcontractor fails to complete work under the subcontract for any reason, the recipient must require the prime contractor to employ the six good faith efforts described in § 33.301 if soliciting a replacement subcontractor.
- d) A Project Owner must require its prime contractor to employ the six good faith efforts described in §33.301 even if the prime contractor has achieved its fair share objectives under §33.301 subpart D above.
- e) A recipient must require its prime contractor to provide **ORF Form 6100-2**—DBE Program Subcontractor Participation Form to all of its DBE subcontractors. **ORF Form 6100-2** gives a DBE subcontractor the opportunity to describe the work the DBE subcontractor received from the prime contractor, how much the DBE subcontractor was paid and any other concerns the DBE subcontractor might have, for example reasons why the DBE subcontractor believes it was terminated by the prime contractor. DBE subcontractors may send completed copies of **ORF Form 6100-2** directly to the appropriate EPA DBE Coordinator.
- f) A recipient must require its prime contractor to have its DBE subcontractors complete **ORF Form 6100-3**—DBE Program Subcontractor Performance Form. A recipient must then require its prime contractor to include all completed forms as part of the prime contractor's bid or proposal package.
- g) A recipient must require its prime contractor to complete and submit **ORF Form 6100-4**—DBE Program Subcontractor Utilization Form as part of the prime contractor's bid or proposal package.

- h) Copies of **ORF Form 6100–2**—DBE Program Subcontractor Participation Form, **ORF Form 6100–3**—DBE Program Subcontractor Performance Form and **ORF Form 6100–4**—DBE Program Subcontractor Utilization Form may be obtained from EPA OSDDBU's Home Page on the Internet or directly from EPA OSDDBU.
- i) A recipient must ensure that each procurement contract it awards contains the term and condition specified in the Appendix A concerning compliance with the requirements of this part. A recipient must also ensure that this term and condition is included in each procurement contract awarded by an entity receiving an identified loan under a financial assistance agreement to capitalize a revolving loan fund.

§ 33.410 Can a recipient be penalized for failing to meet its fair share objectives?

A recipient cannot be penalized, or treated by EPA as being in noncompliance with this subpart, solely because it's MBE or WBE participation does not meet its applicable fair share objective. However, EPA may take remedial action under § 33.105 for a recipient's failure to comply with other provisions of this part, including, but not limited to, the good faith efforts requirements described in subpart C of this part.

Source: *Federal Requirements and Contract Provisions for Special Appropriation Act Projects, US Environmental Protection Agency, Region III, June 2008*

**APPENDIX C: RESOURCE LISTING CONTACT INFORMATION FOR
UTILIZATION OF MINORITY AND WOMEN'S BUSINESS ENTERPRISES**

Resource Listing	Contact Information	Website
U.S. Small Business Administration (SBA) In addition to the national office, the SBA has local district and regional offices to assist small businesses in contracting with the public and private sector.	US Small Business Administration 409 3rd St, SW Washington DC 20416 Phone: 800-827-5722	https://www.sba.gov/
U. S. Small Business Administration (SBA) - OK. District Office	301 NW 6 th St. Oklahoma City, OK 73102 Phone: 405.609.0800	https://www.sba.gov/offices/district/ok/oklahoma-city
Minority Business Development Administration (MBDA): The MBDA is an agency within the U.S. Dept. of Commerce, created to foster the development and growth of minority businesses in the U.S. and coordinates resources in the public and private sectors to help MBEs.	1401 Constitution Ave NW Washington, D.C. 20230 Email: support@mbda.gov Phone: (202) 482-2000	http://www.mbda.gov/
Standard Industrial Classification Codes (SIC) or North American Industry Classification System (NAICS) codes visit the websites.	U.S. Bureau of Labor Statistics Postal Square Building, 2 Massachusetts Ave. NE Washington, DC 20212-0001 Phone: 1-202-691-5200	http://www.bls.gov/iag/tgs/iag_index_naics.htm
Oklahoma Department of Transportation (ODOT) and the Minority/Disadvantaged Business Enterprise (ODOT – MBE/DBE). Project Owners and bidders may locate qualified M/WBE's through the MBE/WBE Directory	200 NE 21 st Street Oklahoma City, OK 73105 Phone: 405.521.2082	https://okdot.gob2g.com/Default.asp

US EPA Office of Small and Disadvantaged Business Utilization (OSDBU): advocates and advances the business, regulatory, and environmental compliance concerns of small and socio-economically disadvantaged businesses. The Small Business Vendor Profile System contains information of number of small and disadvantaged companies registered with OSDBU.	USEPA Office of Small Programs 1200 Pennsylvania Ave. NW Mail Code 1230T Washington, D.C. 20460 Phone: 202 566-2075	http://cfpub.epa.gov/sbvps/ Select “search the OSBP Registry” and click on the search criteria of interest (ethnicity, size, SIC, etc.)
National Black Chamber of Commerce	4400 Jenifer St NW #331, Washington, DC 20015 Phone: 202 466-6888 Fax: 202 466-4918 Email: info@nationalbcc.org	http://www.nationalbcc.org
U.S. Hispanic Chamber of Commerce	424 K St NW #401, Washington, DC 20005 Phone: (202) 842-1212	http://www.usbcc.com
National Association of Minority Contractors (NAMC)	910 17th Street, NW, Suite 413 Washington, DC 20006 Phone: 202.296.1600 info@namcnational.org	http://namcnational.org/
National Association of Women’s Business Owners (NAWBO)	601 Pennsylvania Ave NW South Building, Ste 900 Washington, DC 20004 Phone: 800-556-2926 Fax: 202-403-3788	www.nawbo.org
National Minority Supplier Development Council, Inc. (NMSDC)	1359 Broadway, 10th Floor, Suite 1000 New York, NY 10018 Phone: (212) 944-2430 Fax: (212) 719-9611	http://www.nmsdc.org/

Native American Development Corporation (NADC) - provides technical assistance, financial lending opportunities, and champions small businesses	17 N. 26th St. Billings, MT 59101 Phone: (406) 259-3804 Fax: (406) 259-4569 Email: nadcptac@nadc-nabn.org	http://www.nadc-nabn.org/
City of Tulsa - Human Rights Department Maintains a list of Minority and Female business Enterprises that are certified through the “building Resources in Developing and Growing Enterprises	175 E. 2nd St. Tulsa, OK. 74103 Phone: (918) 596-7818	https://www.cityoftulsa.org/government/departments/resilience-and-equity/small-business-enterprise-program/ Click on the ‘member list”
Southwest Minority Supplier Development Council: Maintains lists of certified Minority Business Enterprises in Oklahoma	7301 Broadway Ext Ste 224, OKC, OK 73116 Phone: (405) 767-9900	http://www.smsdc.org/
National Association of Women in Construction (NAWIC)	327 S. Adams Street Fort Worth, TX 76104 Phone: 800-552-3506 817.877.5551 Fax: 817.877.0324	http://www.nawic.org/
Oklahoma Department of Central Services Maintains a list of MBE/WBEs	OMES Central Purchasing 5005 N. Lincoln Blvd., Suite 300 OKC, OK 73105 Phone: 405-522-0955	https://omes.ok.gov/services/purchasing
Bureau of Indian Affairs - Maintains a list of Native American Contractors and Suppliers by Trade	P.O. Box 368 (1 Mile North on Hwy 281) Anadarko, OK 73005 Phone: (405) 247-6673 Fax: (405) 247-5611	https://www.bia.gov/as-ia/ieed/division-economic-development/native-american-business-development
Oklahoma Department of Commerce Certification Programs and information	900 N Stiles Ave. Oklahoma City, OK 73104 Phone: (405) 815-6552 Toll-Free: (800) 879-6552	https://okcommerce.gov/business/certifications/
Cherokee Nation Tribal Employment Rights Office - Maintains a directory of Indian-owned businesses	Cherokee Nation TERO Dept. P.O. Box 948 Tahlequah, OK 74465 Phone: (918) 453-5334 or Toll Free: 800-256-0671 ext 5334	http://cherokeetero.com/

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form

OWRB Financial Assistance Agreement recipients must require prime contractors to provide this form to their DBE¹ subcontractors². This form gives a DBE subcontractor the opportunity to describe work received and/or report any concerns regarding the project.

Subcontractor Name _____	Project Name _____
Bid Proposal # _____	Point of Contact _____
Address _____	
Phone _____	e-mail _____
Prime Contractor Name _____	Funding Entity Oklahoma Water Resources Board

Contract Item Number	Description of Work Received from the Prime Contractor Involving Construction, Services, Equipment or Supplies	Amount Received from Prime Contractor

¹ A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

² Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form

This form is intended to capture the DBE¹ subcontractor's² description of work to be performed and the price of the work submitted to the prime contractor. OWRB Financial Assistance Agreement Recipients must require prime contractors to provide this form to their DBE subcontractors.

Subcontractor Name _____	Project Name _____
Bid Proposal # _____	Point of Contact _____
Address _____	
Phone _____	e-mail _____
Prime Contractor Name _____	Funding Entity Oklahoma Water Resources Board

Contract Item Number	Description of Work Received from the Prime Contractor Involving Construction, Services, Equipment or Supplies	Price of Work Submitted to the Prime Contractor

DBE Certified by: ☐ DOT ☐ SBA ☐ Other: _____
 Meets or exceeds EPA certification standards? ☐ Yes ☐ No ☐ Unknown

¹ A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

² Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does not signify a commitment to utilize the subcontractors above. I am aware of that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 (c).

Prime Contractor signature	Print Name
Title	Date

Subcontractor signature	Print Name
Title	Date

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Utilization form

This form is intended to capture the prime contractor's actual and/or anticipated use of identified certified DBE¹ subcontractors² and the estimated dollar amount of each subcontract. OWRB Financial Assistance Agreement recipients must require their prime contractors to complete this form and include it in the bid or proposal package. Prime contractors should also maintain a copy of this form on file.

Prime Contractor Name _____	Project Name _____		
Bid Proposal # _____	Point of Contact _____		
Address _____			
Phone _____	e-mail _____		
Funding Entity Oklahoma Water Resources Board	I have identified potential DBE certified subcontractors: ☐ YES ☐ NO		
If yes, please complete the table below. If no, please explain: _____			
Subcontractor Name/ Company Name	Address/Phone/Email	Estimated \$ Amount	Currently Certified?

¹ A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

² Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does not signify a commitment to utilize the subcontractors above. I am aware of that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 (c).

Prime Contractor signature	Print Name
Title	Date

Davis Bacon compliance software requirements

The _____ (hereafter the Owner) has decided to use a Davis Bacon compliance software provided by Elation Systems. This is a cloud-based software that simplifies compliance with Davis Bacon Act, and that is provided free of charge for State Revolving Fund (SRF) projects.

In order for bidders to be considered eligible, it is mandatory that they agree to use the Elation Systems software throughout the life of the project, and work with the Owner and funding agency to ensure all required information is provided in a timely manner. Failure to do this could result in an event of default and the Owner shall have all the rights and remedies at law or equity as may be allowed by law including but not limited to the termination of the Contract.

For more information related to the Elation Systems software, please visit www.elationsys.com or contact OWRB at (405) 530-8800.

I, _____, representing _____ (the Bidder) agree to create a free account in the Elation Systems software, and to upload all necessary information to their website to verify compliance with the Davis Bacon Act.

Bidder's Authorized Representative signature

____/____/____
Date

DEBARMENT / SUSPENSION CERTIFICATION

I, _____, hereby certify that I have checked on the
(Authorized Representative of Recipient)

federal System for Award Management (www.sam.gov) website and determined that
_____ is not shown as an “excluded party” that is

(Name of entity)

debarred, suspended or otherwise excluded from or ineligible for participation in federal assistance programs under Executive Order 12549. (See 2 CFR Part 180 and 2 CFR Part 1532 for additional information on the federal governmentwide debarment and suspension system for nonprocurement programs and activities.)

I understand that a false statement herein may subject me to penalties under federal and state laws relating to filing false statements and other relevant statutes.

Signature

Date

Title

Name of Recipient

Verifying prime contractors and subcontractors for construction, equipment, supplies and services: Using the www.sam.gov website, the recipient must verify prior to awarding the contract that the prime contractor is not listed as an “excluded party” that is debarred, suspended or otherwise excluded from or ineligible. Once any subcontractors are known, they also must be verified as not listed as an “excluded party” prior to award of a subcontract. The recipient must print a dated record of the verification from the www.sam.gov website and retain a copy that is available for review by OWRB. The prime contractors and subcontractors must be verified prior to the contract award or the costs may be disallowed.

The undersigned authorized representatives:

_____, representing _____ (Owner),

_____, representing _____ (Engineer),

_____, representing _____ (Contractor),

for _____,

Brief description of Contract

hereby certify that:

The contract or portion of the contract funded by the Oklahoma Water Resources Board (OWRB) through loan ORF-__-____- CW, was completed on _____, and a final inspection of the completed work was conducted on _____.

The above referenced contract or portion of contract was constructed in accordance with the approved Plans and Specifications, and all applicable laws, rules and regulations. All completed construction items are in operation and have been accepted by the Owner. All relevant federal and state CWSRF requirements were complied with. All requests for loan proceeds relevant to the contract or portion of contract have been drawn as per the Final Pay Request and none of the expenses incurred under this contract or portion of contract have been requested more than once.

The as-built plans, if applicable, have been provided to the Oklahoma Department of Environmental Quality (ODEQ). The Contractor has been paid in full for the contract or portion of contract completed being closed out, in accordance with the Contract Agreement, pending receipt of the amount retained. The Contractor has paid in full for all materials purchased and all labor employed, and there are no claims against the Contractor as an employer under this contract or portion of contract on account of injuries sustained by workmen employed by the Contractor. The Contractor releases the Owner from any claims arising by virtue of this contract or portion of contract.

☐ (Check if applicable) OWRB is hereby authorized to de-obligate any remaining loan proceeds.

Owner's authorized representative signature

Date

Engineer's authorized representative signature

Date

Contractor's authorized representative signature

Date

<https://sam.gov/content/wage-determinations>

INSERT CURRENT WAGE DECISIONS THAT APPLY
TO THE CONSTRUCTION PROJECT HERE
IN CONTRACT SPECIFICATIONS

See Requirements in ORF-185

DAVIS-BACON WAGE DECISION

OKLAHOMA WATER RESOURCES BOARD

Supplemental Conditions

for

Projects funded from the

Clean Water State Revolving Loan Fund

RULES AND REGULATIONS

TITLE 41 - PUBLIC CONTRACT AND PROPERTY MANAGEMENT

CHAPTER 60 - OFFICE OF FEDERAL CONTRACT COMPLIANCE PROGRAMS, EQUAL EMPLOYMENT OPPORTUNITY, DEPARTMENT OF LABOR COMPLIANCE RESPONSIBILITY FOR EQUAL EMPLOYMENT OPPORTUNITY FINAL RULE

60-1.4 Equal opportunity clause.

(b) Federally assisted construction contracts.

(1) Except as otherwise provided, each administering agency shall require the inclusion of the following language as a condition of any grant, contract, loan, insurance, or guarantee involving federally assisted construction which is not exempt from the requirements of the equal opportunity clause:

The applicant hereby agrees that it will incorporate or cause to be incorporated into any contract for construction work, or modification thereof, as defined in the regulations of the Secretary of Labor at 41 CFR Chapter 60, which is paid for in whole or in part with funds obtained from the Federal Government or borrowed on the credit of the Federal Government pursuant to a grant, contract, loan insurance, or guarantee, or undertaken pursuant to any Federal program involving such grant, contract, loan, insurance, or guarantee, the following equal opportunity clause:

During the performance of this contract, the contractor agrees as follows:

(1) The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, or national origin. such action shall include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

- (2) The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive considerations for employment without regard to race, color, religion, sex, or national origin.
- (3) The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
- (4) The contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
- (5) The contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
- (6) In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as

otherwise provided by law.

- (7) The contractor will include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, That in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency the contractor may request the United States to enter into such litigation to protect the interests of the United States.

The applicant further agrees that it will be bound by the above equal opportunity clause with respect to its own employment practices when it participates in federally assisted construction work: Provided, That if the applicant so participating is a State or local government, the above equal opportunity clause is not applicable to any agency, instrumentality or subdivision of such government which does not participate in work on or under the contract.

The applicant agrees that it will assist and cooperate actively with the administering agency and the Secretary of Labor in obtaining the compliance of contractors and subcontractors with the equal opportunity clause and the rules, regulations, and relevant orders of the Secretary of Labor, that it will furnish the administering agency and the Secretary of Labor such information as they may require for the supervision of such compliance, and that it will otherwise assist the administering agency in the discharge of the agency's primary responsibility for securing compliance.

The applicant further agrees that it will refrain from entering into any contract or contract modification subject to Executive Order 11246 of September 24, 1965, with a contractor debarred from, or who has not demonstrated eligibility for, Government contracts and federally assisted construction contracts pursuant to the Executive order and will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by the administering

agency or the Secretary of Labor pursuant to Part II, Subpart D of the Executive order. In addition, the applicant agrees that if it fails or refuses to comply with these undertakings, the administering agency may take any or all of the following actions: Cancel, terminate, or suspend in whole or in part this grant (contract, loan, insurance, guarantee); refrain from extending any further assistance to the applicant under the program with respect to which the failure or refund occurred until satisfactory assurance of future compliance has been received from such applicant; and refer the case to the Department of Justice for appropriate legal proceedings.

- (c) Subcontracts. Each nonexempt prime contractor or subcontractor shall include the equal opportunity clause in each of its nonexempt subcontracts.
- (d) Incorporation by reference. The equal opportunity clause may be incorporated by reference in all Government contracts and subcontracts, including Government bills of lading, transportation requests, contracts for deposit of Government funds, and contracts for issuing and paying U.S. savings bonds and notes, and such other contracts and subcontracts as the Deputy Assistant Secretary may designate.
- (e) Incorporation by operation of the order. By operation of the order, the equal opportunity clause shall be considered to be a part of every contract and subcontract required by the order and the regulations in this part to include such a clause whether or not it is physically incorporated in such contracts and whether or not the contract between the agency and the contractor is written.
- (f) Adaptation of language. Such necessary changes in language may be made in the equal opportunity clause as shall be appropriate to identify properly the parties and their undertakings.
[43 FR 49240, Oct. 20, 1978, as amended at 62 FR 66971, Dec. 22, 1997]

60-4.2 Solicitations.

- (a) All Federal contracting officers and all applicants shall include the notice set forth in paragraph (d) of this section and the Standard Federal Equal Employment Opportunity Construction Contract Specifications set forth in § 60-4.3 of this part in all solicitations for offers and bids on all Federal and federally assisted construction contracts or subcontracts to be performed in geographical areas designated by the Director pursuant to § 60-4.6 of the part. Administering agencies shall require the inclusion of the notice set forth in paragraph (d) of this section and the specifications set forth in § 60-4.3 of this part as a condition of any grant, contract, subcontract, loan, insurance

- or guarantee involving federally assisted construction covered by this Part 60-4.
- (b) All nonconstruction contractors covered by Executive Order 11246 and the implementing regulations shall include the notice in paragraph (d) of this section in all construction agreements which are necessary in whole or in part to the performance of the covered nonconstruction contract.
 - (c) Contracting officers, applicants and nonconstruction contractors shall give written notice to the Director within 10 working days of award of a contract subject to these provisions. The notification shall include the name, address and telephone number of the contractor; employer identification number; dollar amount of the contract, estimated starting and completion dates of the contract; the contract number; and geographical area in which the contract is to be performed.
 - (d) The following notice shall be included in, and shall be a part of, all solicitations for offers and bids on all Federal and federally assisted construction contracts or subcontracts in excess of \$10,000 to be performed in geographical areas designated by the Director pursuant to § 60-4.6 of this part (see 41 CFR 60-4.2(a)):

Notice of Requirement for Affirmative Action To Ensure Equal Employment Opportunity (Executive Order 11246)

1. The Offeror's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Specifications" set forth herein.
2. The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Goals for MBE
 CONSTRUCTION 13.94%; SUPPLIES - 7.48%;
 SERVICES - 14.29%; EQUIPMENT - 9.13%

Goals for WBE
 CONSTRUCTION - 6.92%; SUPPLIES - 0%;
 SERVICES - 26.51%; EQUIPMENT - 19.90%

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such

geographical area where the work is actually performed. With regard to this second area, the contractor also is subject to the goals for both its federally involved and nonfederally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of \$10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.
4. As used in this Notice, and in the contract resulting from this solicitation, the "covered area" is (insert description of the geographical areas where the contract is to be performed giving the state, county and city, if any).

[43 FR 49254, Oct. 20, 1978; 43 FR 51401, Nov. 3, 1978, as amended at 45 FR 65977, Oct. 3, 1980]

60-4.3 Equal opportunity clauses.

- (a) The equal opportunity clause published at 41 CFR 60-1.4(a) of this chapter is required to be included in, and is part of, all nonexempt Federal contracts and subcontracts, including construction contracts and subcontracts. The equal opportunity clause published at 41 CFR 60-1.4(b) is required to be included in, and is a part of, all nonexempt federally assisted construction contracts and subcontracts. In addition to the clauses described

above, all Federal contracting officers, all applicants and all nonconstruction contractors, as applicable, shall include the specifications set forth in this section in all Federal and federally assisted construction contracts in excess of \$10,000 to be performed in geographical areas designated by the Director pursuant to § 60-4.6 of this part and in construction subcontracts in excess of \$10,000 necessary in whole or in part to the performance of nonconstruction Federal contracts and subcontracts covered under the Executive order.

Standard Federal Equal Employment Opportunity Construction Contract Specifications (Executive Order 11246)

1. As used in these specifications:
 - a. "Covered area" means the geographical area described in the solicitation from which this contract resulted;
 - b. "Director" means Director, Office of Federal Contract Compliance Programs, United States Department of Labor, or any person to whom the Director delegates authority;
 - c. "Employer identification number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.
 - d. "Minority" includes:
 - (i) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
 - (ii) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);
 - (iii) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
 - (iv) American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).
2. Whenever the Contractor, or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include

in each subcontract in excess of \$10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.

3. If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.
4. The Contractor shall implement the specific affirmative action standards provided in paragraphs 7 a through p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered Construction contractors performing construction work in geographical areas where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.
5. Neither the provisions of any collective

bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

6. In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.
7. The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:
 - a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.
 - b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.
 - c. Maintain a current file of the names, addresses and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or

community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefor, along with whatever additional actions the Contractor may have taken.

- d. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.
- e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under 7b above.
- f. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.
- g. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment decisions including specific review of these items with onsite supervisory

- personnel such as Superintendents, General Foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.
- h. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and Subcontractors with whom the Contractor does or anticipates doing business.
 - i. Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.
 - j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's work force.
 - k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.
 - l. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.
 - m. Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.
 - n. Ensure that all facilities and company activities are nonsegregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.
 - o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.
 - p. Conduct a review, at least annually, of all supervisors' adherence to and performance under the Contractor's EEO policies and affirmative action obligations.
8. Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations (7a through p). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under 7a through p of these Specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.
 9. A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in

violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

10. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.
11. The Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.
12. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.
13. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.
14. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained

in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).
- (b) The notice set forth in 41 CFR 60-4.2 and the specifications set forth in 41 CFR 60-4.3 replace the New Form for Federal Equal Employment Opportunity Bid Conditions for Federal and Federally Assisted Construction published at 41 FR 32482 and commonly known as the Model Federal EEO Bid Conditions, and the New Form shall not be used after the regulations in 41 CFR Part 60-4 become effective.

[43 FR 49254, Oct. 20, 1978; 43 FR 51401, Nov. 3, 1978, as amended at 45 FR 65978, Oct. 3, 1980]

DAVIS BACON ACT REQUIREMENTS
(subchapter IV of Chapter 31 of Title 40, United States Code and 29 CFR parts 1, 3, and 5) (SEE APPENDIX 1 FOR CLARIFYING INFORMATION)

The Project or Program to which the construction work covered by this contract pertains is being assisted by the United States of America and the following Federal Labor Standards Provisions are included in this contract pursuant to the provisions applicable to such assistance.

(a) Any contract in excess of \$2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a public building or public work, or building or work financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in Sec. 5.1.

(1) Minimum wages. (i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of

Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in Sec. 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(ii)(A) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their

representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii) (B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding. The **OWRB SRF** or the **Owner** shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the contractor under this contract or any other Federal contract with

the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records. (i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the **Owner for transmission to the OWRB SRF**. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an

individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired.

Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at beta.SAM.gov or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors.

Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the **OWRB SRF** if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit them to the **Owner**, as the case may be, for transmission to the **OWRB SRF**, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the Owner.

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance" signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under Sec. 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under Sec. 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or

subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the **CWSRF** or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees--(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's

level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable

predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the (write in the name of the Federal agency) may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts.

The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility. (i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

(b) Contract Work Hours and Safety Standards Act. The following clauses set forth in paragraphs

(b)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by Sec. 5.5(a) or 4.6 of part 4 of this title. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (b)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The **Owner or the OWRB SRF** shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these

clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

(c) In addition to the clauses contained in paragraph (b), in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in Sec. 5.1, the Agency Head shall cause or require the contracting officer to insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Agency Head shall cause or require the contracting officer to insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the **Owner or OWRB SRF** and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

WAGE RATE REQUIREMENTS

Notwithstanding any other provision of law and in a manner consistent with other provisions, all laborers and mechanics employed by contractors and subcontractors on projects funded directly by or assisted in whole or in part with CWSRF funds shall be paid wages at rates not less than those prevailing on projects of a character similar in the locality as determined by the Secretary of Labor in accordance with subchapter IV of chapter 31 of title 40, United States Code. With respect to the labor standards specified in this section, the Secretary of Labor shall have the authority and functions set forth in Reorganization Plan Numbered 14 of 1950 (64 Stat. 1267; 5 U.S.C. App.) and section 3145 of title 40, United States Code.

See Appendix 1 for clarifying information.

Build America, Buy America

P.L 117-58, Infrastructure Investment and Jobs Act, 2021, Title IX Build America, Buy America, section 70914.

(a) **IN GENERAL.**—Not later than 180 days after the date of enactment of this Act, the head of each Federal agency shall ensure that none of the funds made available for a Federal financial assistance program for infrastructure, including each deficient program, may be obligated for a project unless all of the iron, steel, manufactured products, and construction materials used in the project are produced in the United States.

(b) **WAIVER.**—The head of a Federal agency that applies a domestic content procurement preference under this section may waive the application of that preference in any case in which the head of the Federal agency finds that—

(1) applying the domestic content procurement preference would be inconsistent with the public interest;

(2) types of iron, steel, manufactured products, or construction materials are not produced in the United States in sufficient and reasonably available quantities or of a satisfactory quality; or

(3) the inclusion of iron, steel, manufactured products, or construction materials produced in the United States will increase the cost of the overall project by more than 25 percent.

2 CFR Part 184.3

Construction materials means articles, materials, or supplies that consist of only one of the items listed in paragraph (1) of this definition, except as provided in paragraph (2) of this definition. To the extent one of the items listed in paragraph (1) contains as inputs other items listed in paragraph (1), it is nonetheless a construction material.

(1) The listed items are:

(i) Non-ferrous metals;

(ii) Plastic and polymer-based products

(including polyvinylchloride, composite building materials, and polymers used in fiber optic cables);

(iii) Glass (including optic glass);

(iv) Fiber optic cable (including drop cable);

(v) Optical fiber;

(vi) Lumber;

(vii) Engineered wood; and

(viii) Drywall.

(2) Minor additions of articles, materials, supplies, or binding agents to a construction material do not change the categorization of the construction material.

Iron or steel products means articles, materials, or supplies that consist wholly or predominantly of iron or steel or a combination of both.

Manufactured products means:

(1) Articles, materials, or supplies that have been:

(i) Processed into a specific form and shape; or
 (ii) Combined with other articles, materials, or supplies to create a product with different properties than the individual articles, materials, or supplies.

(2) If an item is classified as an iron or steel product, a construction material, or a section 70917(c) material under [§ 184.4\(c\)](#) and the definitions set forth in this section, then it is not a manufactured product. However, an article, material, or supply classified as a manufactured product under [§ 184.4\(c\)](#) and paragraph (1) of this definition may include components that are construction materials, iron or steel products, or section 70917(c) materials.

Predominantly of iron or steel or a combination of both means that the cost of the iron and steel content exceeds 50 percent of the total cost of all its components. The cost of iron and steel is the cost of the iron or steel mill products (such as bar, billet, slab, wire, plate, or sheet), castings, or forgings utilized in the manufacture of the product and a good faith estimate of the cost of iron or steel components.

Produced in the United States means:

(1) In the case of iron or steel products, all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States.

(2) In the case of manufactured products:

(i) The product was manufactured in the United States; and

(ii) The cost of the components of the manufactured product that are mined, produced, or manufactured in the United States is greater than 55 percent of the total cost of all components of the manufactured product, unless another standard that meets or exceeds this standard has been established under applicable law or regulation for determining the minimum amount of domestic content of the manufactured product. ***See § 184.2(a).*** The costs of components of a manufactured product are determined according to [§ 184.5](#).

(3) In the case of construction materials, all manufacturing processes for the construction material occurred in the United States. ***See § 184.6*** for more information on the meaning of “all manufacturing processes” for specific construction materials.

Section 70917(c) materials means cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives. ***See*** section 70917(c) of the Build America, Buy America Act.

SYSTEM FOR AWARD MANAGMENT (SAM)

SAM registration is required for all SRF programs (CWSRF and DWSRF) applicants and Awardees (Entities, Prime Contractors, Subcontractors, Vendors) in order to be awarded

contracts by the SRF Programs. SAM replaces Central Contractor Registration/Federal Agency Registration, Online Representations and Certifications Application, and Excluded Parties List System. Applicants and awardees are required to complete a one-time free registration to provide basic information relevant to procurement and financial transactions. Registrants must retain an active status to be eligible for SRF projects. New Applicants and Awardees can go to SAM.gov to complete the registration process.

Note: In order to register in SAM, a Data Universal Number System (DUNS) number will be required. DUNS number is a unique, non-indicative 9-digit identifier issued and maintained by Dun & Bradstreet (D&B) that verifies the existence of a business entity globally. D&B assigns DUNS numbers for each physical location of a business. All entities doing business with the U.S Government can receive a DUNS number FREE of charge and, under normal circumstances, within 1-2 business days when using D&B web form process at <http://fedgov.dnb.com/webform>.

OTHER SUPPLEMENTAL CONDITIONS

Disadvantaged Business Enterprises (DBE)

40 CFR 33.301 Contracting with disadvantaged business enterprises and labor surplus area firms.

The SRF loan recipient and subcontractors will take all necessary affirmative steps to assure that minority firms, women's business enterprises, and labor surplus area firms are used when possible.

DBE participation requirements apply to projects constructed with funds directly made available by the federal capitalization grant (equivalency projects).

(1) EPA and the State will negotiate a "Fair Share Objective" (which shall represent a percentage of DBE participation).

(2) When soliciting for a subcontractor (A/E or construction contractor), the loan recipient shall take the following six good faith efforts:

(A) Include qualified Small, DBE businesses on solicitation lists.

(B) Assure that Small, DBE businesses are solicited whenever they are potential sources.

(C) When economically feasible, divide total requirements into smaller tasks or quantities so as to permit maximum Small, DBE business participation.

(D) Where the requirements of the work permits, establish delivery schedules which will encourage participation by Small, DBE businesses.

(E) Use the services and assistance of the Small Business Administration, the Office of Minority Business Enterprise of the United States Department of Commerce, as appropriate.

(F) If any subcontracts are to be let, require the prime contractor or A/E to take the good faith efforts in (A) through (E) of this paragraph (2).

2. Affirmative Steps shall include:

(i) Placing qualified small and minority businesses and women's business enterprises on solicitation lists;

(ii) Assuring that small and minority businesses, and women's business enterprises are solicited whenever they are potential sources;

(iii) Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by small and minority business, and women's business enterprises;

(iv) Establishing delivery schedules, where the requirement permits, which encourage participation by small and minority business, and women's business enterprises;

(v) Using the services and assistance of the Small Business Administration, and the Minority Business Development Agency of the Department of Commerce; and

(vi) Requiring the prime contractor, if subcontracts are to be let, to take the affirmative steps listed in paragraphs (e)(2)(i) through (v) of this section.

Electronics

2 CFR 200.216, Section 889 of Public Law 115-232-Prohibition on certain telecommunication and video surveillance services or equipment.

Completion Date

If not stated elsewhere in these specifications, the contractor shall complete work under this contract within _____ calendar days. Time for completion shall begin on the 10th day after issuance of the work order, which shall consist of a written request by the engineer for the contractor to proceed with the construction of the project.

Contractor's Liability and Builders All Risk Insurance

The contractor shall furnish the following insurance when the contract is awarded:

(A) Workmen's Compensation: The contractor shall carry on his work in accordance with the requirements of the Workmen's Compensation Law of the State of Oklahoma, and shall not reject the provisions thereof during the life of the contract. A certificate of coverage must be returned with the contract.

(B) Public Liability and Property Damage: He shall also protect himself by liability reinsurance against any and all claims for damages to persons or property which may arise out of operations under this contract, whether such operations be by himself or a subcontractor or by anyone directly employed by either of them. Certificates of such insurance shall be file with the Owner and shall be subject to its approval as to adequacy of protection. The public liability insurance shall have limits of not less than \$100,000/\$300,000 or an amount to be determined by OWRB and Property Damage insurance of not less than \$50,000/\$100,000 or an amount to be determined by OWRB shall be carried by the contractor during the life of the contract. A certificate of such coverage must be returned with the contract.

(C) Builder's Risk: Provide Builders Risk Insurance only if called for in other sections of the specifications.

Bonds

All bonds are for the full value of the contract and must be issued by a surety company authorized by the Oklahoma Insurance Commission to do business in the State of Oklahoma. They will be required after the award of the contract.

Three bonds are required for all contracts with a value exceeding Fifty Thousand Dollars (\$50,000.00) They are: (1.) Performance Bond to insure the completion of the work in accordance with the contract documents in the time stipulated; (2.) Maintenance Bond to provide for defects in construction or materials for a period of one (1) year from the date of acceptance of the completed work; and (3.) Statutory Bond to assure the Owner is protected from the action

of subcontractors, suppliers and employees
for unpaid debts of the contractor.

Irrevocable Letters of Credit may be used as a substitute for bonds on contracts exceeding Fifty Thousand Dollars (\$50,000.00). The letters of credit must be issued by a financial institution insured by the Federal Deposit Insurance Corporation or the Federal Savings and Loan Insurance Corporation on forms obtained from the Owner.

Appendix 1

Wage Rate Requirements

I. Requirements Under The Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6) For Subrecipients That Are Governmental and Not Governmental Entities:

The following terms and conditions specify how recipients will assist EPA in meeting its Davis-Bacon (DB) responsibilities when DB applies to EPA awards of financial assistance under the FY 2013 Continuing Resolution with respect to State recipients and subrecipients that are governmental entities, and for subrecipients that are not governmental entities. If a subrecipient has questions regarding when DB applies, obtaining the correct DB wage determinations, DB provisions, or compliance monitoring, it may contact the State recipient for guidance. If a State recipient needs guidance, the recipient may contact Dannell Brown at brown.dannell@epa.gov or at 214-665-7279 of EPA, Region VI Grants and Audit Management Branch for guidance. The recipient or subrecipient may also obtain additional guidance from DOL's website at <http://www.dol.gov/whd/>.

Under these terms and conditions, the Non-Governmental subrecipient must submit its proposed DB wage determinations to the State recipient for approval prior to including the wage determination in any solicitation, contract task orders, work assignments, or similar instruments to existing contractors.

1. Applicability of the Davis- Bacon (DB) prevailing wage requirements.

Under the FY 2013 Continuing Resolution, DB prevailing wage requirements apply to the construction, alteration, and repair of treatment works carried out in whole or in part with assistance made available by a State water pollution control revolving fund and to any construction project carried out in whole or in part by assistance made available by a drinking water treatment revolving loan fund. If a subrecipient encounters a unique situation at a site that presents uncertainties regarding DB applicability, the subrecipient must discuss the situation with the recipient State before authorizing work on that site.

2. Obtaining Wage Determinations.

(a) Subrecipients must obtain wage determinations for the locality or localities in which a covered activity subject to DB will take place at www.beta.sam.gov prior to issuing requests for bids, proposals, quotes or other methods for soliciting contracts (solicitation) for activities subject to DB. After the Subrecipient obtains its proposed wage determination, it must submit the wage determination to the assigned Financial Assistance Division Engineer, Oklahoma Water Resources Board, 3800 N. Classen Blvd, Oklahoma City, OK 73118. These wage determinations shall be incorporated into solicitations and any subsequent contracts. Prime contracts must contain a provision requiring that subcontractors follow the wage determination incorporated into the prime contract.

- (i) While the solicitation remains open, the subrecipient shall monitor www.beta.sam.gov weekly to ensure that the wage determination contained in the solicitation remains current. The subrecipients shall amend the solicitation if DOL issues a modification more than 10 days prior to the closing date (i.e. bid opening) for the solicitation. If DOL modifies or supersedes the applicable wage determination less than 10 days prior to the closing date, the subrecipients may request a finding from the State recipient that there is not a reasonable time to notify interested contractors of the modification of the wage determination. The State recipient will provide a report of its findings to the subrecipient.

- (ii) If the subrecipient does not award the contract within 90 days of the closure of the solicitation, any modifications or supersedes DOL makes to the wage determination contained in the solicitation shall be effective unless the State recipient, at the request of the subrecipient, obtains an extension of the 90 day period from DOL pursuant to 29 CFR 1.6(c)(3)(iv). The subrecipient shall monitor www.beta.sam.gov on a weekly basis if it does not award the contract within 90 days of closure of the solicitation to ensure that wage determinations contained in the solicitation remain current.

(b) If the subrecipient carries out activity subject to DB by issuing a task order, work assignment or similar instrument to an existing contractor (ordering instrument) rather than by publishing a solicitation, the subrecipient shall insert the appropriate DOL wage determination from www.beta.sam.gov into the ordering instrument.

(c) Subrecipients shall review all subcontracts subject to DB entered into by prime contractors to verify that the prime contractor has required its subcontractors to include the applicable wage determinations.

(d) As provided in 29 CFR 1.6(f), DOL may issue a revised wage determination applicable to a subrecipient's contract after the award of a contract or the issuance of an ordering instrument if DOL determines that the subrecipient has failed to incorporate a wage determination or has used a wage determination that clearly does not apply to the contract or ordering instrument. If this occurs, the subrecipient shall either terminate the contract or ordering instrument and issue a revised solicitation or ordering instrument or incorporate DOL's wage determination retroactive to the beginning of the contract or ordering instrument by change order. The subrecipient's contractor must be compensated for any increases in wages resulting from the use of DOL's revised wage determination.

3. Contract and Subcontract provisions.

(a) The Recipient shall insure that the subrecipient(s) shall insert in full in any contract in excess of \$2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a treatment work under the CWSRF or a construction project under the DWSRF financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in § 5.1 or the FY 2013 Continuing Resolution, the following clauses:

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe

benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

Subrecipients may obtain wage determinations from the U.S. Department of Labor's web site, www.dol.gov.

(ii)(A) The subrecipient(s), on behalf of EPA, shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The State award official shall approve a request for an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

- (1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and
- (2) The classification is utilized in the area by the construction industry; and
- (3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the subrecipient(s) agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), documentation of the action taken and the request, including the local wage determination shall be sent by the subrecipient (s) to the State award official. The State award official will transmit the request, to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210 and to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification request within 30 days of receipt and so advise the State award official or will notify the State award official within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the subrecipient(s) do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the award official shall refer the request and the local wage determination, including the views of all interested parties and the recommendation of the State award official, to the Administrator for determination. The request shall be sent to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt of the request and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii)(B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding. The subrecipient(s), shall upon written request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly, for each week in which any contract work is performed, a copy of all payrolls to the subrecipient, that is, the entity that receives the sub-grant or loan from the State capitalization grant recipient. Such documentation shall be available on request of the State recipient or EPA. As to each payroll copy received, the subrecipient shall provide written confirmation in a form satisfactory to the State indicating whether or not the project is in compliance with the requirements of 29 CFR 5.5(a)(1) based on the most recent payroll copies for the specified week. The payrolls shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on the weekly payrolls.

Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at <http://www.dol.gov/whd/forms/wh347instr.htm> or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the subrecipient(s) for transmission to the State or EPA if requested by EPA, the State, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the subrecipient(s).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance" signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under § 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under § 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the State, EPA or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency or State may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency

recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA determines may be appropriate, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination; debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and Subrecipient(s), State, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

4. Contract Provision for Contracts in Excess of \$100,000.

(a) Contract Work Hours and Safety Standards Act. The subrecipient shall insert the following clauses set forth in paragraphs (a)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by Item 3, above or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (a)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to

each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (a)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (a)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The subrecipient, upon written request of the EPA Award Official or an authorized representative of the Department of Labor, shall withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (a)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (a)(1) through (4) of this section.

(b) In addition to the clauses contained in Item 3, above, in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1, the Subrecipient shall insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Subrecipient shall insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the (write the name of agency) and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

5. Compliance Verification

(a) The subrecipient shall periodically interview a sufficient number of employees entitled to DB prevailing wages (covered employees) to verify that contractors or subcontractors are paying the appropriate wage rates. As provided in 29 CFR 5.6(a)(6), all interviews must be conducted in confidence. The subrecipient must use Standard Form 1445 (SF 1445) or equivalent documentation to memorialize the interviews. Copies of the SF 1445 are available from EPA on request.

(b) The subrecipient shall establish and follow an interview schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. Subrecipients must conduct more frequent interviews if the initial interviews or other information indicated that there is a risk that the contractor or subcontractor is not complying with DB. Subrecipients shall immediately conduct interviews in response to an alleged violation of the prevailing wage requirements. All interviews shall be conducted in confidence."

(c) The subrecipient shall periodically conduct spot checks of a representative sample of weekly payroll data to verify that contractors or subcontractors are paying the appropriate wage rates. The subrecipient

shall establish and follow a spot check schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, if practicable, the subrecipient should spot check payroll data within two weeks of each contractor or subcontractor's submission of its initial payroll data and two weeks prior to the completion date the contract or subcontract . Subrecipients must conduct more frequent spot checks if the initial spot check or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. In addition, during the examinations the subrecipient shall verify evidence of fringe benefit plans and payments there under by contractors and subcontractors who claim credit for fringe benefit contributions.

(d) The subrecipient shall periodically review contractors and subcontractors use of apprentices and trainees to verify registration and certification with respect to apprenticeship and training programs approved by either the U.S Department of Labor or a state, as appropriate, and that contractors and subcontractors are not using disproportionate numbers of, laborers, trainees and apprentices. These reviews shall be conducted in accordance with the schedules for spot checks and interviews described in Item 5(b) and (c) above.

(e) Subrecipients must immediately report potential violations of the DB prevailing wage requirements to the EPA DB contact listed above and to the appropriate DOL Wage and Hour District Office at 405-231-4158.

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: Moore WWTP Improvements Projects
 - 1. Project Location: 4000 S. Service Rd. Moore, OK 73160.
- B. Owner: City of Moore.
 - 1. Owner's Representative: Jerry Ihler.
- C. Project Engineer: Garver.
 - 1. Engineer's Representative: Michael Nguyen (Project Manager).

1.3 SUMMARY OF WORK

- A. Work of the Project generally includes the replacement of the roof system, odor control modifications, channel and wet well covers, concrete repair and wet well coating, and HVAC improvements. More specifically, the Work includes, but is NOT limited to, construction of:
 - 1. Headworks
 - a. Replacement of the roof.
 - b. Concrete repair within the diversion box.
 - c. Coating of the interior diversion box and wet well.
 - d. Covering the channels, diversion box, and wet well.
 - e. Modifications to the existing odor control ducting.
 - f. Installation of a new makeup air unit and associated ductwork.
 - 2. Digesters
 - a. Demolition of the metal building structure and interior walkways.
 - b. Covering of the digester basins.
 - c. Replacement of the digester control instrumentation.
 - d. Installation of odor control ducting.
 - 3. Sequencing Batch Reactors
 - a. Replacement of the roof ridge cap.
 - b. Installation of odor control intake louvers.

4. UV and Effluent Pump Station Building
 - a. Replacement of the grating with plating at the pump station junction box.
 - b. Cleaning and coating the interior roof system.
 - c. Replacement of the monorail crane.
 - d. Demolition of the ventilation system.
 - e. Installation of two wall exhaust fans, ducting, and intake louvers.
 - f. Relocation of existing unit heater.
5. North Storm Ponds
 - a. Cleaning and disposing existing storm pond interior solids and debris.
 - b. Demolition of existing blower concrete pads and surrounding sidewalk
 - c. Installation of concrete pads.
 - d. Installation of (3) blowers, air piping, and coarse bubble diffusers.
 - e. Electrical feed upgrades at the electrical building.
 - f. Installation of blower VFDs.
 - g. Installation of packaged air conditioning system with ductwork.

1.4 WORK BY OWNER OR OTHERS

- A. Owner, utilities, and others may perform activities within the project site and premises while the Work is in progress. Schedule the Work with Owner, utilities, and others to minimize interference or delays. Owner, utilities, and others may perform activities within the project site and premises while the Work is in progress. Schedule the Work with Owner, utilities, and others to minimize interference or delays.
- B. If Owner-awarded contracts interfere with each other due to Work being performed at the same time or at the same Site, Owner will determine the sequence of Work under all contracts.

1.5 OWNER–FURNISHED PRODUCTS

- A. Owner's Responsibilities:
 1. Arrange for and deliver Owner-reviewed Shop Drawings, Product Data, and Samples to Contractor.
 2. Arrange and pay for delivery to Site.
 3. Upon delivery, inspect products jointly with Contractor.
 4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
 5. Arrange for manufacturers' warranties, inspections, and service.
- B. Contractor's Responsibilities:
 1. Review Owner-reviewed Shop Drawings, Product Data, and Samples.
 2. Receive and unload products at Site; inspect for completeness or damage jointly with Owner.
 3. Repair or replace items damaged after receipt.
 4. Handle, store, install, and finish products.

1.6 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. Oklahoma One-Call System, Inc./OKIE811, (405) 840-9955
 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 file 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.

1.7 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.

1.8 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.

1.9 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.

1.10 DESIGN CRITERIA

- A. Project Design Criteria:
 - 1. All equipment and materials for the project are to be suitable for performance in the headworks environment.
 - 2. Outdoor temperatures: 0°F – 105°F.
 - 3. Indoor process area temperatures: 40°F – 105°F.
 - 4. Indoor conditioned spaces: 50°F – 90°F.
 - 5. Frost line is assumed 18" below grade.
 - 6. Moisture conditions: Defined in Specification Sections.
 - 7. Site elevation: Generally ranges from 1165 – 1175 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: Default-D
 - 3) Design spectral acceleration at short period, S_{DS} : 0.338g.
 - 4) Design spectral acceleration at short period, S_{D1} : 0.134g.
 - 5) Seismic Design Category: C
 - 6) Importance Factor, I : 1.25
 - 7) Component amplification factor, a_p : As specified in ASCE 7-10
 - 8) Component response modification factor, R_p : As specified in ASCE 7-10.
 - 9) Component importance factor, I_p : As specified in ASCE 7-10.
 - 10) DO NOT use friction to resist sliding due to seismic forces.
- b. Wind Criteria:
- 1) Occupancy category: III
 - 2) Basic wind speed: 115 mph
 - 3) Exposure Category: C
 - 4) Topographic Factor, K_{zt} : 1.0
 - 5) Wind Importance Factor, I_w : 1.10
- 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

SECTION 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. Wastewater Treatment Facilities:
 - 1. The existing facility is the City of Moore's only means of treating domestic and industrial wastewater prior to discharging. Impairing the operational capabilities of this facility will result in serious environmental damage and monetary fines.
 - 2. Contractor shall bear the cost of penalties imposed on the Owner for discharge violations 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 below levels sufficient to treat the quality of raw wastewater to the water quality limitations specified in the discharge permit.
 - 4. The status of the treatment plant shall be defined as "operational" when it is capable of treating the entire quantity of wastewater received to the water quality limits specified in the discharge permit.
- B. Time Restrictions for Performing Work:
 - 1. Regular operating hours as determined by the Owner.
- C. Onsite Workday Restrictions:
 - 1. DO NOT perform Work on Site during Work blackout days specified by Owner.
- D. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction (AHJ).
- E. Provide safe, continuous access to process control equipment for plant operations personnel.
- F. 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.
- G. 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.

- H. Employee Identification:
 - 1. Provide identification tags for Contractor personnel working on Project Site. Require personnel to use identification tags at all times.
- I. 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 40 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. Bypass pumping around the headworks must be done during the dry weather periods.
 - b. Three of the six digester basins will be in operation. Phasing of which digesters that will need to be offline shall be coordinated with the Owner.
 - c. The return lift station at the North Pond Electrical building, which is powered out of the North Pond Electrical building, must remain fully operational during improvements in that area. Contractor shall provide backup power generators for continuous operation of the pump station.
- 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.
 - 3. Dry Weather Period:
 - a. Generally, June 15 – October 1.
 - b. Final determination made by Owner based on weather, flows entering the plant, and plant operation requirements.
 - 4. Wet Weather Period:
 - a. Any time NOT within the defined dry weather period.
 - 5. Low Flow Period:
 - a. 2:00am – 6:00am.
- 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.
 - 6. Shutdowns will only be allowed in dry weather periods or as determined by Owner. Shutdowns may be limited to low flow periods.

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 phases during construction period. Coordinate construction schedule and operations with Engineer and Owner:
 - 1. Task 1: Headworks Improvements
 - a. Phase 1: Bypass Headworks Pump Station
 - 1) Sequence 1: Isolate influent flow to the Headworks pump station junction box and wet well by installing a temporary stop log system to block all flow through the parshall flume channel.
 - 2) Sequence 2: Install bypass pumps within parshall flume channel. Install bypass pump discharge piping to the existing pump station discharge pipe header.
 - 3) Sequence 3: Provide bypass pumping around the Headworks pump station junction box and wet well while junction box and wet well work is being performed.
 - 4) Sequence 4: Remove bypass pumping when junction box and wet well repairs and coatings are completely cured and ready for service.
 - b. Phase 2: Repair and coat interior of Headworks junction box and wet well.
 - 1) Sequence 1: Clean and prep the interior of the Headworks junction box and wet well.
 - 2) Sequence 2: Repair concrete in junction box.
 - 3) Sequence 3: Coat the junction box and wet well.
 - c. Phase 3: Channel and Wet Well Covers
 - 1) Sequence 1: Remove existing grating as needed.
 - 2) Sequence 2: Install channel and wet well covers.
 - d. Phase 4: Roof Replacement
 - 1) Sequence 1: Remove roof.
 - 2) Sequence 2: Clean and coat roof support system.
 - 3) Sequence 3: Install roof.
 - e. Phase 5: HVAC and Odor Control Ductwork Modifications (This phase can done concurrently with other phases as needed)
 - 1) Sequence 1: Install makeup air unit and ductwork.
 - 2) Sequence 2: Install and repair odor control ductwork.
 - 2. Task 2: Digester Improvements (This task can done concurrently with other tasks as needed)
 - a. Phase 1: Removal of existing interior walkways, grind and coat embedded walkway supports, and chip concrete around existing building anchor bolts, remove anchor bolts and grout flush.
 - b. Phase 2: Installation of digester covers.
 - 1) Installation of the digester covers may be sequenced as needed, as 3 of the 6 digester basins must remain in operation.
 - c. Phase 3: Installation of digester instrumentation.
 - d. Phase 4: Installation of digester odor control ducting.
 - e. Phase 5: Installation of digester handrails and lighting.
 - 3. Task 3: Sequencing Batch Reactor Building Improvements (This task can done concurrently with other tasks as needed)

- a. Phase 1: Replacement of the building ridge cap.
 - b. Phase 2: Installation of the odor control intake louvers.
- 4. Task 4: UV and Effluent Pump Station Building Improvements
 - a. Phase 1: Replacement of the grating with plating at the pump station junction box.
 - b. Phase 2: Clean and coat the interior roof system.
 - c. Phase 3: Replacement of the monorail crane.
 - d. Phase 4: Demolition and installation of the ventilation systems.
- 5. Task 5: North Storm Ponds
 - a. Phase 1: Cleaning and disposing existing storm pond interior solids and debris.
 - b. Phase 2: Demolition of existing blower concrete pads and surrounding sidewalk.
 - c. Phase 3: Installation of sub-grade blower piping.
 - d. Phase 4: Installation of blower pads and concrete.
 - e. Phase 5: Electrical feed upgrades at the electrical building.
 - 1) Provide temporary power to return lift station until permanent power is provided.
 - f. Phase 6: Installation of packaged air conditioning system.
 - g. Phase 7: Installation of the blower VFDs and other required electrical gear.

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)

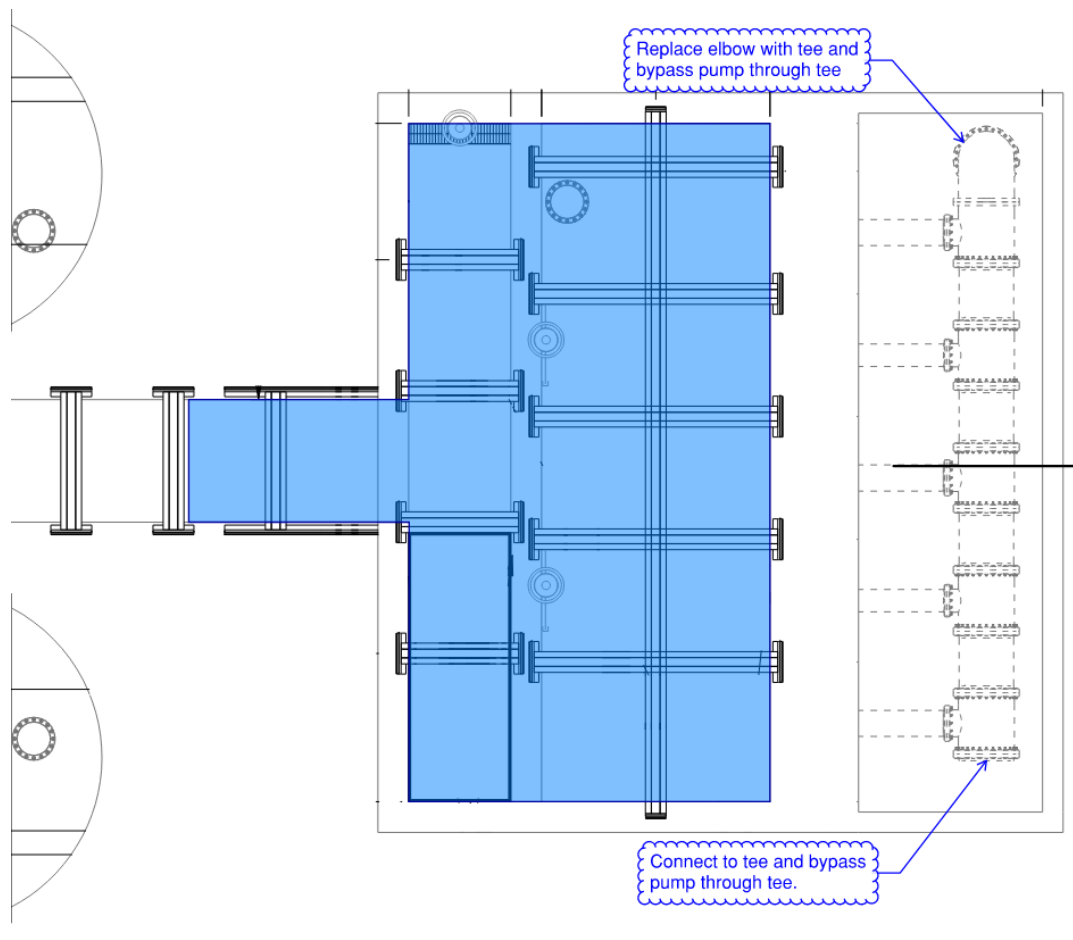
PART 3 - EXECUTION

3.1 GENERAL

- 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.

PROPOSED PHASE 1 SEQUENCE

Sequence	Sequence 1 - Bypass Pumping
Description	Bypass pumping of the Headworks junction box and wet well
Work to be Completed	Repair the junction box concrete and coat the junction box and wet well walls.
Shutdowns Required During Sequence	Minor Shutdown of headworks pumps for forcemain tie-in.
Isolation Locations	Headworks parshall flume channel. Headworks effluent pump discharge isolation valves.
Construction Duration during Shutdown	As needed to complete repair of junction box concrete and coating of the junction box and wet well.
Total Shutdown	As needed to complete repair of junction box concrete and coating of the junction box and wet well.
Temporary Bypass Pumping or Piping	Temporary bypass pumping and piping is required for rerouting plant flows from downstream of the screens and grit system to the headworks pump station discharge piping. Up to 14 MGD is the estimated bypass flow required to handle plant influent flow.
Notes	Sequence 1 may occur with other phases.



END OF SECTION

SECTION 01 20 00 – PRICE AND PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Schedule of Values.
 - 2. Application for Payment.
 - 3. Partial Payments.
 - 4. Defect assessment.
 - 5. Unit prices.
 - 6. Alternates.

1.2 BID ITEM DESCRIPTIONS

- A. The Basis of Payment will be as established in the Contract Documents and as described below:
 - 1. Bid Item 1: Mobilization/Demobilization
 - 2. Bid Item 2: HVAC System
 - 3. Bid Item 3: Roof Demolition and Replacement
 - 4. Bid Item 4: Odor Control Covers
 - 5. Bid Item 5: Odor Control Duct Modifications
 - 6. Bid Item 6: Concrete Removal and Repair (0.5 in. to 3 in.)
 - 7. Bid Item 7: Concrete Coating (includes up to 0.49 in. of concrete repair if needed)
 - 8. Bid Item 8: Bypass Pumping

1.3 SCHEDULE OF VALUES

- A. Submit electronic file to Project website of schedule on Progress Estimate schedule on EJCDC C-620 or form approved by Engineer and Owner. Document shall be a Microsoft Excel file type.
- B. Apparent “low-bidder” shall submit a preliminary Schedule of Values as electronic file within 2 days after bid opening.
- C. Submit complete Schedule of Values as electronic file to Project website within 10 days after date of Owner-Contractor Agreement.
- D. Format: Use Table of Contents of this Project Manual. Identify each line item with number and title of major Specification Section. Also identify mobilization, bonds and insurance, progress schedule development, startup and commissioning, contract closeout, and demobilization as separate line items.
- E. Include in each line item amount of allowances as specified in this Section. For unit cost allowances, identify quantities taken from Contract Documents multiplied by unit cost to achieve total for each item.
- F. Include within each line item, direct proportional amount of Contractor's overhead and profit.
- G. Revise schedule to list approved Change Orders with each Application for Payment.
- H. An unbalanced or front-loaded schedule of values, or a schedule of values substantially different than the preliminary schedule, will not be accepted.
- I. Mobilization value shall not exceed <3>% of the project total.

- J. Summation of the complete schedule of values representing all Work shall equal the Contract Price.

1.4 APPLICATION FOR PAYMENT

- A. Submit electronic file to project management website of each Application for Payment on EJCDC C-620 – Contractor's Application for Payment or similar form approved by Engineer and Owner.
- B. Content and Format:
 - 1. Use Schedule of Values for listing items in Application for Payment.
- C. Submit updated construction schedule with each Application for Payment.
- D. Payment Period:
 - 1. Submit at intervals stipulated in the Agreement.
- E. Submit submittals with transmittal letter as specified in Section 01 33 00 – Submittal Procedures.
- F. Substantiating Data:
 - 1. When Engineer requires substantiating information, submit data justifying dollar amounts in question.
 - 2. Include with Application for Payment:
 - a. Current construction photographs specified in Section 01 33 00 – Submittal Procedures.
 - b. Partial release of liens from major Subcontractors and vendors.
 - c. Record Documents as specified in Section 01 77 00 – Closeout Procedures, for review by Owner, which will be returned to Contractor.
 - d. Affidavits attesting to offsite stored products.
 - e. Construction Progress Schedule, revised and current as specified in Section 01 33 00 – Submittal Procedures.

1.5 PARTIAL PAYMENTS FOR STORED MATERIALS

- A. No payments will be made for materials and equipment delivered or stored unless shop drawings and preliminary operations and maintenance manuals are accepted by Engineer. Thereafter, partial payments for materials and equipment delivered and stored, but not yet incorporated into the Work, shall not exceed 90% of the material value.
- B. Storage must meet General Conditions requirements, be deemed acceptable by the Engineer and Owner, be located on the Site or a location agreed to by Engineer and Owner, and meet the documented storage recommendations from the Material Manufacturer.

1.6 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.

1.7 UNIT PRICES

- A. Engineer will take measurements and compute quantities accordingly. Provide assistance in taking of measurements.
- B. Unit Quantities:
 - 1. Quantities and measurements indicated on Bid Form are for Contract purposes only. Quantities and measurements supplied or placed in the Work shall determine payment. Actual quantities provided shall determine payment.
 - 2. When actual Work requires more or fewer quantities than those quantities indicated, provide required quantities at contracted unit sum/prices.
 - 3. When actual Work requires 25% or greater change in quantity than those quantities indicated, Owner or Contractor may claim a Contract Price adjustment.
- C. Payment Includes:
 - 1. Full compensation for required labor, products, tools, equipment, plant and facilities, transportation, services and incidentals; erection, application, or installation of item of the Work; overhead and profit.
- D. Final payment for Work governed by unit prices will be made on basis of actual measurements and quantities accepted by Engineer multiplied by unit sum/price for Work incorporated in or made necessary by the Work.
- E. Measurement of Quantities:
 - 1. Weigh Scales:
 - a. Inspected, tested, and certified by applicable State of Oklahoma weights and measures department within past year.
 - 2. Platform Scales:
 - a. Of sufficient size and capacity to accommodate conveying vehicle.
 - 3. Metering Devices:
 - a. Inspected, tested, and certified by applicable State of Oklahoma department within past year.
 - 4. Measurement by Weight:
 - a. Concrete reinforcing steel, rolled or formed steel, or other metal shapes will be measured by handbook weights. Welded assemblies will be measured by handbook or scale weight.
 - 5. Measurement by Volume:
 - a. Measured by cubic dimension using mean length, width, and height or thickness.
 - 6. Measurement by Area:
 - a. Measured by square dimension using mean length and width or radius.
 - 7. Linear Measurement:
 - a. Measured by linear dimension, at item centerline or mean chord.

8. Stipulated Sum/Price Measurement:
 - a. Items measured by weight, volume, area, or linear means or combination, as appropriate, as completed item or unit of the Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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. Engineer will not consider requests for substitutions prior to the date of the Owner-Contractor Agreement.
- B. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.
- C. 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.
- D. 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.
- E. 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.
- F. 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.
- B. Video Recordings
 - 1. Submit video recordings to web-based project management software, and on USB flash drive.
 - 2. Project Video Log: Maintain an ongoing log that incorporates date of coverage in year-month-day-time format followed by a short description of video coverage.

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 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
 - 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 temporary piping system is scheduled to be installed.

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

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. 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.
- B. 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.

- C. 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 ther 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.

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.

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.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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. Submit data bound in 8 1/2 in. by 11 in. text pages, three D side ring binders with durable plastic covers.
- C. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS," title of Project, and subject matter of binder when multiple binders are required.
- D. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- E. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

- F. 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. Include table of contents and assemble in three D side ring binder with durable plastic cover.
- F. Submit prior to final Application for Payment.
- G. 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.
- H. 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.

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. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
 - 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. Section 31 23 23.13 – Fill and Backfill.

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.

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. For fill in structures, use sand as specified in Section 31 23 23.13 – Fill and Backfill. Top 6 in. of backfill to grade shall be select fill as specified in Section 31 23 23.13 – Fill and Backfill and shall be compacted to 90% standard proctor density.
 - 2. 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., Armatec 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 jiffle-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 in. 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 in. of 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-inch 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-inch bevels at concrete edges, unless otherwise shown.
 - 2. Where beveled edges on existing adjacent structures are other than 3/4 in., 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 15 00 – CONCRETE JOINTS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Waterstops
 - 2. Joint Fillers
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete

1.2 REFERENCES

- A. ASTM International:
 - 1. A36 – Specification for Carbon Structural Steel.
 - 2. C920 – Specification for Elastomeric Joint Sealants.
 - 3. D570 – Standard Test Method for Water Absorption of Plastics.
 - 4. D624 – Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
 - 5. D638 – Standard Test Method for Tensile Properties of Plastics.
 - 6. D2240 – Standard Test Method for Rubber Property – Durometer Hardness.
- B. USACE (U.S. Army Corps of Engineers):
 - 1. CRD-C-572 – Specification for Polyvinyl Chloride Waterstop.
- C. NSF International:
 - 1. 61 – Drinking Water Components – Health Effects.

1.3 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures, specifies requirements for submittals.
- B. Product Data:
 - 1. Polyvinyl Chloride (PVC) Waterstop
 - 2. Bond Breaker
 - 3. Premolded Joint Fillers
 - 4. Pourable Joint Fillers
 - 5. Preformed Control Joints
 - 6. Dowels
- C. Shop Drawings:
 - 1. Construction Joints, Expansion Joints, and Control Joints: Layout and location for each type. Include joint locations as specified in Drawings, additional required joint locations, and any proposed alternate locations.
- D. Samples:
 - 1. PVC waterstop prefabricated splice, joint and cross of each type used on the project.
- E. Manufacturer's Certificate:
 - 1. Joint Filler for Potable Water Structures: Confirmation that material is certified to NSF 61.
 - 2. Joint Filler for Aeration or Oxygenation Basins: Confirmation that material is suitable for the oxygen content used in the process.

3. PVC Waterstop meets or exceeds the physical properties requirements of USACE CRD-C-572.

F. Manufacturer's Instructions:

1. For storage, handling, application/installation, and repair of:
 - a. Waterstop
 - b. Bond Breaker
 - c. Premolded Joint Fillers
 - d. Pourable Joint Fillers
 - e. Preformed Control Joints

1.4 QUALITY ASSURANCE

A. Field-Welded Joints:

1. PVC waterstop field-welded joints shall be free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the resistance to water pressure. Replace defective joints.

B. Inspections:

1. Quality of welded joints shall be subject to acceptance by the Engineer.
2. PVC Waterstop:
 - a. Grounds For Rejection:
 - 1) Offset of joints greater than 1/16 in.
 - 2) Exterior crack at joint due to incomplete bond which is greater than 1/16 in.
 - 3) Any combination of offset and crack resulting in a net reduction of the cross-section greater than 1/16 in.
 - 4) Misalignment of joint which shall result in misalignment of the waterstop in excess of 1/2 in. in 10 ft.
 - 5) Porosity in the welded joint detectable through visual inspection
 - 6) Bubbles or inadequate bonding

1.5 MOCKUPS

A. Welding Demonstration

1. Demonstrate ability to weld acceptable joints in PVC waterstops before installing waterstops in forms.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials under cover to protect from oil, dirt, and sunlight as required by the Manufacturer.

1.7 WARRANTY

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

PART 2 - PRODUCTS

2.1 METAL WATERSTOPS

A. Stainless Steel Waterstops:

1. For use in chemical containment where PVC or TPER is NOT compatible.
2. ASTM A240, Type 316L, 20 GA thickness, nominal 6 in. wide.
3. Manufacturers:
 - a. Greenstreak, Model No. 499

- b. Earthshield, Model No. JP 558
- c. Or equal.

2.2 THERMOPLASTIC ELASTOMERIC RUBBER (TPER) WATERSTOP

- A. For use where ozone resistance is required.
- B. Compound shall NOT contain scrapped material, reclaimed material, or pigment.
- C. Ozone resistance per ASTM D1171 for 450 pphm.
- D. Type: Ribbed with center bulb:
 - 1. Construction Joints – 6 in.
 - 2. Expansion Joints – 9 in.
- E. Manufacturers:
 - 1. Westec Barrier Technologies
Envirostop 600 Series.
 - 2. Vinylex
Model:
 - 1) VRB6316 – 6 in.
 - 2) VRB9316 – 9 in.
 - 3. Or equal.

2.3 POLYVINYL CHLORIDE (PVC) WATERSTOP

- A. Manufactured from prime virgin PVC. Compound shall have no scrap or reclaimed material.
- B. Properties as specified:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D792	NOT less than 1.3.
Hardness	ASTM D2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D638	NOT less than 2,000 psi.
Ultimate Elongation	ASTM D638	NOT less than 300%.
Alkali Extraction	CRD-C-572	7-day weight change between (-0.1)% – 0.25%. Hardness change within 5 points.
Low Temperature Brittle Point	ASTM D746	No sign of cracking or chipping at (-35)°F minimum.
Water Absorption	ASTM D570	NOT more than 0.15% after 24 hours.
Accelerated Extraction Tensile	CRD-C-572	NOT less than 1,600 psi.
Stiffness in Flexure	ASTM D747	NOT less than 600 psi.
Tear Resistance	ASTM D624	NOT less than 225 psi.
Thickness	–	3/8 in.

- C. Performance requirements per COE Specification CRD-C-572.
- D. Waterstop Types (Unless Otherwise Specified in Drawings):
 - 1. Construction Joints:
 - a. 6 in. wide flat ribbed or centerbulb
 - 2. Manufacturers (Flat Ribbed):
 - a. Vinylex; R638
 - b. Sika Greenstreak; 679
 - c. Or equal.

3. Manufacturers (Centerbulb):
 - a. Vinylex; RB638H
 - b. Sika Greenstreak; 732
 - c. Or equal.
4. Expansion and Contraction Joints:
 - a. 9 in. wide centerbulb
5. Manufacturers:
 - a. Vinylex; RB938H
 - b. Sika Greenstreak; 735
 - c. Or equal.

2.4 HYDROPHILIC WATERSTOP

- A. For use only where new concrete is placed against existing concrete and as specified in Drawings.
- B. Non-bentonite hydrophilic rubber compound.
- C. Manufacturers:
 1. Adeka Ultra Seal; MC-2010M with 3M-2141 adhesive and P-201 sealant
 2. Sika Greenstreak; Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant
 3. Or equal.

2.5 INJECTION-TYPE WATERSTOP

- A. Reinjectable Waterstop Hose System – use as specified in Drawings.
- B. Waterstop Hose:
 1. PVC compound.
 2. Creates uniform discharge of injection material over entire length of hose.
 3. Can be cleaned using water and vacuum pressure.
- C. Injection Material:
 1. Resin grout as recommended by waterstop hose manufacturer.
- D. Manufacturers:
 1. Deneef; TRIOject Injection Hose System with Hydro Active Grout
 2. Sika Greenstreak; Fuko Injection Hose System with Multigel 850
 3. Or equal.

2.6 RETROFIT PVC WATERSTOP

- A. Material – see PVC waterstop.
- B. Stainless Steel Batten Bar – AISI Type 304.
- C. Manufacturers:
 1. Vinylex; RET638
 2. Sika Greenstreak; 609
 3. Or equal.

2.7 BOND BREAKER

- A. Tape for Joints:
 1. Adhesive-backed glazed butyl or polyethylene tape.

- B. Use bond breaker as specified in Section 03 30 00 – Cast-In-Place Concrete, except where bond breaking tape is specifically called out on drawings.

2.8 PREMOLDED JOINT FILLER

- A. Sponge Rubber:
 - 1. Neoprene, closed cell, ASTM D1056 Type 2C5
 - 2. Manufacturer:
 - a. Monmouth Rubber and Plastics
Durafoam DK5151
 - b. Or Equal.

2.9 POURABLE JOINT FILLERS

- A. Meet requirements of NSF 61 for potable water containment structures.
- B. Self-leveling or non-sag for use in level, sloping, or vertical joints.
- C. Manufacturer:
 - 1. Sika Corp.
Sikaflex-2c SL
 - 2. Or Equal.

2.10 PREFORMED CONTROL JOINTS

- A. One-Piece, flexible PVC.
- B. Manufacturer:
 - 1. WR Meadows
 - 2. Keyway
 - 3. Or Approved Equal.

2.11 JOINT SEALANT

- A. One-part polyurethane, moisture curing, ASTM C920, Type S, Grade NS or P, Class 25, capable of being continuously immersed in water.
- B. Manufacturer:
 - 1. Sika Corp.
Sikaflex-1a
 - 2. Or Equal.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Construction Joints:
 - 1. Remove laitance from reinforcement and dowels
 - 2. Roughen surface to min 1/4 in. amplitude
 - 3. Protect waterstop, if present
- B. Expansion Joints:
 - 1. Mechanically roughen joint on each side of waterstop
 - 2. Use high-pressure air to clean joint
 - 3. Prime surfaces as required before placing joint filler

4. Protect waterstop

C. Contraction Joint:

1. Coat concrete surfaces above and below waterstop with bond breaker.
2. DO NOT coat waterstop.

3.2 INSTALLATION OF WATERSTOPS

A. General:

1. Waterstop shall be installed in all wall and slab joints of hydraulic structures and below grade structures, unless noted otherwise.
2. Join waterstop at intersections to provide a continuous seal.
3. The center axis of the waterstop shall be placed at the joint. The waterstop shall be placed in the center of the wall or slab to be sealed, unless noted otherwise on the drawings.
4. Secure waterstop in position using tie wire to reinforcement at a maximum spacing of 24 in. DO NOT displace waterstop during concrete placement.
5. Repair or replace damaged waterstop.
6. 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.
7. If any waterstop, once installed on one side of a joint, is exposed to the atmosphere for more than 2 days, suitable precautions shall be taken to protect the exposed waterstop from direct sunlight until embedded in concrete.

B. Metal Waterstops:

1. Where spliced, lap at least 12 in. and secure with sheet metal screws.
2. Install per manufacturer's written instructions.
3. Install as specified in Drawings.

C. TPER Waterstops:

1. Install similar to PVC waterstops as specified in manufacturer's written instructions.
2. Use only factory-made waterstop fabrications for all intersections, changes of direction and transitions.
3. Field splice permitted only for straight butt welds.

D. PVC Waterstops:

1. Install per manufacturer's written instructions.
2. Splice using Teflon-coated thermostatically controlled heating iron at approximately 380°F.
 - a. Use only factory-made waterstop fabrications for all intersections, changes of direction and transitions.
 - b. Field splice permitted only for straight butt welds.
 - c. The continuity of the waterstop ribs and center bulb shall be maintained.
 - d. Allow at least 10 minutes before the new splice is strained in any way.
 - e. Finished splices shall provide a cross-section that is dense and free of porosity with a tensile strength that is NOT less than 80% of the original materials.

E. Hydrophilic Waterstop:

1. Install as specified in manufacturer's written instructions.
2. Provide a minimum of 2 1/2 in. of concrete cover over waterstop.
3. Lap ends of waterstop strip together at splices and corners and join with sealant.
4. DO NOT allow the vibrator to contact the waterstop.
5. Lap hydrophilic waterstop a minimum of 2 ft with intersecting plastic waterstop.

- F. Injection-Type Waterstop:
 - 1. Install per manufacturer's written instructions.
 - 2. After concrete has cured for a minimum of 28 days, inject resin grout into waterstop hose as instructed by manufacturer.
 - 3. When complete, clean out hose to allow for future injections.
- G. Retrofit PVC Waterstop:
 - 1. Install per manufacturer's written instructions.
 - 2. Apply a bed of epoxy slightly wider than the waterstop base to the concrete surface.
 - 3. Before the epoxy cures, place the waterstop, securing with stainless steel batten bars and stainless steel post-installed anchors. Make sure to eliminate any air pockets or voids between the waterstop and the existing concrete.
 - 4. Butt splice as with PVC waterstop prior to attaching to concrete.
- H. Pre-Molded Joint Filler:
 - 1. Install per manufacturer's written instructions.
 - 2. Sufficient in width to completely fill joint space.
 - 3. Where waterstop is present, cut to butt tightly against waterstop and concrete face.
- I. Pourable Joint Filler:
 - 1. Install per manufacturer's written instructions and:
 - a. Apply primer prior to pouring joint filler.
 - b. Fill entire joint above waterstop.
 - c. Use masking tape at top of slab at each side of the joint; move tape, and clean spillage.
 - d. Sealant products used as fillers need NOT meet sealant geometry parameters.
- J. Preformed Control Joints:
 - 1. Use only as specified in Drawings. DO NOT use in water-holding basins.
 - 2. Install per manufacturer's written instructions.

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:
 - 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 7 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
 - c. Type C – Accelerating
 - d. Type D – Water-Reducing and Retarding
 - e. Type E – Water-Reducing and Accelerating
 - f. Type F – Water-Reducing, High Range
 - g. 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.
 4. Thickness: 10 mils min.
 5. 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.
5. Deposit concrete at final position, preventing segregation of mix. Limit vertical free fall to 5 ft.
6. 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.
7. DO NOT use aluminum conveying devices.
8. Retempering of concrete is NOT permitted where cement has partially hydrated.
9. 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.
10. 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.
11. Maintain records of concrete placement, including date, location, quantity, air temperature, and test samples taken.
12. 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.
13. DO NOT interrupt successive placement and DO NOT permit cold joints to occur.
14. 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.
15. 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.
 - 16. 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.
 - 17. 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.
 - 18. 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.
 - a. Cylinder Molding and Curing Procedures: Comply with ASTM C31.
 - b. Cylinder Specimens: Standard cured.
 2. 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.
 3. 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 7 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 .004%, 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° apart, when possible where attachments such as ladders exist, at 24-hour 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-hour 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

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.

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 96 00 – High-Performance 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 96 00 – High-Performance Coatings
 4. Dry areas, NOT coated – WF-2
 5. Dry areas, coated – WF-2 and Section 09 96 00 – High-Performance Coatings
- 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 60 00 – GROUT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Non-shrink grout
 - 2. Topping grout
 - 3. Concrete Fill
 - 4. Cement grout for pipe invert fill
 - 5. Construction joint mortar
- B. Related Sections:
 - 1. Section 03 10 00 – Concrete Forming
 - 2. Section 03 30 00 – Cast-In-Place Concrete

1.2 REFERENCES

- A. ASTM International:
 - 1. C230 – Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
 - 2. C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nontrunk).
- B. Cement Grout (Non-Shrink):
 - 1. COE (Corps of Engineers):
 - a. CRD-C 611 – Flow of Grout for Prep laced Aggregate Concrete.
 - b. CRD-C 621 – Specification for Non-shrink Grout.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product data for each type of product specified.
- C. Certified test results verifying compliance with compressive strength, shrinkage and expansion requirements and manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, and appropriate uses for each type of non-shrink and epoxy grout.
- D. Fine aggregate gradation.
- E. One copy of each 30 consecutive strength test results and mix design used from a record of past performance, or one copy of laboratory trial mix and design and results, and one copy of the mix design proposed for each cementitious mixture and use under this contract.
- F. Qualification for testing agency.
- G. Material test reports:
 - 1. From a qualified testing agency, as specified in requirements.
 - 2. Aggregates; include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
 - 3. Non-shrink grout
 - 4. Epoxy grout
- H. Material certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials

2. Non-shrink grout
 3. Epoxy grout
- I. Field quality-control tests and observation reports.
- J. Ready mix concrete (Cement Grout)
1. Provide delivery tickets for ready-mix concrete (cement grout) or weigh master's certificate per ASTM C 94, include weights of cement and each size aggregate and amount of water added at the plant and a record of placements. Record the amount of water added at the job site on the delivery ticket. Water added at the plant shall account for the moisture in aggregate. If water is added at the job site, then the total water content shall not exceed the water content of the approved design mix.
 2. Keep records showing time and place of each placement of concrete, joint mortar bed material or cement grout, together with transit delivery slips certifying the contents of the placement. Furnish records to Engineer.
- K. Joint Mortar Bed:
1. Provide material analysis and certification for each placement.
- L. Shop Drawings:
1. Product data of grouts.
 2. Curing method for grout.
 3. Mix design of cement-sand grout mixture for pipe invert/structure fill.
 4. Mix design of Joint Mortar Bed.
- M. Information Submittals:
1. Manufacturer's written instructions for mixing of grout.
 2. Manufacturer's Certificate of Compliance: Grout free from chlorides and other corrosion-causing chemicals.
 3. Manufacturer's Certificate of Proper Installation.
 4. Statements of Qualification: Non-shrink grout manufacturer's representative.
 5. Test Reports: Test report for 24-hour evaluation of non-shrink grout.
- 1.4 QUALIFICATIONS
- A. Manufacturer's qualifications for cement grout and joint mortar bed:
1. A firm experienced in manufacturing ready-mixed concrete products and a firm that complies with ASTM C94 requirements for production facilities and equipment.
- B. Testing Agency Qualifications:
1. An independent agency, acceptable to authorities having jurisdiction, qualified as specified ASTM C1077 and ASTM E329 for testing specified, as documented as specified ASTM E548.
 2. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, as specified ACI CP-01 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.
- C. Source limitations:
1. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source and obtain admixtures through one source from a single manufacturer.

1.5 QUALIFICATIONS

- A. Non-shrink Grout Manufacturer's Representative:
 - 1. Authorized and trained representative of grout manufacturer, with minimum of 1 year experience that has resulted in successful installation of grouts like those for this Project.
- B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Non-shrink Grout Test Form, attached at the end of this section. Independent testing laboratory to certify that testing was conducted within last 18 months.

1.6 GUARANTEE

- A. Manufacturer's guarantee shall not contain disclaimer on the product data sheet, grout bag, or container limiting responsibility to only the purchase price of products and materials furnished.
- B. Manufacturer guarantees participation with Contractor in replacing or repairing grout found defective due to faulty materials, as determined by industry standard test methods.

1.7 WARRANTY

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

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cementitious Material:
 - 1. Use the same type, brand, and source throughout project.
 - 2. Portland Cement (Nonhydraulic Above Grade Structures): ASTM C150, Type I or II or combination of Type I with fly ash.
 - 3. Portland Cement (Hydraulic and Below Grade Structures): ASTM C150 Type II or combination of Type I with fly ash.
 - 4. Fly Ash: ASTM C618, Class F, fly ash shall not exceed 15%.
- B. Fine aggregates:
 - 1. ASTM C 33, Class 4S or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials. Aggregates shall be free of materials with deleterious reactivity to alkali in cement. Aggregates for cement grout and/or mortar bed shall be provided from the same source as aggregate for the cast-in-place concrete.
- C. Water:
 - 1. ASTM C94 and potable.

2.2 ADMIXTURES

- A. As specified in Section 03 30 00 – Cast-In-Place Concrete.

2.3 NON-SHRINK GROUT SCHEDULE

- A. Furnish non-shrink grout for applications in grout category in the following schedule:

Application	Temperature Range	Max. Placing Time	
	40 – 100°F	20 min	Greater than 20 min
Filling tie hole	I	I	I
Machine bases 25 hp or less	II	II	II
Through-bolt openings	II	II	II
Patching Concrete Walls	II	II	II
Machine bases 26 hp and up	III	III	III
Base plates and/or soleplates with vibration, thermal movement, etc.	III	III	III
Other applications not listed	II	II	II

2.4 NON-SHRINK GROUT

- A. Category I:
- Nonmetallic and non-gas-liberating.
 - Prepackaged natural aggregate grout requiring only the addition of water.
 - Test as specified in ASTM C1107:
 - Flowable consistency 140%, five drops in 30 sec, as specified in ASTM C230.
 - Flowable for 15 minutes
 - Grout shall not bleed at maximum allowed water.
 - Minimum strength of flowable grout: 3,000 psi at 3 days, 5,000 psi at 7 days, and 7,000 psi at 28 days.
 - Manufacturers and Products:
 - Chemrex, Inc., Shakopee, MN; Set Grout
 - Euclid Chemical Co., Cleveland, OH; NS Grout
 - Dayton Superior Corp., Miamisburg, OH; 1107 Advantage Grout
 - US MIX Products, Denver, CO; US Spec Multi-Purpose Grout
 - L & M Construction Chemicals, Inc., Omaha, NE; Duragrout
 - Master Builders
- B. Category II:
- Nonmetallic, non-gas-liberating.
 - Prepackaged natural aggregate grout requiring only the addition of water.
 - Aggregate shall show no segregation or settlement at fluid consistency – at specified times or temperatures.
 - Test as specified in COE CRD-C 621 and ASTM C 1107, Grade B:
 - Fluid consistency 20 sec – 30 sec as specified in COE CRD-C 611.
 - Temperatures of 40, 80, and 100°F.
 - 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
 - Minimum strength of fluid grout: 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
 - Maintain fluid consistency when mixed in 1 yd – 9 yd loads in ready-mix truck.
 - Manufacturers and Products:
 - Chemrex, Inc., Shakopee, MN; Master Flow 928
 - Five Star Products Inc., Fairfield, CT; Five Star 100
 - Euclid Chemical Co., Cleveland, OH; Hi Flow Grout
 - Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout
 - L & M Construction Chemicals, Inc., Omaha, NE; Crystex
 - Master Builders

- C. Category III
1. Metallic and non-gas-liberating flowable fluid.
 2. Prepackaged aggregate grout requiring only the addition of water.
 3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
 4. Test as specified in CRD-C 621 and ASTM C 1107, Grade B:
 - a. Fluid consistency 20 sec – 30 sec as specified in CRD-C 611.
 - b. Temperatures of 40°F and 100°F.
 5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
 6. Minimum strength of grout: 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
 7. Maintain fluid consistency when mixed in 1 to 9 yard loads in ready-mix truck.
 8. Manufacturers and Products: Chemrex, Inc., Shakopee, MN; EMBECO 885.

2.5 TOPPING GROUT AND CONCRETE/GROUT FILL

- A. Where fill is thicker than 3 in, structural concrete 03 30 00 – Cast-In-Place Concrete, may be used when accepted by the Engineer.
- B. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tank, channel and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water and admixtures proportioned and be mixed as specified. Bonding Agent shall be used to enhance adhesion to basin concrete. Materials and procedures specified for normal concrete in Section 03 30 00 – Cast-In-Place Concrete, shall apply unless otherwise specified.
- C. Topping grout and concrete/grout fill shall contain a minimum of 564 lbs. of cement per cubic yard with a maximum water cement ratio of 0.45. Topping grout in clarifiers shall contain between 750 lbs.–8,900 lbs. of cement per cubic yard with a maximum water cement ratio of 0.42.
- D. Aggregate shall be graded:

U.S. STANDARD SIEVE SIZE	PERCENT BY WEIGHT PASSING
1/2 in.	100
3/8 in.	90 – 100
No. 4	20 – 55
No. 8	5 – 30
No. 16	0 – 10
No. 30	0

- E. Final mix design shall be as determined by trial mix design as specified in Section 03 30 00 – Cast-In-Place Concrete except that drying shrinkage tests are not required.
- F. Topping grout and concrete grout/fill shall contain air-entraining agent per Section 03 30 00 – Cast-In-Place Concrete.
- G. Strength:
 1. Minimum compressive strength of topping grout and concrete/grout fill at 28 days shall be 4,000 psi.
- H. Topping grout used in clarifiers shall contain fiber reinforcing. Fiber shall be 100% virgin polypropylene fibrillated fibers specifically manufactured in a blended gradation for use as concrete secondary reinforcement. Fibers shall be added at a rate of 1.5 lbs/yd³ of concrete. Fibers shall conform to ASTM C1116 – Fiber Reinforced Concrete and Shotcrete. Type III.

2.6 CEMENT-GROUT (CEMENT-SAND GROUT) MIXTURE FOR PIPE INVERT/STRUCTURE FILL

- A. Prepare Design Mixture:
 - 1. Proportions based on laboratory trial mixture, field test data, or both, as specified in ACI 301.
 - 2. Submit proposed mixture design to Engineer for review.
 - 3. As specified in Section 03 30 00 – Cast-In-Place Concrete.
 - 4. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based upon laboratory trial mixtures.
- B. Cementitious Materials:
 - 1. Limit percentage, by weight, of cementitious materials other than Portland cement in concrete and cement grout:
 - a. Fly Ash, 15%, Class F
- C. Admixtures:
 - 1. All materials other than Portland cement, water and aggregates that are added to the concrete or cement grout, shall be subject to the approval of the Engineer. If so approved, use admixtures as specified in manufacturer's written instructions.
 - 2. Use water reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 3. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 4. Use water-reducing admixture in pumped concrete, concrete for heavy-use slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
- D. Minimum compressive strength:
 - 1. 2,000 psi at 28 days
- E. Minimum cementitious material of 846 lbs. (9 bags) per cubic yard of cement grout.
- F. Air content:
 - 1. ASTM C94, 5%, plus or minus 1.0% at point of delivery.
- G. Aggregate shall be sand, three parts sand to one part cementitious material by volume. The sand gradation shall be such that 100% shall pass the No. 16 sieve and not more than 30% shall be retained on a No. 30 sieve.
- H. Water
 - 1. Cementitious material ratio. The Contractor shall submit a proposed mix design to the Engineer for review. The amount of water shall be the minimum amount of water necessary to make a workable mixture.
- I. Slump:
 - 1. Maximum of 4 in.

2.7 JOINT MORTAR BED

- A. Joint Mortar Bed:
 - 1. Mortar placed on horizontal construction joints shall be a mixture of cement, sand and water in the same proportions used in the approved 4000 psi cast-in-place concrete mix design and/but with the coarse aggregate omitted.

PART 3 - EXECUTION

3.1 NON-SHRINK GROUT

- A. General:
 - 1. Mix, place, and cure non-shrink grout as specified in grout Manufacturer's representative's training instructions.
 - 2. Used for repair of holes and defects and at locations indicated where epoxy grout is not indicated. Execution shall follow manufacturer's recommendations.
 - 3. Base plates and equipment where indicated. Execution shall follow manufacturer's recommendations.
- B. Form Tie or Through-Bolt Holes:
 - 1. Provide non-shrink grout, Category I and II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes; coordinate dry pack dense grout application with vinyl plug in Section 03 10 00 – Concrete Forming, and bonding agent in Section 03 30 00 – Cast-In-Place Concrete.
- C. Grouting Machinery Foundations:
 - 1. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material.
 - 2. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts.
 - 3. Form with watertight forms at least 2 in. higher than bottom of plate.
 - 4. Fill space between bottom of machinery base and original concrete as specified in Manufacturer's representative's training instructions.

3.2 CEMENT GROUT

- A. Place cement grout topping over concrete slabs as specified in Drawings. Place as specified in the procedures of this section and the manufacturer's or suppliers of equipment recommendations. The finish surface of the grout topping shall be similar to a steel trowel finish and which will facilitate the proper operation of the mechanical equipment. The finish of the structural slab below the cement grout topping shall be a heavy broom finish.
- B. Where cement grout is to be placed without mechanical equipment, the fresh surface of the cement grout shall be a smooth trowel finish.
- C. Placement Procedure at Areas With Mechanical Equipment:
 - 1. Notify Project Representative or Engineer a minimum of 48 hrs. in advance of placement.
 - 2. Make a trial cement grout batch of not less than 1/2 yd³ to allow time for adjustment in mix design if required.
 - 3. Clean the exposed structural slab by sandblasting and washing clean.
 - 4. Thoroughly broom a neat cement paste containing an epoxy binder into the concrete slab surface immediately ahead of placing the cement grout topping.
 - 5. Where applicable, install level and trial operate mechanical screed equipment over the floor slab to provide a minimum thickness of 2 in. plus or minus 1/4 in. In areas where the distance between the mechanical screed and the structural slab is less than the above clearances, grind surface as directed by Engineer to provide such clearance. The mechanical screed shall operate at a speed acceptable to the cement grout topping placement procedures. Screeding procedures shall account for the effects of differential temperatures on the mechanical screed equipment.
 - 6. Place cement grout topping in a continuous operation. If grouting operations are interrupted, clean the edge of the previously placed topping by water jetting and add a coat of cement paste to provide a bond to the fresh topping.

7. Temporarily equip the mechanical screed mechanism on at least two arms with a 2 in. by 10 in. continuous wood plate with light gauge metal angles and surface plates or channels. The bottom of the screed plates or steel plates shall be adjustable and set to elevations which allow the proper operation of equipment and as recommended by the equipment manufacturer or supplier.
8. Screed the topping immediately after consolidation with vibrators or tampers and provide a steel trowel finish.
9. Cure cement grout topping with water and cover with PVC sheeting to prevent damage from foot traffic for seven days. When/If the cement grout topping is found not to be acceptable, remove and replace. Cement grout topping not acceptable shall include, but is not limited to, poor bonding with the concrete slab, low strength, excessive cracking and unevenness in finish or elevation.

3.3 JOINT MORTAR BED

- A. Joint Mortar Bed:
 1. Immediately prior to placement of fresh concrete at horizontal joints, or as specified, place joint mortar bed to cover horizontal joint and protect water stop as applicable. Spread uniformly and work into all irregularities of the surface. The water cement ratio of the joint mortar bed shall not exceed that of the concrete being placed and the consistency of the mortar shall be suitable for placing and working. The fresh concrete shall then be immediately placed in a time and manner so that the joint mortar bed and the fresh concrete mix to form a homogenous concrete meeting all requirements.

3.4 EPOXY GROUT

- A. Used to embed all anchor bolts and reinforcing steel set in grout, specific machinery base plates as indicated and at other locations where indicated. Execution shall follow manufacturer's recommendations.

3.5 FIELD QUALITY CONTROL

- A. Evaluation and Acceptance of Non-shrink Grout:
 1. Consistency:
 - a. As specified in Paragraph 2.4 – Non-Shrink Grout.
 - b. Grout with consistencies outside range requirements shall be rejected.
 2. Segregation:
 - a. As specified in Paragraph 2.4 – Non-Shrink Grout.
 - b. Grout when aggregate separates shall be rejected.

3.6 MANUFACTURER'S SERVICES

- A. Coordinate demonstrations, training sessions, and applicable site visits with grout manufacturer's representative.

3.7 SUPPLEMENTS

- A. The supplement below is part of this Section.
 1. 24-hour Evaluation of Non-shrink Grout Test Form and Grout Testing Procedures.

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 three (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% 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 hour.
 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 4
MASONRY

SECTION 04 20 00 – UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work required for unit masonry assemblies:
 - a. Concrete masonry units (CMUs)
 - b. Mortar and grout
 - c. Reinforcing steel
 - d. Masonry joint reinforcement
 - e. Miscellaneous masonry accessories
- B. Related Sections:
 - 1. Section 03 20 00 – Concrete Reinforcing
 - 2. Section 03 30 00 – Cast-in-Place Concrete
 - 3. Section 05 50 00 – Metal Fabrications
 - 4. Section 07 92 00 – Joint Sealants

1.2 DEFINITIONS

- A. Reinforced Masonry:
 - 1. Masonry containing reinforcing steel in grouted cells.

1.3 REFERENCES

- A. ASTM International:
 - 1. A153 – Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
 - 2. A580 – Standard Specification for Stainless Steel Wire
 - 3. A951 – Standard Specification for Steel Wire for Masonry Joint Reinforcement.
 - 4. A1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - 5. C90 – Standard Specification for Loadbearing Concrete Masonry Units.
 - 6. C91 – Standard Specification for Masonry Cement.
 - 7. C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - 8. C144 – Standard Specification for Aggregate for Masonry Mortar.
 - 9. C150 – Standard Specification for Portland Cement.
 - 10. C207 – Standard Specification for Hydrated Lime for Masonry Purposes.
 - 11. C270 – Standard Specification for Mortar for Unit Masonry.
 - 12. C404 – Standard Specification for Aggregates for Masonry Grout.
 - 13. C476 – Standard Specification for Grout for Masonry.
 - 14. C578 – Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - 15. C780 – Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
 - 16. C1019 – Standard Test Method for Sampling and Testing Grout.
 - 17. C1093 – Standard Practice for Accreditation of Testing Agencies for Masonry.
 - 18. C1314 – Standard Test Method for Compressive Strength of Masonry Prisms.
 - 19. C1623 – Standard Specification for Manufactured Concrete Masonry Lintels.
 - 20. D226 – Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
 - 21. D1056 – Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.
 - 22. D2000 – Standard Classification System for Rubber Products in Automotive Applications.
 - 23. E514 – Standard Test Method for Water Penetration and Leakage Through Masonry.

- B. TMS (The Masonry Society):
 - 1. TMS 402/602 – Building Code Requirements and Specification for Masonry Structures.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry assemblies that develop net-area compressive strengths (f'_m) of 2000 psi at 28 days (assumes 2000 psi CMU).
- B. Determine net-area compressive strength (f'_m) of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to the current adopted edition of the TMS 402/602.

1.5 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product data:
 - 1. For each type of product indicated.
- C. Shop Drawings:
 - 1. Masonry Units:
 - a. Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel:
 - a. Detail bending and placement of unit masonry reinforcing bars.
 - b. Comply with ACI 315R, Guide to Presenting Reinforcing Steel Design Details.
 - 3. Accessories.
- D. Qualification Data: For testing agency.
- E. Material Certificates:
 - 1. Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards.
 - 2. Provide for each type and size of the following:
 - a. Concrete masonry units:
 - 1) Include material test reports substantiating compliance with ASTM C90.
 - b. Cementitious materials:
 - 1) Include brand, type, and name of manufacturer.
 - c. Preblended, dry mortar mixes:
 - 1) Include description of type and proportions of ingredients.
 - d. Grout mixes.
 - 1) Include description of type and proportions of ingredients.
 - e. Reinforcing bars
 - f. Joint reinforcement
 - g. Anchors, ties, and metal accessories
- F. Mix Designs:
 - 1. For each type of mortar and grout:
 - a. Include description of type and proportions of ingredients.
 - b. Include test reports, per ASTM C780, for mortar mixes required to comply with property specification.
 - c. Include test reports, per ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- G. Method of Placing Grout:
 - 1. High lift or low lift

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications:
 - 1. An independent agency qualified according to ASTM C1093 for testing indicated.
- B. Source Limitations for Masonry Units:
 - 1. Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- C. Source Limitations for Mortar Materials:
 - 1. Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.
 - 2. As detailed in TMS 402/602.
- D. Contractor/Fabricator Qualifications:
 - 1. Provide documentation of prior work experience with projects of similar size, design, and unit type as this project and whose work has resulted in construction projects with a record of successful in-service performance.
 - 2. Masonry Contractor/Installer: A firm with a minimum of 5 years' experience in CMU installations with a minimum of 5 commercial type projects similar in size to this specific project and able to provide references and similar project information if so requested.
- E. Conduct initial preinstallation conference to review Contract Documents and requirements prior to any submittal. Required representatives of each entity directly concerned with Unit Masonry shall attend:
 - 1. Engineer or representative.
 - 2. Contractor's superintendent.
 - 3. Independent testing agency responsible for masonry testing.
 - 4. Unit masonry Subcontractor.
 - 5. Other Approved representative.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units and face brick on elevated platforms in a dry location. If units are NOT stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, DO NOT install until they are dry. Store and handle to avoid chipping.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. DO NOT use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 PROJECT CONDITIONS

- A. Protection of Masonry:
 - 1. During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work.
 - 2. Cover partially completed masonry when construction is NOT in progress.
 - a. Extend cover a minimum of 24 in. down both sides and hold cover securely in place.
- B. DO NOT apply uniform floor or roof loads for at least 12 hrs. and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention:
 - 1. Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted.
 - 2. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 3. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 4. Protect sills, ledges, and projections from mortar droppings.
 - 5. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 6. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements:
 - 1. DO NOT use frozen materials or materials mixed or coated with ice or frost.
 - 2. DO NOT build on frozen substrates.
 - 3. Remove and replace unit masonry damaged by frost or by freezing conditions.
 - 4. Comply with cold-weather construction requirements contained in TMS 402/602.
- E. Cold-Weather Cleaning:
 - 1. Use liquid cleaning methods only when air temperature is 40°F and above and shall remain so until masonry has dried, but NOT less than 7 days after completing cleaning.
- F. Hot-Weather Requirements:
 - 1. Comply with hot-weather construction requirements contained in TMS 402/602.

1.9 WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are NOT limited to, products specified.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are NOT limited to, manufacturers specified.

2.2 CONCRETE MASONRY UNITS (CMUS)

- A. Shapes:
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 2. Provide square-edged units for outside corners, unless otherwise indicated.
- B. Concrete Masonry Units:
 - 1. ASTM C90.
 - 2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2000 psi.
 - 3. Weight Classification: Normal weight.
 - 4. Size (Width): Unless otherwise indicated, 2 cell units 7 5/8 in. by 15 5/8 in. by width specified.
 - 5. DO NOT use damaged units in the work.
 - 6. DO NOT use chipped units in exposed locations.
- C. Integral Water Repellent:
 - 1. Provide units made with integral water repellent for exterior units.
 - 2. Liquid polymeric, integral water-repellent admixture that does NOT reduce flexural bond strength.
 - 3. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E514, with test period extended to 24 hrs., show no visible water or leaks on the back of test specimen.
 - a. Available Products:
 - 1) Addiment Incorporated; Block Plus W-10
 - 2) Grace Construction Products, a unit of W. R. Grace & Co. – Conn.; Dry-Block
 - 3) BASF Construction Chemicals.; MasterPel

2.3 CONCRETE AND MASONRY LINTELS

- A. Provide masonry lintels complying with requirements below.
 - 1. Masonry Lintels: Built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with grout. Temporarily support built-in-place lintels until cured.
- B. Provide concrete lintels complying with requirements below.
 - 1. ASTM C1623, matching CMU's in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength NOT less than CMU's.
 - 2. Precast or formed-in-place concrete lintels as specified in Section 03 30 00 – Cast-In-Place Concrete, and with reinforcing bars indicated.

2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement:
 - 1. ASTM C150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime:
 - 1. ASTM C207, Type S

- C. Portland Cement-Lime Mix:
 - 1. Packaged blend of Portland cement complying with ASTM C150, Type I or Type III, and hydrated lime complying with ASTM C207, Type S.
- D. Masonry Cement:
 - 1. ASTM C91.
 - 2. Available Products:
 - a. Capital Materials Corporation; Flamingo Color Masonry Cement
 - b. Essroc, Italcementi Group; Brixment or Velvet
 - c. Holcim (US) Inc.; Mortamix Masonry Cement, Rainbow Mortamix Custom Buff Masonry Cement, or White Mortamix Masonry Cement
 - d. Lafarge North America Inc.; Magnolia Masonry Cement, Lafarge Masonry Cement Florida Super Masonry, Trinity Super White Masonry Type S, or Trinity White Masonry Type N
 - e. Lehigh Cement Company; Lehigh Masonry Cement or Lehigh White Masonry Cement
 - f. National Cement Company, Inc.; Coosa Masonry Cement
- E. Aggregate for Mortar:
 - 1. ASTM C144.
 - 2. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 3. For joints less than 1/4 in. thick, use aggregate graded with 100% passing the No. 16 sieve.
 - 4. Sand shall be clean, well screened, natural, ASTM C144.
- F. Aggregate for Grout: ASTM C404.
- G. Water: Potable.
- H. Water-Repellent Admixture:
 - 1. Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
 - 2. Available Products:
 - a. Addiment Incorporated; Mortar Tite
 - b. Grace Construction Products, a unit of W.R. Grace & Co. – Conn Dry-Block Mortar Admixture
 - c. BASF Construction Chemicals, MasterPel

2.5 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars:
 - 1. See Section 03 20 00 – Concrete Reinforcing.
- B. Masonry Joint Reinforcement, General:
 - 1. ASTM A951.
 - 2. Walls: Hot-dip galvanized, carbon steel.
 - 3. Wire Size for Side Rods: W1.7 or 0.148 in. diameter
 - 4. Wire Size for Cross Rods: W1.7 or 0.148 in. diameter
 - 5. Wire Size for Veneer Ties: W1.7 or 0.148 in. diameter
 - 6. Spacing of Cross Rods, Tabs, and Cross Ties: NOT more than 16 in. o.c.
 - 7. Provide in lengths of NOT less than 10 ft, with prefabricated corner and tee units

- C. Masonry Joint Reinforcement:
1. Standard, diagonally braced, galvanized, "Dur-O-Wall or approved equal, widths to fit concrete block walls in which used. Reinforcement shall meet ASCE/ACI Building Code requirements for Masonry Structures for design, materials, and coating (1.5 oz./ft² ASTM A153 Class B2). Use if face brick is laid at same time as block.
 2. For Single-Wythe Masonry: ladder type with single pair of side rods.
 3. For Multi-Wythe Masonry: Adjustable (two-piece) type, ladder design, with one side rod at each face shell of backing wythe and with separate ties that extend into facing wythe. Ties have two hooks that engage eyes or slots in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least 5/8 in. cover on outside face.

2.6 TIES AND ANCHORS

- A. Brick to Block Backup Walls:
1. Galvanized "pintle and eye" adjustable wall ties, equal to "Dur-O-Wall", with proper length pintle and eye sections for the cavity dimension indicated.
 2. Ties shall be "Dur-O-Wall D/A 515" or approved equal, meeting TMS Building Code Requirements for Masonry Structures.
 3. Use if face brick is laid at different time than block.
- B. Materials:
1. Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with either subparagraph below, unless otherwise indicated.
 2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064; with ASTM A153, Class B-2 coating.
 3. Stainless-Steel Wire: ASTM A580, Type 304 or 316.
- C. Wire Ties, General:
1. Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8 in. cover on outside face.
 2. Outer ends of wires are bent 90 degrees and extend 4 in. minimum parallel to face of veneer.
- D. Individual Wire Ties:
1. Rectangular units with closed ends and NOT less than 4 in. wide.
 2. Use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1 1/4 in.
 3. Wire: Fabricate from minimum 0.148 in. diameter, hot-dip galvanized steel or stainless-steel wire.

2.7 CLEAR SURFACE TREATMENT REPELLENTS

- A. General:
1. In addition to the integral water repellent provided within the concrete masonry units and the integral water repellent provided within the mortar, provide a compatible clear surface treatment repellent post applied in accordance with the manufacturers' recommendations to all concrete masonry work.
 2. Water-based, clear, specially formulated VOC compliant penetrating sealer consisting of water-based blends of silanes and siloxanes to provide maximum water repellency when post applied to integrally water-repellent-treated concrete masonry unit construction.
- B. Available Products:
1. INFINISEAL ® DB by Grace Construction Products
 2. BASF: MasterProtect H 185
 3. Approved Equal.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

- A. Preformed Control-Joint Gaskets:
 - 1. Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- B. Compressible Filler:
 - 1. Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35%; of width and thickness indicated; formulated from neoprene.
- C. Bond-Breaker Strips:
 - 1. Asphalt-saturated, organic roofing felt complying with ASTM D226, Type I (No. 15 asphalt felt).
- D. Reinforcing Bar Positioners:
 - 1. Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells.
 - 2. Units are formed from 0.142 in. steel wire, hot-dip galvanized after fabrication.
 - 3. Provide units with either two loops or four loops as needed for number of bars indicated.
 - a. Available Products:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817
 - 2) Heckmann Building Products Inc.; No. 376 Rebar Positioner
 - 3) Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner
 - 4) Wire-Bond; O-Ring or Double O-Ring Rebar Positioner

2.9 EXPANSION AND CONTROL JOINT MATERIALS

- A. Backer rod and sealant in expansion joints and sealant in control joints as specified in Section 07 92 00 – Joint Sealants.
- B. Preformed Control Joints:
 - 1. Dayton Superior: DA 2001 Control Joint Regular Rubber
 - 2. Hohmann and Barnard: #RS Standard

2.10 THROUGH-WALL FLASHING

- A. Where shown built into masonry, and unless noted otherwise, use 5 oz. copper fabric flashing. Seal all laps with flashing mastic.

2.11 WEEP HOLE/VENT PRODUCTS

- A. Weeps:
 - 1. Mortar Net USA, Ltd. "Mortar Net Weeps Vents" or approved equal.

2.12 MASONRY-CELL INSULATION

- A. Molded-Polystyrene Insulation Units
 - 1. Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C578, Type I. Provide specially shaped units designed for installing in cores of masonry units.
 - 2. Available Products:
 - a. Concrete Block Insulating Systems; Korfil
 - b. Shelter Enterprises Inc.; Omni Core

2.13 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner:
 - 1. Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 - 2. Available Manufacturers:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.

2.14 MORTAR AND GROUT MIXES

- A. General:
 - 1. DO NOT use admixtures, including pigments, air-entraining agents, accelerators, retarders, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 2. DO NOT use calcium chloride in mortar or grout.
 - 3. Limit cementitious materials in mortar to Portland cement and lime.
- B. Preblended, Dry Mortar Mix:
 - 1. Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry:
 - 1. Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
- D. Mortar for Unit Masonry:
 - 1. Comply with ASTM C270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 2. For masonry below grade or in contact with earth, use Type S.
 - 3. For reinforced masonry, use Type S.
 - 4. For interior non-load-bearing partitions, use Type S.
- E. Mortar Mixing:
 - 1. Proportion and mix according to ASTM C270.
- F. Grout for Unit Masonry:
 - 1. Comply with ASTM C476.
 - 2. Use grout of type indicated or, if NOT otherwise indicated, of type (fine or coarse) that complies with TMS 402/602 for dimensions of grout spaces and pour height.
 - 3. Provide grout with a slump of 8 to 11 in. as measured according to ASTM C143.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. No masonry work when ambient temperature is below 35°F; DO NOT build on frozen work or surface with water or frost film; protect masonry from freezing for 48 hrs. after being laid.
- B. Lay out coursing with story pole prior to laying masonry to insure joints of uniform thickness.
- C. Lay in plumb, true to line level course, head joints aligned; adjust to final position before mortar stiffens.
- D. Keep cavities, chases, etc., free of debris or mortar droppings.
- E. Unless otherwise required, completely fill spaces around built-in items with mortar; fill heads and jambs of hollow metal frames with mortar as the wall is laid. Install anchors, flashing, etc., as the wall is laid.
- F. Tolerance of offset between vertical faces of block masonry:
1. 1/8 in.
- G. Rake control joints to depth of 3/8" and leave ready for sealant.
- H. Step back unfinished work for joining with new; DO NOT "tooth" unless specifically approved. Protect tops or openings in exposed masonry walls from rain or snow with a strong waterproof membrane, adequately secured in place.
- I. DO NOT use mortar that has begun to set; DO NOT use mortar more than 2 1/2 hrs. after mixing when air temperature is 80°F or higher or more than 3 1/2 hrs. after mixing when air temperature is less than 80°F.
- J. Brace walls to resist all lateral loads that may be encountered.
- K. Thickness:
1. Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- L. Build chases and recesses to accommodate items specified in this and other Sections.
- M. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- N. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

- O. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.
- P. Matching Existing Masonry:
 - 1. Match coursing, bonding, color, and texture of existing masonry.
- Q. Comply with construction tolerances in TMS 402 and with the following:
 - 1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, DO NOT vary from plumb by more than 1/8 in. in 10 ft, 1/4 in. in 20 ft, or 1/2 in. maximum.
 - 2. For vertical alignment of exposed head joints, DO NOT vary from plumb by more than 1/4 in. in 10 ft, or 1/2 in. maximum.
 - 3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, DO NOT vary from level by more than 1/8 in. in 10 ft, 1/4 in. in 20 ft, or 1/2 in. maximum.
 - 4. For exposed bed joints, DO NOT vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 in. DO NOT vary from bed-joint thickness of adjacent courses by more than 1/8 in.
 - 5. For exposed head joints, DO NOT vary from thickness indicated by more than plus or minus 1/8 inch. DO NOT vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
 - 6. For faces of adjacent exposed masonry units, DO NOT vary from flush alignment by more than 1/16 in. except due to warpage of masonry units within tolerances specified for warpage of units.
 - 7. For exposed bed joints and head joints of stacked bond, DO NOT vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.3 LAYING MASONRY WALLS

- A. Laying Concrete Block:
 - 1. General: Cut block with masonry saws. Set head joints in running bond. For other joints, provide full mortar coverage in joints on horizontal and vertical face shells, none on web edges. Bond each course at corners. Remove sharp edges and irregularities at exposed corners of concrete block work with an abrasive block.
 - 2. Joints: 3/8 in. wide, struck flush.
 - 3. Lintels: Unless otherwise noted or indicated, constructed of U-shape units filled with 3,000 psi concrete, extending at least 8 in. beyond each side of opening. Reinforce as indicated, but NOT less than one No. 5 bar.
 - 4. Joint Reinforcing: Place in first (continuous) and second bed joints (to 2 ft each side of opening) above and below openings and continuous in every second bed joint throughout remainder of structure, Lap splices 6 in. Bend longitudinal wires around corners to provide a continuous bond.
 - 5. Anchors: Space NOT more than 16 in. o. c. vertically and 24 in. o. c. horizontally, with NOT less than 1 anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 in. of openings and at intervals, NOT exceeding 8 in. around the perimeter.
- B. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- C. Bond Pattern for Exposed Masonry:
 - 1. Unless otherwise indicated, lay exposed masonry in running bond; DO NOT use units with less than nominal 4 in. horizontal face dimensions at corners or jambs.

- D. Lay concealed masonry with all units in a wythe in running bond. Bond and interlock each course of each wythe at corners. DO NOT use units with less than nominal 4 in. horizontal face dimensions at corners or jambs.
- E. Stopping and Resuming Work:
 - 1. Stop work by racking back units in each course from those in course below; DO NOT tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- F. Built-in Work:
 - 1. As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- G. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- H. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.
 - 1. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2 in. clearance between end of anchor rod and end of tube. Space anchors 48 in. o.c., unless otherwise indicated.
 - 2. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3.4 MORTAR BEDDING AND JOINTING

- A. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- B. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.
- C. Lay hollow brick and concrete masonry units as follows:
 - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 - 2. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 - 3. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are NOT grouted.
- D. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. DO NOT deeply furrow bed joints or slush head joints.

3.5 MASONRY-CELL INSULATION

- A. Install Molded-Polystyrene Insulation Units into masonry unit cells NOT grouted before laying units.

3.6 MASONRY JOINT REINFORCEMENT

- A. General:
 - 1. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 in. elsewhere. Lap joint reinforcement a minimum of 6 in.
 - 2. Space reinforcement NOT more than 16 in. o.c.

3. Space reinforcement NOT more than 8 in. o.c. in foundation walls and parapet walls.
4. Provide reinforcement NOT more than 8 in. above and below wall openings and extending 12 in. beyond openings.
 - a. Reinforcement above is in addition to continuous reinforcement.

- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL AND EXPANSION JOINTS

- A. General:
 1. Install control and expansion joint materials in unit masonry as masonry progresses. DO NOT allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 1. Install preformed control-joint gaskets designed to fit standard sash block.
 2. Unless indicated or noted otherwise, on the exterior, control joints shall occur at all interior corners of intersecting masonry walls.
 3. Square rake mortar cleanly to depth of 3/8 in. to receive sealant as specified in Division 07 –Thermal and Moisture Protection.
- C. Provide expansion joints in exterior above grade masonry walls NOT to exceed 40 ft o. c., placed as shown on drawings or as located and directed by Engineer.
- D. Use specified expansion joint materials in all expansion joints unless otherwise directed.

3.8 THROUGH-WALL FLASHING

- A. Install continuous, embedded in mortar or a troweled-on layer of bituminous mastic, with end joints lapped 6" and sealed with manufacturer's mylar tape, and with ends adjacent to opening jambs turned up to form a pan. Outer edge shall extend completely to face of mortar joint.
- B. At rear of through-wall flashing between stud walls and brick veneer, extend through cavity and build in as shown. Extend up between sheathing and building wrap.
- C. Required Locations:
 1. Install through-wall flashing at heads and sills of windows, heads of doors in exterior walls, continuous under weep holes in brick veneer, and where shown.
- D. Where grade slopes and weep holes above grade step with the slope, through-wall flashing shall step correspondingly and shall overlap at the stepped ends a minimum of 24 in. Turn up ends approximately 2 in. and turn into head joints of masonry.

3.9 LINTELS

- A. Provide minimum bearing of 8 in. at each jamb, unless otherwise indicated.

3.10 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General:

1. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

3.11 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores:

1. Construct formwork and shores as needed to support reinforced masonry elements during construction.
2. Construct formwork to provide shape, line, and dimensions of completed masonry as needed. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
3. DO NOT remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. Placing Reinforcement:

1. Comply with requirements in TMS 602.

C. Grouting:

1. DO NOT place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
2. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
3. Limit height of vertical grout pours to NOT more than 60 in.

3.12 FIELD QUALITY REQUIREMENTS

A. Inspectors:

1. Owner shall engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
2. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
3. Comply with Level C Quality Assurance in TMS 602 Latest Edition and International Building Code Chapter 17 Structural Tests and Inspection, Latest Edition and as follows:
 - a. Testing Frequency: One set of tests for each 1500 ft² of wall area or portion thereof.
 - b. Mortar Test (Property Specification): For each mix provided, per ASTM C780. Test mortar for mortar air content and compressive strength.
 - c. Grout Test (Compressive Strength): For each mix provided, per ASTM C1019.

3.13 REPAIRING, POINTING, AND CLEANING

- #### A.
- Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that DO NOT match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing:

1. During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to

provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning:

1. Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave 1/2 of panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.14 CLEAR SURFACE TREATMENT REPELLENTS

- A. In addition to the integral water repellent provided within the concrete masonry units and the integral water repellent provided within the mortar, provide a compatible clear surface treatment repellent post applied in accordance with the manufacturers' recommendations to all concrete masonry work.

3.15 CLEANING

- A. Clean off loose mortar without damage to brick and CMU. Cut out defective joints, repoint and tool to match adjacent work.
- B. Insure adequate water supply for presoaking and rinsing. Delay cleaning of any section at least 28 days after topping out.
- C. Use "Sure Klean" or approved equal in strict accordance with manufacturer's instructions. Specific product shall be as recommended by the manufacturer for the type of masonry involved.
- D. Protect non-masonry surfaces. Masonry below the working area shall be kept wet by flushing with water.
- E. High pressure water cleaning methods are NOT permitted unless approved by the Engineer.

3.16 MASONRY WASTE DISPOSAL

A. Salvageable Materials:

1. Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material:

1. Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed. DO NOT dispose of masonry waste as fill within 18 in. of finished grade.

C. Excess Masonry Waste:

1. Remove excess clean masonry waste that can NOT be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

DIVISION 5
METALS

SECTION 05 12 00 – STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. The Work required for structural steel.
 - 2. The Work required for grout.
- B. Related Sections:
 - 1. Section 03 62 00 – Non-Shrink Grouting
 - 2. Section 09 96 00 – High-Performance Coatings

1.2 DEFINITIONS

- A. Structural Steel:
 - 1. Elements of structural-steel frame, as classified by AISC – “Code of Standard Practice for Steel Buildings and Bridges,” that support design loads.

1.3 REFERENCES

- A. ASTM International:
 - 1. A6
 - 2. A36
 - 3. A53
 - 4. A108
 - 5. A123
 - 6. A500
 - 7. A563
 - 8. A780
 - 9. A992
 - 10. C1107
 - 11. F436
 - 12. F1554
 - 13. F3125
- B. AWS:
 - 1. D1.1 – “Structural Welding Code – Steel.”
- C. AISC:
 - 1. “Code of Standard Practice for Steel Buildings and Bridges.”
 - 2. “Seismic Provisions for Structural Steel Buildings” and “Supplement No.2.”
 - 3. “Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design.”
 - 4. “Specification for the Design of Steel Hollow Structural Sections.”
 - 5. “Specification for Allowable Stress Design of Single-Angle Members”.
- D. SSPC:
 - 1. SP 3 – “Power Tool Cleaning.”
 - 2. PS Guide 7.00 – “Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems.”
- E. RCSC:
 - 1. “Specifications for Structural Joints Using ASTM F3125 Bolts.”

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. For each type of product indicated.
- C. Shop Drawings:
 - 1. Show fabrication of structural-steel components.
 - 2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 3. Include embedment drawings.
 - 4. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
- D. Welding certificates.
- E. Qualification Data:
 - 1. For Installer and fabricator.
- F. Mill Test Reports:
 - 1. Signed by Manufacturers certifying that the following products comply with requirements:
 - 2. Structural steel including chemical and physical properties.
 - 3. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 4. Shop primers.
 - 5. Non-shrink grout.
- G. Source quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. A qualified installer who regularly erects structural steel with scope and complexity like that of this project.
- B. Fabricator Qualifications:
 - 1. A qualified fabricator who regularly fabricates structural steel with scope and complexity like that of this project.
- C. Welding:
 - 1. Qualify procedures and personnel as specified in AWS D1.1 – “Structural Welding Code – Steel.”
- D. Comply with applicable provisions of the listed specifications and documents:
 - 1. AISC – “Code of Standard Practice for Steel Buildings and Bridges.”
 - 2. AISC – “Seismic Provisions for Structural Steel Buildings” and “Supplement No.2.”
 - 3. AISC – “Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design.”
 - 4. AISC – “Specification for the Design of Steel Hollow Structural Sections.”
 - 5. AISC – “Specification for Allowable Stress Design of Single-Angle Members”.
 - 6. RCSC – “Specifications for Structural Joints Using ASTM F3125 Bolts.”

- E. Preinstallation Conference:
 - 1. Conduct conference at Project Site as specified in Section 01 10 00 – Summary and Section 01 30 00 – Administrative Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Relubricate bolts and nuts that become dry.
 - 2. DO NOT store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
 - 3. DO NOT clean and use rusty bolts.

1.7 COORDINATION

- A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.8 WARRANTY

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

PART 2 - PRODUCTS

2.1 STRUCTURAL–STEEL MATERIALS

- A. W-Shapes:
 - 1. ASTM A992.
- B. Channels, Angles, and Shapes:
 - 1. ASTM A36, unless otherwise noted.
- C. Plate and Bar:
 - 1. ASTM A36, unless otherwise noted.
- D. Cold-Formed Hollow Structural Sections:
 - 1. ASTM A500, Grade B structural tubing
- E. Steel Pipe:
 - 1. ASTM A53, Type E or S, Grade B
 - 2. Weight Class: Standard unless otherwise indicated.
 - 3. Finish: Black, except where indicated to be galvanized.
- F. Welding Electrodes:
 - 1. Comply with AWS requirements.
 - 2. Tensile strength should be the same or greater than base metal.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM F3125 Type 1, heavy hex steel structural bolts; ASTM A563 heavy hex carbon steel nuts; and ASTM F436 hardened carbon-steel washers.
 - 1. Finish: Plain unless noted or indicated otherwise.

- B. Un-headed Anchor Rods:
1. ASTM F1554, Grade 36, unless otherwise indicated.
 2. Configuration: as indicated.
 3. Nuts: ASTM A563, heavy hex carbon steel
 4. Plate Washers: ASTM A36 carbon steel
 5. Washers: ASTM F436, hardened carbon steel
 6. Finish: Plain, unless noted or indicated otherwise.

- C. Threaded Rods:
1. ASTM A36
 2. Nuts: ASTM A563 heavy hex carbon steel
 3. Washers: ASTM F436 hardened carbon steel
 4. Finish: Plain, unless noted or indicated otherwise.

- D. Clevises or turnbuckles:
1. ASTM A108, Grade 1035, cold-finished carbon steel

- E. Eye Bolts and Nuts:
1. ASTM A108, Grade 1030, cold-finished carbon steel

- F. Sleeve Nuts:
1. ASTM A108, Grade 1018, cold-finished carbon steel

2.3 PRIMER

- A. Primer:
1. Fabricator's standard lead and chromate free non-asphaltic rust inhibiting primer.
- B. Galvanizing Repair Paint:
1. MPI#18, MPI#19, or SSPC-Paint 20.

2.4 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout:
1. ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time and as specified in Section 03 62 00 – Non-Shrink Grouting.

2.5 FABRICATION

- A. Structural Steel:
1. Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC – “Code of Standard Practice for Steel Buildings and Bridges” and AISC – “Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design”.
 2. Camber structural-steel members where indicated.
 3. Identify high-strength structural steel according to ASTM A6 and maintain markings until structural steel has been erected.
 4. Mark and match-mark materials for field assembly.
 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting:
1. Perform thermal cutting by machine to greatest extent possible.
 2. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

- C. Bolt Holes:
 - 1. Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing:
 - 1. Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning:
 - 1. Clean and prepare steel surfaces that are to remain unpainted as specified in SSPC-SP 3 – “Power Tool Cleaning.”
- F. Steel Wall-Opening Framing:
 - 1. Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.
- G. Welded Door Frames:
 - 1. Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced NOT more than 10 in. o.c., unless otherwise indicated.
- H. Holes:
 - 1. Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
 - 2. Cut, drill, or punch holes perpendicular to steel surfaces.
 - 3. Base-Plate Holes: Cut, drill, or punch holes perpendicular to steel surfaces.
 - 4. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

- A. High-Strength Bolts:
 - 1. Shop install high-strength bolts according to RCSC – “Specification for Structural Joints Using ASTM F3125 Bolts” for type of bolt and type of joint specified.
 - 2. Joint Type: Snug tightened.
- B. Weld Connections:
 - 1. Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC – “Code of Standard Practice for Steel Buildings and Bridges” for mill material.

2.7 SHOP PRIMING

- A. Shop prime steel surfaces except:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 in.
 - 2. Surfaces to be field welded.
 - 3. Surfaces to be high-strength bolted with slip-critical connections.
 - 4. Surfaces to receive sprayed fire-resistive materials.
 - 5. Galvanized surfaces.
- B. Surface Preparation:
 - 1. Clean the surfaces to be painted.

2. Remove loose rust and mill scale and spatter, slag, or flux deposits.
3. Prepare surfaces as specified:
 - a. See SSPC-SP 3 – “Power Tool Cleaning.”
- C. Priming:
 1. Immediately after surface preparation, apply primer according to Manufacturer’s written instructions and at rate recommended by SSPC to provide a dry film thickness of NOT less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 2. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 3. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting:
 1. Apply a 1-coat, non-asphaltic primer complying with SSPC-PS Guide 7.00 – “Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems,” to provide a dry film thickness of NOT less than 1.5 mils.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish:
 1. Apply zinc coating by the hot-dip process to structural steel according to ASTM A123.
 2. Fill vent holes and grind smooth after galvanizing.
 3. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of concrete-bearing and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedment, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
 1. DO NOT remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC – “Code of Standard Practice for Steel Buildings and Bridges” and AISC – “Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design”.
- B. Base and Bearing Plates:
 1. Clean concrete-bearing and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.

2. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 3. Weld plate washers to top of base plate.
 4. Snug-tightened anchor rods after supported members have been positioned and plumbed. DO NOT remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
 5. Promptly pack grout solidly between bearing surfaces and base or bearing; plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow it to cure. Comply with Manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC – "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure.
 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. DO NOT use thermal cutting during erection unless approved by Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1.
- G. DO NOT enlarge unfair holes in members by burning or using drift pins. Ream holes that shall be enlarged to admit bolts.
- 3.4 FIELD CONNECTIONS
- A. High-Strength Bolts:
1. Install high-strength bolts according to RCSC – "Specification for Structural Joints Using ASTM F3125 Bolts" for type of bolt and type of joint specified.
 2. Joint Type: Snug tightened, unless noted or indicated otherwise.
- B. Weld Connections:
1. Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 2. Comply with AISC – "Code of Standard Practice for Steel Buildings and Bridges" and AISC – "Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design", for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 3. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 4. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC – "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
- 3.5 FIELD QUALITY REQUIREMENTS
- A. Testing Agency:
1. Owner shall engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

- B. Bolted Connections:
 - 1. Shop-bolted connections shall be tested and inspected as specified in RCSC – “Specification for Structural Joints Using ASTM F3125 Bolts.”
- C. Welded Connections:
 - 1. Field welds shall be visually inspected according to AWS D1.1.
- D. Correct deficiencies in Work that test reports and inspections indicate does NOT comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780 and Manufacturer’s written instructions.
- B. Touchup Painting:
 - 1. After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
 - 2. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 3. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- C. Touchup Painting:
 - 1. Cleaning and touchup painting are specified in Section 09 96 00 – High-Performance Coatings.

END OF SECTION

SECTION 05 50 00 – METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel framing and supports for overhead doors.
 - 2. Steel framing and supports for mechanical and electrical equipment.
 - 3. Steel framing and supports for applications where framing and supports are NOT specified in other Sections.
 - 4. Shelf angles.
 - 5. Loose bearing and leveling plates.
 - 6. Loose lintels.
 - 7. Steel welded plates and angles for casting into concrete NOT specified in other Sections.
 - 8. Miscellaneous steel trim including steel angle corner guards and steel edgings.
 - 9. Metal ladders.
 - 10. Metal bollards.
 - 11. Pipe guards.
 - 12. Metal floor plate and supports.
 - 13. Abrasive metal nosing, treads, and thresholds.
- B. Products furnished, but NOT installed, under this Section include:
 - 1. Loose steel lintels.
 - 2. Anchor bolts, steel pipe sleeves, and wedge-type inserts specified to be cast into concrete or built into unit masonry.
- C. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete
 - 2. Section 03 62 00 – Non-Shrink Grouting
 - 3. Section 07 92 00 – Joint Sealants
 - 4. Section 09 96 00 – High-Performance Coatings

1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Ladders:
 - 1. Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- B. Thermal Movements:
 - 1. Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 2. Temperature Change (Range):
 - a. 120°F, ambient.
 - b. 180°F, material surfaces.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Metal nosing and treads

2. Paint products
3. Grout
4. Fall Protection (ladder)
5. Metal Floor Plate and support

- C. Shop Drawings:
 1. Show fabrication and installation details for metal fabrications.
 2. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 3. Provide templates for anchors and bolts specified for installation under other Sections.
 4. For installed products specified to comply with design loads, include structural analysis data signed and sealed by the qualified professional Engineer responsible for their preparation.
- D. Samples for Verification:
 1. For each type and finish of extruded nosing and tread.
- E. Mill Certificates:
 1. Signed by Manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.
- F. Welding Certificates.

1.4 QUALITY ASSURANCE

- A. Welding:
 1. Qualify Procedures and Personnel:
 - a. AWS D1.1 – Structural Welding Code – Steel
 - b. AWS D1.2 – Structural Welding Code – Aluminum
 - c. AWS D1.3 – Structural Welding Code – Sheet Steel
 - d. AWS D1.6 – Structural Welding Code – Stainless Steel

1.5 PROJECT CONDITIONS

- A. Field Measurements:
 1. Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and specify measurements on Shop Drawings.
 2. Established Dimensions: Where field measurements can NOT be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
 3. Provide allowance for trimming and fitting at site.

1.6 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

1.7 WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are NOT limited to, products specified.
 - 2. Available Manufacturers: Subject to compliance with requirements, Manufacturers offering products that may be incorporated into the Work include, but are NOT limited to, manufacturers specified.

2.2 METALS, GENERAL

- A. Metal Surfaces, General:
 - 1. Provide materials with smooth, flat surfaces, unless otherwise specified.
 - 2. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.3 FERROUS METALS

- A. Steel Plates, Shapes, and Bars:
 - 1. ASTM A36 (Provide Grade 50 where Noted).
- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars:
 - 1. ASTM A666, Type 304.
- C. Stainless-Steel Bars and Shapes:
 - 1. ASTM A276, Type 304.
- D. Steel Tubing:
 - 1. ASTM A500, cold-formed steel tubing.
- E. Steel Pipe:
 - 1. ASTM A53, standard weight (Schedule 40), unless another weight is specified or required by structural loads.
- F. Cast Iron:
 - 1. ASTM A48, Class 30, unless another class is specified or required by structural loads.

2.4 NONFERROUS METALS

- A. Aluminum Plate and Sheet:
 - 1. ASTM B209, Alloy 6061-T6.
- B. Aluminum Extrusions:
 - 1. ASTM B221, Alloy 6061-T6.
- C. Aluminum-Alloy Rolled Tread Plate:
 - 1. ASTM B632, Alloy 6061-T6.

- D. Aluminum Castings:
 - 1. ASTM B26, Alloy 443.0-F.

2.5 FASTENERS

- A. General:
 - 1. Unless otherwise specified, provide Type, 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating as specified in ASTM B633, Class Fe/Zn 5, at exterior walls.
 - 2. Provide stainless-steel fasteners for fastening aluminum.
 - 3. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts:
 - 1. Regular hexagon-head bolts, ASTM A307, Grade A, with hex nuts, ASTM A563; and, where specified, flat washers.
 - 2. Finish: Plain or Hot Dip Zinc-coated ASTM A153 Class C, as specified.
- C. Stainless-Steel Bolts and Nuts:
 - 1. Regular hexagon-head annealed stainless-steel bolts, nuts and, where specified, flat washers; ASTM F593, AISI Type 316, Condition CW for bolts and ASTM F594 for AISI Type 316, Condition CW nuts.
 - 2. All threads on stainless steel rods/bolts shall be protected with antiseize lubricant suitable for submerged stainless bolts and complying with Federal Specification MIL-A-907E.
- D. Anchor Bolts:
 - 1. ASTM F1554, Grade 36.
 - 2. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is specified to be galvanized.
- E. Machine Screws:
 - 1. ASME B 18.6.3.
- F. Lag Bolts:
 - 1. ASME B 18.2.1.
- G. Wood Screws:
 - 1. Flat head, ASME B18.6.1.
- H. Plain Washers:
 - 1. Round, ASME B 18.22.1.
- I. Lock Washers:
 - 1. Helical, spring type, ASME B 18.21.1.
- J. Cast-in-Place Anchors in Concrete:
 - 1. Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing as specified in ASTM E488, conducted by a qualified independent testing agency.
 - 2. Threaded or wedge type; galvanized ferrous castings either: ASTM A47 malleable iron or ASTM A27, cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A153.
- K. Expansion Anchors:
 - 1. Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load

- imposed when installed in concrete, as determined by testing as specified in ASTM E488, conducted by a qualified independent testing agency.
 - 2. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated as specified in ASTM B633, Class Fe/Zn 5.
 - 3. Material for Anchors in Exterior Locations: ASTM F593, AISI Type 316, Condition CW for bolts and ASTM F594 for AISI Type 316, Condition CW nuts.
 - 4. Expansion anchors shall NOT be substituted for adhesive anchors.
- L. Adhesive Anchors:
- 1. Threaded Rod:
 - a. ASTM F593 stainless steel threaded rod, diameter as specified in Drawings.
 - b. Length as required to provide minimum depth of embedment.
 - c. Clean and free of grease, oil, or other deleterious material.
 - d. For hollow-unit masonry, provide galvanized or stainless-steel wire cloth screen tube to fit threaded rod.
 - 2. Adhesive:
 - a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments, with gray color after mixing.
 - b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
 - c. Nonsag, with selected viscosity based on installation temperature and overhead application where applicable.
 - d. HILTI HIT HY-150 or approved equal.
 - 3. Packaging:
 - a. Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
 - b. Cartridge Marking: Include manufacturer's name, product name, material type, batch serial number, and adhesive expiration date.
 - 4. Manufacturers and Products:
 - a. Hilti, Inc.
Tulsa, OK
HIT Doweling Anchor System, HIT HY 150 (HIT HY 20 for hollow masonry).
 - b. Approved Equal.

2.6 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes:
 - 1. Select as specified in AWS specifications for metal alloy welded.
- B. Shop Primers:
 - 1. Provide primers that comply with Division 9 –Finishes.
- C. Universal Shop Primer:
 - 1. Fast-curing, lead-free and chromate-free, universal modified-alkyd primer complying with MPI#79.
 - 2. Use primer with a VOC content of 420 g/L (3.5 lb/gal.), or less when calculated as specified in 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- D. Zinc-Rich Primer:
 - 1. See SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.
 - 2. Use primer with a VOC content of 420 g/L (3.5 lb/gal.), or less when calculated as specified in 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Available Manufacturers and Products:

- a. Benjamin Moore & Co.
Epoxy Zinc-Rich Primer CM18119.
 - b. Carboline Company
Carbozinc 621.
 - c. ICI Devco Coatings
Catha-Coat 313.
 - d. International Coatings Limited
Interzinc 315 Epoxy Zinc-Rich Primer.
 - e. PPG Architectural Finishes, Inc.
Aquapon Zinc-Rich Primer 97-670.
 - f. Sherwin-Williams Company (The)
Corothane I GalvaPac Zinc Primer.
 - g. Tnemec Company, Inc.
Tneme-Zinc 90-97.
 - E. Galvanizing Repair Paint:
 - 1. High-zinc-dust-content paint for re-galvanizing welds in steel, as specified in SSPC-Paint 20.
 - F. Stainless Steel Cleaner:
 - 1. As specified in ASTM A380 Ferroxy Test for Free Iron.
 - 2. Available Products and Manufacturers:
 - a. Bradford Derustit Corp.
Derustit SS-3 Wondergel.
 - b. Or Approved Equal.
 - G. Bituminous Paint:
 - 1. Cold-applied asphalt emulsion as specified in ASTM D1187.
 - H. Non-Shrink, Nonmetallic Grout:
 - 1. Factory-packaged, nonstaining, noncorrosive, nongaseous grout as specified in ASTM C1107.
 - 2. Provide grout specifically recommended by Manufacturer for interior and exterior applications and as specified in Section 03 62 00 – Non-Shrink Grouting.
 - I. Concrete Materials and Properties:
 - 1. See Section 03 30 00 – Cast-In-Place Concrete for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi unless otherwise specified.
- 2.7 FABRICATION, GENERAL
- A. Shop Assembly:
 - 1. Preassemble items in the shop to greatest extent possible.
 - 2. Disassemble units only as necessary for shipping and handling limitations.
 - 3. Use connections that maintain structural value of joined pieces.
 - 4. Clearly mark units for reassembly and coordinated installation.
 - B. Cut, drill, and punch metals cleanly and accurately.
 - C. Remove burrs and ease edges to a radius of approximately 1/32 in, unless otherwise specified.
 - D. Remove sharp or rough areas on exposed surfaces.

- E. Form bent-metal comers to smallest radius possible without causing grain separation or otherwise impairing work.
- F. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
- G. Weld comers and seams continuously as specified:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- H. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise specified. Locate joints where least conspicuous.
- I. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- J. Cut, reinforce, drill, and tap metal fabrications as specified to receive finish hardware, screws, and similar items.
- K. Provide for anchorage of type specified; coordinate with supporting structure, and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
 - 1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 in. by 1 1/2 in, with a minimum 6 in. embedment and 2 in. hook, NOT less than 8 in. from ends and corners of units and 24 in. o.c., unless otherwise specified.

2.8 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General:
 - 1. Design and provide steel framing and supports NOT specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise specified.
 - 1. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports.
 - 2. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 3. Fabricate units from slotted channel framing where specified.
 - 4. Furnish inserts if units are installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where specified.
- D. Prime miscellaneous framing and supports with zinc-rich primer where specified.

2.9 LOOSE STEEL LINTEL

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where specified.

- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but NOT less than 8 in, unless otherwise specified.
- C. Galvanize loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.10 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates after fabrication.
- C. Prime plates with zinc-rich primer.

2.11 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles NOT specified in other Sections, for items supported from concrete construction as needed to complete the Work.
- B. Provide each unit with NOT less than two integrally welded steel strap anchors for embedding in concrete.

2.12 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise specified, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim.
- D. Prime interior miscellaneous steel trim, with zinc-rich primer.

2.13 METAL LADDERS

- A. General:
 - 1. See the more stringent requirements of OSHA and ANSI A14.3, unless otherwise specified.
 - 2. Space side rails 16 in. clear apart, unless otherwise specified.
 - 3. Support each ladder at top and bottom and NOT more than 60 in. o.c, with welded or bolted brackets, made from same metal as ladder.
 - 4. All ladders including ladders less than 20 ft in height shall be equipped with an integral fall protection system.
- B. Design Live Loads:
 - 1. Side rail loads: Ladder rails shall be designed to withstand a minimum of two (2) 300 lb. loads plus 30% impact concentrated between any two consecutive attachments.
 - 2. Rung loads: Ladder rungs shall be designed to withstand a minimum live load of 300 pounds plus 30% impact.

- C. Ladder Deflection:
1. Limit rung deflection to span divided by 360.
- D. Extension (Popup):
1. Every ladder that does NOT have an exterior hand hold shall be equipped with a popup extension designed by the ladder manufacturer.
 2. Popup extension shall be of the same material and finish as the ladder with telescoping tubular section that locks automatically when fully extended.
 3. Upward and downward movement shall be controlled by stainless steel spring balancing mechanisms.
 4. Units shall be completely assembled with fasteners for securing to the ladder rungs as specified in the manufacturer's recommendations.
- E. Fall Prevention System (Ladder):
1. All ladders, including ladders less than 20 ft in height, shall be equipped with an integral fall prevention system. The fall prevention system at each ladder shall include a permanent metal carrier rung/rail, carrier rung/rail extension as required, sliding sleeve arresting unit, ladder rung clamps, full body harness, dismount section and all other components as necessary for complete installation and system to comply with OSHA and ANSI A14.3 standards and requirements.
 2. The fall prevention system manufacturer shall design each fall prevention system, coordinate with the ladder manufacturer, and submit the fall prevention system design and detailed plans to the Engineer for approval.
 3. The carrier rung/rail shall be Type 316 stainless steel or aluminum-alloy 6105-T5.
 4. Carrier rung/rail extensions shall be provided for safe ladder access and egress. The total carrier rung/rail length shall be as designed by the fall prevention system manufacturer.
 - a. Available Manufacturers:
 - 1) Sellstorm Manufacturing
 - 2) North Safety Products, Ltd.
 - 3) Or approved equal.
- F. Steel Ladders:
1. Side rails: Continuous, 1/2 in. by 2 1/2 in. steel flat bars, with eased edges.
 2. Rungs: 3/4 in. steel bars.
 3. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.
 4. Rung spacing shall NOT exceed 12 in. on center.
 5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
 6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung by a proprietary process.
 7. Available Products:
 - a. IKG Industries, a Harsco company; Mebac.
 - b. W. S. Molnar Company; SlipNOT.
 8. Galvanize exterior ladders and interior ladders, where specified, including brackets and fasteners.
- G. Aluminum Ladders:
1. Side rails: Continuous extruded-aluminum channels or tubes, NOT less than 2 1/2 in. deep, 3/4 in. wide, and 1/8 in. thick.
 2. Rungs: Extruded-aluminum tubes, NOT less than 3/4 in. deep and NOT less than 1/8 in. thick, with ribbed tread surfaces.
 3. Fit rungs in centerline of side rails; fasten by welding or with stainless-steel fasteners or brackets and aluminum rivets.
 4. Rung spacing shall NOT exceed 12 in. on center.

2.14 ALUMINUM PLANK

- A. Acceptable Manufacturers:
 - 1. Ohio Gratings Inc.
 - 2. McNichols Co.
 - 3. Amico, a Gibraltar Industries Co.
 - 4. Harsco Industrial IKG.
 - 5. Or approved equal.
- B. Materials:
 - 1. Plank and banding are Aluminum type 6061-T6, ASTM B221.
 - 2. Description:
 - a. Unpunched, Aluminum Heavy Duty Plank Grating: 6 in. wide extruded aluminum plank with support bars spaced 1.2 in. on center, fabricated with banding into panels of standard width to fill areas specified in the Drawings.
 - 1) Top Surface: Slip resistant
 - 2) Finish: Mill finished
 - 3) Plank Type: Unpunched
 - 4) Plank Depth: based on loading requirements and clear span.

2.15 METAL FLOOR PLATE

- A. Also referenced as "Checkered" or "Check" Plate, with raised lugs on one side and smooth surface on other side.
- B. Fabricate from roller-aluminum-alloy 6061-T6, ASTM B632 plate of thickness specified below. Raised lug pattern shall be on top and start at 45 degree angle to edge of plate or tread.
- C. Design and provide stainless steel or aluminum angle and/or aluminum beam supports, as specified, or as required and NOT specified.
- D. Include stainless steel or aluminum angle stiffeners and fixed and removable sections, as specified or required.
- E. Provide flush stainless-steel bar drop handles for lifting removable sections one at each end of each section.
- F. Floor plate, including all support members, reinforcement ribs, stiffeners, edge members, supports and all structural requirements shall be designed by a Professional Engineer licensed in the State of the Work and provided by the manufacturer/fabricator of the floor plate.
- G. Design of the floor plate, including all supports, connections and integral members shall be for the actual dead load plus a live load consisting of:
 - 1. The uniform live load of the adjacent floor,
Or
 - 2. A uniform live load of 200 lbf/ft², whichever load produces the greater effects. Design shall use the loading and pattern loading for multiple spans which produces the greatest loading, stresses, and deflection with the floor plate system.
- H. The maximum fiber stress shall NOT exceed that which is allowed by the Aluminum Association.
- I. The maximum total load deflection shall be limited to the span divided by 180 (L/180), NOT to exceed 0.25 in. between supporting members.

- J. Contractor shall submit sealed shop drawings complete with details and calculations to the Engineer for review prior to fabrication. Submittal data shall be complete with detail and calculations to determine all components of the floor plate system, including plate, reinforcing ribs, supports, rib pattern, connections, and others as necessary.
- K. All ends and openings shall be banded.
- L. Provide 1/4 in. neoprene gaskets for all sealed or odor control floor plate coverings as/where specified.
- M. The weight of a floor plate section shall NOT exceed 80 lbs.
- N. Aluminum surfaces in contact with concrete, grout, or dissimilar metals shall be protected with a coat of bituminous paint, Mylar isolators or other protective system, as approved by the Engineer.
- O. Available Manufacturers
 - 1. Thompson Fabricating, LLC;
Tarrant, AL.
 - 2. Or approved equal.

2.16 METAL BOLLARDS

- A. Fabricate metal bollards from steel shapes as specified.

2.17 ABRASIVE METAL NOSINGS AND TREADS

- A. Cast-Metal Units:
 - 1. Cast aluminum, with an integral abrasive finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in sizes and configurations indicated and in lengths necessary to accurately fit openings or conditions.
 - 2. Manufacturers:
 - a. American Safety Tread Co., Inc.
 - b. Baleo Inc.
 - c. Barry Pattern & Foundry Co., Inc.
 - d. Granite State Casting Co.
 - e. Safe-T-Metal Co.
 - f. Wooster Products Inc.
 - 3. Nosing: Cross-hatched units, 4 in. wide with 1/4 in. lip, for casting into concrete steps.
 - 4. Nosing: Cross-hatched units, 1 1/2 in. by 1 1/2 in, for casting into concrete curbs.
 - 5. Treads: Cross-hatched units, full depth of tread with 3/4 in. by 3/4 in. nosing, for application over bent plate treads or existing stairs.
- B. Extruded Units:
 - 1. Aluminum, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in sizes and configurations indicated and in lengths necessary to accurately fit openings or conditions.
 - 2. Available Manufacturers:
 - a. ACL Industries, Inc.
 - b. American Safety Tread Co., Inc.
 - c. Amstep Products.
 - d. Armstrong Products, Inc.
 - e. Baleo Inc.
 - f. Granite State Casting Co.
 - g. Wooster Products Inc.

3. Provide ribbed units, with abrasive filler strips projecting 1/16 in. above aluminum extrusion.
 4. Provide solid-abrasive-type units without ribs.
 5. Nosing: Square-back units, 3 in. wide, for casting into concrete steps.
 6. Nosing: Beveled-back units, 3 in. wide with 1 3/8 in. lip, for surface mounting on existing stairs.
 7. Nosing: Two-piece units, 3 in. wide, with sub channel for casting into concrete steps.
 8. Treads: Beveled-back units, full depth of tread with 1 3/8 in. lip, for application over existing stairs.
- C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with Manufacturer.
- D. Drill for mechanical anchors and countersink. Locate NOT more than 4 in. from ends and NOT more than 12 in. o.c., evenly spaced between ends, unless otherwise specified. Provide closer spacing if recommended by Manufacturer.
1. Provide two rows of holes for units more than 5 in. wide, with two holes aligned at ends and intermediate holes staggered.
- E. Apply bituminous paint, Mylar isolators or other protective system as approved by the Engineer to concealed bottoms, sides, and edges of cast-metal units set into concrete.
- 2.18 FINISHES, GENERAL
- A. See NAAMM "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.
- 2.19 STEEL AND IRON FINISHES
- A. Hot-dip galvanize items as indicated to comply with applicable standard listed below:
1. ASTM A123 for galvanizing steel and iron products.
 2. ASTM A153 for galvanizing steel and iron hardware.
- B. Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich primer: SP 6/NACE No.3, "Commercial Blast Cleaning."
 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise specified.
1. See SSPC-PA 1, "Paint Application Specification No.1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 2. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- 2.20 STAINLESS-STEEL FINISHES
- A. Remove tool and die marks and stretch lines or blend into finish.
- B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

- C. Bright, Directional Satin Finish:
 - 1. No.4.
- D. Dull Satin Finish:
 - 1. No.6.
- E. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- F. Passivate Complete Fabrications prior to shipping to site with Stainless Steel Cleaner.
- G. Passivate field welded assemblies after welding with Stainless Steel Cleaner.

2.21 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. As-Fabricated Finish:
 - 1. AA-M10 (Mechanical Finish: as fabricated, unspecified).
- C. Class 1, Clear Anodic Finish:
 - 1. AA-M12C22A41 (Mechanical Finish: non-specular as fabricated
 - 2. Chemical Finish: etched, medium matte
 - 3. Anodic Coating: Architectural Class 1, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement:
 - 1. Perform cutting, drilling, and fitting required for installing metal fabrications.
 - 2. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are NOT to be left as exposed joints but CANNOT be shop welded because of shipping size limitations. DO NOT weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction:
 - 1. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

- 2. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Protection:
 - 1. Coat concealed surfaces of aluminum that will encounter grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General:
 - 1. Install framing and supports to comply with requirements of items being supported, including Manufacturers' written instructions and requirements specified in Shop Drawings.
- B. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

3.3 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces.
- B. Clean bottom surface of plates.
- C. Set bearing and leveling plates on wedges, shims, or leveling nuts.
- D. After bearing members have been positioned and plumbed, tighten anchor bolts.
- E. DO NOT remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use non-shrink grout, nonmetallic, in concealed locations where NOT exposed to moisture; use non shrink, nonmetallic grout in exposed locations, unless otherwise specified.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLING METAL BOLLARDS

- A. Anchor bollards in concrete as specified.
- B. Anchor bollards in place with concrete footings.
- C. Center and align bollards in holes 3 in. above bottom of excavation.
- D. Place concrete and vibrate or tamp for consolidation.
- E. Support and brace bollards in position until concrete has cured.
- F. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. DO NOT fill removable bollards with concrete.

3.5 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosing on tread widths.
- B. For nosing embedded in concrete steps or curbs, align nosing flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 07 92 00 – Joint Sealants, to provide a watertight installation.

3.6 ADJUSTING AND CLEANING

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting as specified in SSPC-PA 1 for touching up shop-painted surfaces.
 - 2. Apply by brush or spray to provide a minimum 2.0 mil dry film thickness.
- B. Touchup Painting:
 - 1. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 96 00 – High-Performance Coatings.
- C. Galvanized Surfaces:
 - 1. Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

END OF SECTION

SECTION 05 52 13 – PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Aluminum pipe railings
- B. Related Sections:
 - 1. Section 05 50 00 – Metal Fabrications
 - 2. Section 09 96 00 – High-Performance Coatings

1.2 PERFORMANCE REQUIREMENTS

- A. General:
 - 1. In engineering railings to withstand structural loads specified, determine allowable design working stresses of railing materials based on:
 - a. For aluminum, the lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
- B. Structural Performance:
 - 1. Provide railings capable of withstanding the effects of gravity loads and the loads and stresses within limits and conditions specified.
 - 2. Handrails:
 - a. Uniform load of 50 lbf/ft applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need NOT be assumed to act concurrently.
 - 3. Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need NOT be assumed to act concurrently.
 - 4. Infill of Guards:
 - a. Concentrated load of 200 lbf (0.89 kN) applied horizontally on an area of 1 ft².
 - b. Uniform load of 25 lbf/ft² applied horizontally.
 - c. Infill load and other loads need NOT be assumed to act concurrently.
- C. Thermal Movements:
 - 1. Provide exterior railings that allow for thermal movements resulting from the maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 2. Base the engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 3. Temperature Change (Range):
 - a. 120°F, ambient
 - b. 180°F, material surfaces
- D. Control of Corrosion:
 - 1. Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.

- B. Product Data:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Grout, anchoring cement, and paint products.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. For installed products specified to comply with design loads, include structural analysis data signed and sealed by the qualified professional Engineer responsible for their preparation.
- D. Samples for Initial Selection:
 - 1. For products involving selection of color, texture, or design.
- E. Samples for Verification:
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need NOT be full height.
 - a. Show method of finishing and connecting members at intersections.
- F. Mill Certificates:
 - 1. Signed by Manufacturers of stainless-steel products certifying that products furnished comply with requirements.
- G. Welding certificates.
- H. Qualification Data:
 - 1. For testing agency.
- I. Product Test Reports:
 - 1. Based on evaluation of comprehensive tests performed by a qualified testing agency, as specified in ASTM E894 and ASTM E935.

1.4 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Obtain each type of railing through one source from a single Manufacturer.
- B. Welding:
 - 1. AWS D1.1 – "Structural Welding Code – Steel."
 - 2. AWS D1.2 – "Structural Welding Code – Aluminum."
 - 3. AWS D1.6 – "Structural Welding Code – Stainless Steel."

1.5 PROJECT CONDITIONS

- A. Field Measurements:
 - 1. Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 2. Established Dimensions: Where field measurements CANNOT be made without delaying the Work, establish dimensions and proceed with fabricating railings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
 - 3. Provide allowance for trimming and fitting at site.

1.6 COORDINATION AND SCHEDULING

- A. Coordinate installation of anchorages for railings.
 - 1. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry.
 - 2. Deliver such items to Project site in time for installation.
- B. Schedule installation so wall attachments are made only to completed walls. DO NOT support railings temporarily by any means that DO NOT satisfy structural performance requirements.

1.7 WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers are subject to requirements. Choose ONE of the manufacturers listed.
- B. Available Manufacturers:
 - 1. Thompson Fabricating LLC,
Tarrant, AL
 - 2. Approved equal.

2.2 METALS, GENERAL

- A. Metal Surfaces, General:
 - 1. Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors:
 - 1. Cast or formed metal of same type of material and finish as supported rails, unless otherwise specified.

2.3 ALUMINUM

- A. Aluminum, General:
 - 1. Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish specified, and with NOT less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
- B. Extruded Structural Pipe and Round Tubing:
 - 1. ASTM B429, Alloy 6063-T6.
 - 2. Provide Standard Weight (Schedule 40) pipe, unless otherwise specified.
- C. Drawn Seamless Tubing:
 - 1. ASTM B210, Alloy 6063-T832.
- D. Plate and Sheet:
 - 1. ASTM B209, Alloy 6061-T6.
- E. Die and Hand Forgings:
 - 1. ASTM B247, Alloy 6061-T6.

- F. Castings:
 - 1. ASTM B26, Alloy A356.0-T6.

2.4 RAIL AND POSTS

- A. Nominal 1 1/2 in. diameter.
- B. Rails:
 - 1. 1.900 in. outside diameter by 0.145 in. wall thickness. Schedule 40.
- C. Posts:
 - 1. 1.900 in. outside diameter by 0.200 in. wall thickness. Schedule 80.

2.5 FITTINGS

- A. Top Mount Base:
 - 1. Cast Aluminum
 - 2. For holes in base for concrete anchors
 - 3. For narrow walls or curbs, furnish two holes in base for concrete anchors with required edge distance.
 - 4. Manufacture and Products:
 - a. Thompson Fabricating LLC
Part No. TBF-3.4
 - b. Thompson Fabricating LLC
Part No. TBF-3.2 for narrow walls and curbs.
- B. Handrail and Post Fittings:
 - 1. Extruded, machined bar stock, permanent mold casting, or die castings of sufficient strength to meet load requirements.
 - 2. Fittings shall match color of pipe in handrails.
 - 3. Sand cast parts NOT permitted.
- C. Side Mounted Handrail Bracket:
 - 1. Extruded aluminum, Alloy 6063-T6 with four holes for bolts or concrete anchors.
 - 2. Manufacturer and Product: Thompson Fabricating LLC; Part TSM-1.50
- D. Handrail Connections to Metal Stairway Stringers:
 - 1. Extruded aluminum bracket, Alloy 6060-T6
 - 2. Brackets and bolts 1/2 in. diameter Type 304 or 316 stainless steel bolts.
 - 3. Offset adjustable stir fitting of cast Al-mag, Part No. ASF
- E. Handrail Connections to Metal Beams:
 - 1. Extruded aluminum bracket, Alloy 6060-T6
 - 2. Bracket bolts 1/2 in. diameter Type 304 stainless steel bolts.
 - 3. Manufacturer and Products: Thompson Fabricating LLC; Part Nos. SMB-2 or SMB-3. Use part no. TSM-1.50 if bracket is attached to flat side of a channel.
- F. Handrail Wall Brackets:
 - 1. Cast Al-mag aluminum bracket, Par No. AWF adjustable wall fitting, with provision for three 3/8 in. Type 304 stainless steel bolts or concrete anchors.
 - 2. Manufacturer and Product: Thompson Fabricating LLC; Part No. AWF.
- G. Miscellaneous Rail to Post Fitting:
 - 1. Cast Aluminum Tee Fitting: Part Nos. TF-1 and TX-1
 - 2. Cast Aluminum Ell Fitting: Part Nos. TE-1, TE-2, and TE-3

3. Aluminum Splice Lock: Part No. SL-1
4. Aluminum Expansion Joint Splice: Part No. CF-2
5. Manufacturer: Thompson Fabricating LLC

H. Handrail Gate:

1. Furnish 6063-T6, 6105-T5, or 6061-T6 extruded aluminum
2. Manufacturer: Thompson Fabricating LLC

I. Toeboards and Accessories:

1. Molded or extruded 6063 or 60621 aluminum
2. Manufacturer:
 - a. Thompson Fabricating LLC

J. Casting for Handrails:

1. Cast Al-mag with sufficient strength to meet load and test requirements. Anodizable grade finish with excellent resistance to corrosion when subject to exposure of sodium chloride solution intermittent spray and emersion.

K. Concrete Embedded Metal Anchorage:

1. As specified in Section 05 50 00 – Metal Fabrications.

2.6 FASTENERS

A. General:

1. Provide:
 - a. As specified in Section 05 50 00 – Metal Fabrications.
 - b. Aluminum Railings: Type 304 or 316 stainless-steel fasteners.

B. Locknuts, Washers, and Screws:

1. Elastic Locknuts, Steel Flat Washers, RHMS Rounded Head Machine Screws; Type A 304 or A 316 stainless steel.
2. Flat Washers: Molded Nylon
3. Manufacturer:
 - a. Mc-Master-Carr Supply Co.

C. Concrete Anchors:

1. Stainless steel Type 304 or 316. Use ICBO approved service load allowable values for size, length, embedment, spacing, and edge distance to match required loads shown in calculations.

D. Epoxy Anchors Heavy Duty 1/2 in. diameter, for exterior use only.

2.7 FABRICATION

A. General:

1. Fabricate railings to comply with requirements specified for design, dimensions, member sizes and spacing, details, finish, and anchorage, but NOT less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 in. unless otherwise specified. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that shall be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as specified to receive finish hardware, screws, and similar items.
- G. Nonwelded Connections:
 - 1. Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 2. Fabricate splice joints for field connection using an epoxy structural adhesive if this is Manufacturer's standard splicing method.
- H. Close exposed ends of railing members with prefabricated end fittings.
- I. Provide wall returns at ends of wall-mounted handrails, unless otherwise specified. Close ends of returns unless clearance between end of rail and wall is 1/4 in. or less.
- J. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- K. For railing posts set in concrete, provide steel sleeves NOT less than 6 in. long with inside dimensions NOT less than 1/2 in. greater than outside dimensions of post, with steel plate forming bottom closure.
- L. For removable railing posts, fabricate slip-fit sockets from stainless-steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to NOT more than 1/40 of post height. Provide socket covers designed and fabricated to resist being dislodged.
 - 1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations specified.
 - 2. Fabricate from same metal as railings.
- M. Toeboards:
 - 1. Where specified, provide toe boards at railings around openings and at edge of open-sided floors and platforms.
 - 2. Fabricate to dimensions and details specified.
 - 3. Dimension between bottom of toeboard and walking surface NOT to exceed 1/4 in.

2.8 FINISHES, GENERAL

- A. See NAAMM – “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work:
 - 1. Variations in appearance of abutting or adjacent pieces are acceptable if they are within 1/2 of the range of approved Samples.

2. Noticeable variations in the same piece are NOT acceptable.
 3. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.9 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
1. Handrail Pipe and Posts: As specified in AA 45, designation AA-M32-C22-A41.
 2. Cast Fittings and Toeboards: As specified in AA 45, designation AA-M10-C22-A41.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if NOT already done.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints and as specified in Manufacturers written instructions.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
1. DO NOT weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 2. Set posts plumb within a tolerance of 1/16 in. in 3 ft.
 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members DO NOT exceed 1/4 in. in 12 ft.
- C. Corrosion Protection:
1. Prevent galvanic action and other forms of corrosion caused from direct contact with concrete and dissimilar metals by coating metal surfaces as specified in manufacturers' recommendations and Section 09 96 00 – High-Performance Coatings.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction:
1. Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.
- F. Mount handrails only on completed walls. DO NOT support handrails temporarily by means NOT satisfying structural performance requirements.

3.3 RAILING CONNECTIONS

- A. Set rails horizontal or parallel to slope of steps. Install posts and rails in the same plane. Remove projects or irregularities and provide smooth surface for sliding hand continuously

along top rail. Use offset rail for use on stairs and platforms if post is attached to web of stringers or structural platform supports.

B. Expansion Joints:

1. Install expansion joints at locations specified but NOT farther apart than required to accommodate thermal movement, maximum interval of 54 ft on center and at structural joints. Provide slip-joint internal sleeve extending 2 in. beyond joint on either side, fasten internal sleeve securely to 1 side, and locate joint within 6 in. of post.

3.4 ANCHORING POSTS

- A. Where specified, use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves fill annular space between the post and sleeve with non-shrink, nonmetallic grout, or anchoring cement mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes NOT less than 5 in. deep and 3/4 in. larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, nonmetallic grout, or anchoring cement, mixed and placed to comply with anchoring material per Manufacturer's written instructions.
- C. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 1/8 in. buildup, sloped away from post.
- D. Where specified, anchor posts with fittings engineered for anchoring posts to concrete.
- E. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members:
 1. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.
- F. Install removable railing sections, where specified, in slip-fit metal sockets cast in concrete.
- G. Anchor bolts shall be stainless steel.

3.5 ANCHORING RAILING ENDS

- A. Anchor railing ends to concrete and masonry with round flanges connected to railing ends and anchored to wall construction with anchors and bolts.

3.6 ATTACHING HANDRAILS TO WALLS

- A. Attach handrails to wall with wall brackets. Provide brackets with 1 1/2 in. clearance from inside face of handrail and finished wall surface.
 1. Use type of bracket with predrilled hole for exposed bolt anchorage.
- B. Locate brackets as specified or, if NOT specified, at spacing required to support structural loads.
- C. Secure wall brackets to building construction:
 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 2. For hollow masonry anchorage, use toggle bolts.

3.7 ADJUSTING AND CLEANING

- A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

3.8 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing Manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that CANNOT be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

END OF SECTION

DIVISION 7
THERMAL AND MOISTURE PROTECTION

SECTION 07 41 13 – METAL ROOF AND WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Metal roof panels
 - 2. Metal wall panels
- B. Related Sections:
 - 1. Section 07 92 00 – Joint Sealants
 - 2. Section 08 90 00 – Louvers and Vents

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Action Submittals:
 - 1. Shop Drawings:
 - a. Layout, profiles and product components including dimensions, anchorage, erection details, flashing details, elevations, plans and sections required to indicate conditions.
 - 2. Samples:
 - a. 12 in. by 12 in. (305 mm by 305 mm) samples of each roofing soffit and flashing product to show selected colors, finishes, and textures used on project.
 - 3. Product Data:
 - a. Submit product data, including manufacturer's SPEC-DATA® product sheet, for specified products.
 - b. MSDS (Material Safety Data Sheets).
- C. Information Submittals:
 - 1. Quality Assurance:
 - a. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
 - b. Manufacturer's instructions: Manufacturer's installation instructions.
 - c. Manufacturer's field reports: Manufacturer's field reports specified.
- D. Closeout Submittals:
 - 1. Warranty: Submit warranty documents specified.
 - 2. Operation and Maintenance Data: Submit Operation and Maintenance Data for installed products.
 - a. Include:
 - 1) Manufacturer's instructions covering maintenance requirements.

1.3 SYSTEM DESCRIPTION:

- A. Materials:
 - 1. G90 hot-dipped galvanized Grade A structural quality steel as specified in ASTM A653 or ASTM A792.
- B. Performance requirements:
 - 1. Wind uplift in compliance with UL Classification 580 for UL Classified 90 rated assemblies.

2. Static air infiltration of 0.06 ft³ per minute/ft² (0.028 liters/second) with 6.24 psi (43 kilopascals) air pressure differential as tested as specified in ASTM E283, E1592, E1646, and E1680.
3. No water infiltration at inward static air pressure differential of NOT less than 6.24 psi (43 kilopascals) and NOT more than 12 psi (83 kilopascals) as tested as specified in ASTM E331.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 1. Installer experienced in performing work of this Section who has specialized in installation of work similar to that required for this project.
 2. Manufacturer qualifications: Manufacturer capable of providing field service representation during construction and approving erection method.
- B. Regulatory Requirements:
 1. FM Class I-90
 2. SMACNA Architectural Sheet Metal Manual
 3. UL 263
 4. UL 580
 5. UL 790
 6. UL 1897
 7. UL 2218
- C. Preinstallation meetings:
 1. Conduct preinstallation meeting to verify project requirements, manufacturer's installation instructions, and manufacturer's warranty requirements.
 2. As specified in Section 01 30 00 – Administrative Requirements.

1.5 DELIVERY, STORAGE & HANDLING

- A. Delivery:
 1. Deliver materials in manufacturer's original packaging with identification labels intact.
- B. Storage and protection:
 1. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
 2. Stack prefinished material to prevent twisting, bending, abrasion, scratching and denting.
 3. Elevate one end of each skid to allow for moisture runoff.
 4. Prevent contact with material that may cause corrosion, discoloration, or staining.
 5. Provide factory-installed strippable vinyl film protective coating to panels.

1.6 PROJECT AMBIENT CONDITIONS

- A. Installation location:
 1. Assemble and erect components only when temperatures are above 40°F (4°C).

1.7 SEQUENCING

- A. Sequence with other work:
 1. Comply with manufacturer's written recommendations for sequencing construction operations.

1.8 WARRANTY

- A. Project Warranty:
 - 1. Refer to Conditions of the Contract for project warranty provisions.
 - 2. Provide 20-year coastal finish warranty.
- B. Manufacturer's Warranty:
 - 1. Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and NOT a limitation of, other rights Owner may have under Contract Documents.
- C. Warranty:
 - 1. Commencing on date of acceptance by Owner.
- D. See Section 01 78 36 – Warranties and Bonds for additional information.

1.9 MAINTENANCE

- A. Comply with manufacturer's written instructions to maintain installed product.

1.10 EXTRA MATERIALS

- A. Provide maintenance materials as specified in Section 01 33 00 – Submittal Procedures.

PART 2 - PRODUCTS

2.1 METAL ROOF PANELS

- A. Trapezoidal-Rib, Standing-Seam Metal Roof Panels:
 - 1. Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.
 - 2. Material: Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet, 22 GA.
 - a. Exterior Finish: Fluoropolymer.
 - b. Color: As selected by Owner or Engineer from manufacturer's full range.
 - 3. Clips: Manufacturer's standard, floating type to accommodate thermal movement; fabricated from zinc-coated (galvanized) steel, aluminum-zinc alloy-coated steel, or stainless-steel sheet.
 - 4. Joint Type: Mechanically seamed, folded as specified in manufacturer's standard.
 - 5. Panel Coverage: 24 in.
 - 6. Panel Height: 3 in.
 - 7. Uplift Rating: UL 60
- B. Finishes:
 - 1. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing NOT less than 70% PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions. Two-coat Fluoropolymer shall be in addition to the manufacturer's prime/adhesive coat.
 - b. PVDF finish shall be equal to, or exceed, Kynar 500 or Hylar 500 specifications.
 - 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.2 INTERIOR AND EXTERIOR METAL WALL PANELS

- A. Tapered-Rib-Profile, Exposed-Fastener Metal Wall Panels:
1. Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Interior wall panels also noted as interior liner panels.
 2. Material:
 - a. Zinc-coated (galvanized) or Aluminum-zinc alloy-coated steel sheet.
 - b. Exterior thickness 24 GA
 - c. Interior thickness 28 GA
 - d. Exterior Finish:
 - 1) Exposed Coil-Coated Finish:
 - a) Two-Coat Fluoropolymer:
 - i. AAMA 621. Fluoropolymer finish containing NOT less than 70% PVDF resin by weight in both color coat and clear topcoat.
 - ii. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - iii. Two-coat Fluoropolymer shall be in addition to the manufacturer's prime/adhesive coat.
 - b) PVDF finish shall be equal to, or exceed, Kynar 500 or Hylar 500 specifications.
 - e. Interior Finish: Manufacturers standard siliconized polyester or approved equal.
 - f. Color: As selected by Owner or Engineer from manufacturer's full range.
 3. Major-Rib Spacing: 12 in o.c.
 4. Panel Coverage: 36 in.
 5. Panel Height: 1.5 in.

B. Materials:

 1. Metallic-Coated Steel Sheet: Restricted-flatness steel sheet, metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A755.
 - a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653, G90 coating designation; structural quality.
 - b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792, Class AZ50 coating designation, Grade 40; structural quality.
 - c. Surface: Smooth, flat finish

2.3 ACCESSORIES

- A. General:
1. Provide all accessories as standard with metal building system manufacturer and as required, whether specified or not, whether indicated or not. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. See indicated profiles and with dimensional and structural requirements.
 2. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
- B. Roof Panel Accessories:
1. Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

2. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
 3. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 4. Closure Strips: Closed-cell, expanded, cellular, rubber or cross-linked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1 in. thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to make sure of weather tight construction.
- C. Wall Panel Accessories:
1. Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.
 2. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
 3. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 4. Closure Strips: Closed-cell, expanded, cellular, rubber or cross-linked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1 in. thick, flexible closure strips; cut or pre-molded to match metal wall panel profile. Provide closure strips where indicated or necessary to make sure weather tight construction.
- D. Flashing and Trim:
1. Formed from 24 GA nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet pre-painted with coil-coating; finished to match adjacent metal panels.
 2. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are NOT limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
- E. Gutters:
1. 6 in. K style, formed from 24 GA nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet pre-painted with coil-coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96 in. long sections, sized as specified in SMACNA's "Architectural Sheet Metal Manual."
 2. Gutter Supports: Fabricated from same material and finish as gutters.
 3. Strainers: Bronze, copper, or aluminum wire ball type at outlets.
- F. Downspouts:
1. Formed from 24 GA nominal-thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet pre-painted with coil-coating; finished to match metal wall panels. Fabricate in minimum 10 ft long sections, complete with formed elbows and offsets.
 2. Mounting Straps: Fabricated from same material and finish as gutters.
- G. Louvers:
1. See Section 08 90 00 – Louvers and Vents, and Drawings.
- H. Roof Curbs:
1. Fabricated from minimum 0.052 in. nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet pre-painted with coil-coating; finished to match metal roof panels; with welded top box and bottom skirt, and integral full-length cricket; capable of withstanding loads of size and height indicated.

2. Curb Sub-framing: Fabricated from 0.064 in. nominal-thickness, angle-shaped, C-shaped, or Z-shaped metallic-coated steel sheet.
 3. Insulation: 1 in. thick, rigid type.
- I. Materials:
1. Fasteners:
 - a. Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
 - b. Fasteners for Metal Roof Panels:
 - 1) Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless-steel cap or zinc-aluminum-alloy head and EPDM sealing washer.
 - c. Fasteners for Metal Wall Panels:
 - 1) Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with EPDM sealing washers bearing on weather side of metal panels.
 - d. Fasteners for Flashing and Trim:
 - 1) Blind fasteners or self-drilling screws with hex washer head.
 - e. Blind Fasteners:
 - 1) High-strength aluminum or stainless-steel rivets.
 2. Corrosion-Resistant Coating:
 - a. Cold-applied asphalt mastic, compounded for 15 mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
 3. Nonmetallic, Shrinkage-Resistant Grout:
 - a. ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30 minute working time.
 4. Metal Panel Sealants:
 - a. Sealant Tape:
 - 1) Pressure-sensitive, 100% solids, gray polyisobutylene-compound sealant tape with release-paper backing.
 - 2) Provide permanently elastic, non-sag, nontoxic, nonstaining tape of manufacturer's standard size.
 - b. Joint Sealant:
 - 1) ASTM C920
 - 2) One-part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weather tight.
 - 3) As recommended by metal building system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Before erection proceeds, survey elevations and locations of concrete-bearing and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.
- C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and prepare surfaces to be painted as specified in manufacturer's written instructions for each substrate condition.
- B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 METAL PANEL INSTALLATION, GENERAL

- A. Examination:
 - 1. Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.
 - 2. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.
- B. General:
 - 1. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 2. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.
 - a. Field cutting of metal panels by torch is NOT permitted unless approved in writing by manufacturer.
 - 3. Install metal panels perpendicular to structural supports unless otherwise indicated.
 - 4. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
 - 5. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 6. Locate metal panel splices over, but NOT attached to, structural supports with end laps in alignment.
 - 7. Lap metal flashing over metal panels to allow moisture to run over and off the material.
- C. Lap-Seam Metal Panels:
 - 1. Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.
 - 2. Arrange and nest side-lap joints so prevailing winds blow over, NOT into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weather tight enclosure. Avoid "panel creep" or application NOT true to line.
- D. Metal Protection:
 - 1. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
- E. Joint Sealers:
 - 1. Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if NOT indicated, provide types recommended by metal panel manufacturer.

2. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
3. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 – Joint Sealants.

3.4 METAL ROOF PANEL INSTALLATION

- A. General:
 1. Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
 2. Install ridge caps as metal roof panel work proceeds.
 3. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.
- B. Lap-Seam Metal Roof Panels:
 1. Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.
 2. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.
 3. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
 4. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
 5. At metal panel splices, nest panels with minimum 6 in. end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.
- C. Metal Fascia Panels:
 1. Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.
- D. Metal Roof Panel Installation Tolerances:
 1. Shim and align metal roof panels within installed tolerance of 1/4 in. in 20 ft on slope and location lines as indicated and within 1/8 in. offset of adjoining faces and of alignment of matching profiles.

3.5 METAL WALL PANEL INSTALLATION

- A. General:
 1. Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 2. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
 3. Shim or otherwise plumb substrates receiving metal wall panels.
 4. When two rows of metal panels are required, lap panels 4 in. minimum.
 5. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
 6. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Predrill panels.
 7. Flash and seal metal wall panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
 8. Install screw fasteners in predrilled holes.
 9. Install flashing and trim as metal wall panel work proceeds.

10. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated; or, if NOT indicated, as necessary for waterproofing.
 11. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
 12. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
- B. Metal Wall Panels:
1. Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.
- C. Installation Tolerances:
1. Shim and align metal wall panels within installed tolerance of 1/4 in. in 20 ft, non-accumulative, on level, plumb, and on location lines as indicated, and within 1/8 in. offset of adjoining faces and of alignment of matching profiles.

END OF SECTION

SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Custom flashing and trim fabrications, made from:
 - a. Sheet metal materials
 - b. Underlayment
 - c. Miscellaneous materials
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete
 - 2. Section 04 20 00 – Unit Masonry
 - 3. Section 07 72 00 – Roof Accessories

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Action Submittals:
 - 1. Product Data:
 - a. For each type of product.
 - 2. Shop Drawings:
 - a. For sheet metal flashing and trim.
 - b. Plans, elevations, sections, and attachment details.
 - c. Fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
 - d. Identification of material, thickness, weight, and finish for each item and location in Project.
 - e. Details for forming, including profiles, shapes, seams, and dimensions.
 - f. Details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 - g. Details of termination points and assemblies.
 - h. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
 - i. Details of roof-penetration flashing.
 - j. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
 - k. Details of special conditions.
 - l. Details of connections to adjoining work.
 - m. Formed flashing and trim at scale of not less than 1 1/2 in. per 12 in.
 - 3. Samples:
 - a. For each exposed product and for each color and texture specified, 12 in. long by actual width.
 - b. Samples for Initial Selection:
 - 1) Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.
 - c. Samples for Verification:
 - 1) Actual sample of finished products for each type of exposed finish for sheet metal and other metal accessories.
 - 2) Sheet Metal Flashing and Trim: Manufacturers' standard size. Include finished seam with required profile. Include fasteners, cleats, clips, closures, and other attachments.

- 3) Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

C. Informational Submittals:

1. Certificates:
 - a. For each type of coping and roof edge flashing that is FM Approvals approved.
2. Product Test Reports:
 - a. For each product, for tests performed by a qualified testing agency.
3. Research Reports:
 - a. For copings and roof edge flashing, as specified in ANSI/SPRI/FM 4435/ES-1.
4. Qualification Statements:
 - a. For fabricator.
5. Warranties.
6. Closeout Submittals:
 - a. Maintenance Data: For sheet metal flashing and trim, and its accessories.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference:

1. Conduct conference at Project site.
2. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
4. Review requirements for insurance and certificates if applicable.
5. Review sheet metal flashing observation and repair procedures after flashing installation.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications:

1. Entity that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications:

1. Entity that employs a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers.

- C. For roof edge flashings and copings that are FM Approvals approved, shop is to be listed as able to fabricate required details as tested and approved.

1.5 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical roof edge, including gutter, fascia, fascia trim, approximately 10 ft long, including supporting construction cleats, seams, attachments, and accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Subject to requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
 - 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
 - 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.7 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.8 WARRANTY

- A. Special Warranty on Finishes:
 - 1. Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 2. Exposed Panel Finish: Deterioration includes, but is not limited to:
 - a. Color fading more than 5 Delta E units when tested as specified in ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested as specified in ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 3. Finish Warranty Period: 20 years from date of Substantial Completion.
- B. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.
- B. Sheet Metal Standard for Flashing and Trim:
 - 1. As specified in NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are specified.
- C. SPRI Wind Design Standard:
 - 1. Manufacture and install roof edge flashings and copings tested as specified in ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:
 - 2. Design Pressure: As specified in Drawings.
- D. FM Approvals Listing:

1. Manufacture and install roof edge flashings and copings that are as specified in FM Approvals 4471 as part of a roofing system and that are listed in FM Approvals' "Approval Guide" and approved for windstorm classification, Class 1A-90. Identify materials with name of fabricator and design approved by FM Approvals.

E. Thermal Movements:

1. Allow for thermal movements from ambient and surface temperature changes.
2. Temperature Change: 120°F, ambient; 180°F, material surfaces.

2.2 SHEET METAL MATERIALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet:

1. Zinc-coated (galvanized) steel sheet as specified in minimum ASTM A653, G90 coating designation, or aluminum-zinc alloy-coated steel sheet as specified in minimum ASTM A792, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process as specified in ASTM A755.
2. Nominal Thickness: 0.022 in.
3. Surface: To match existing.
4. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70% PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces as specified in coating and resin manufacturers' written instructions.
5. Color: As selected by Owner
6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

C. Aluminum Sheet:

1. Coil-coated sheet, ASTM B209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
2. Thickness: 0.032 in.
3. Surface: To match existing.
4. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70% PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces as specified in coating and resin manufacturers' written instructions.
5. Color: As selected by Owner.
6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.
7. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
8. Color Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. Color: As selected by Owner.
 - b. Color Range: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
9. As-Milled Finish: Standard two-side bright.
10. Alclad Finish: Metallurgically bonded surfacing alloy on both sides, forming aluminum sheet with reflective luster.

11. Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil.

D. Stainless Steel Sheet:

1. ASTM A240, Type 316, dead soft, fully annealed.
2. Nominal Thickness: 0.0250 in.
3. Surface: To match existing.
4. Exterior Finish: ASTM A480, No. 2B (bright, cold rolled).
 - a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 - b. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1) Run grain of directional finishes with long dimension of each piece.
 - 2) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.3 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise specified.

B. Fasteners:

1. Self-tapping screws and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
2. General:
 - a. Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - b. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - c. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
 - d. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
3. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel as specified in ASTM A153 or ASTM F2329.
4. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
5. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
6. Fasteners for Copper, Zinc-Tin Alloy-Coated Copper, or Copper-Clad Stainless Steel Sheet: Copper, hardware bronze or passivated Series 300 stainless steel.
7. Fasteners for Zinc Sheet: Series 300 stainless steel.

C. Sealant Tape:

1. Pressure-sensitive, 100% solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 in. wide and 1/8 in. thick.

D. Elastomeric Sealant:

1. ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant:

1. ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Epoxy Seam Sealer:
1. Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- G. Bituminous Coating:
1. Cold-applied asphalt emulsion as specified in ASTM D1187.
- H. Asphalt Roofing Cement:
1. ASTM D4586, asbestos free, of consistency required for application.

2.4 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim as specified in details and in recommendations for cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 2. Fabricate sheet metal flashing and trim in thickness or weight needed as specified in performance requirements, but not less than that specified for each application and metal.
 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 in. in 20 ft on slope and location lines specified in Drawings and within 1/8 in. offset of adjoining faces and of alignment of matching profiles.
 2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions:
1. Form metal for thermal expansion of exposed flashing and trim.
 2. Form expansion joints of intermeshing hooked flanges, not less than 1 in. deep, filled with butyl sealant concealed within joints.
 3. Use lapped expansion joints only where specified in Drawings.
- D. Sealant Joints:
1. Where movable, non-expansion-type joints are required, form metal as specified in cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.
- G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

H. Do not use graphite pencils to mark metal surfaces.

2.5 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters:

1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
2. Fabricate in minimum 96 in. long sections.
3. Furnish flat-stock gutter brackets and gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
4. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
5. Gutter Profile: As selected by Owner.
6. Expansion Joints: Lap type.
7. Accessories: Continuous, removable leaf screen with sheet metal frame and hardware cloth screen.
8. Gutters with Girth up to 15 in. (380 mm):
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.022 in. thick.

B. Built-in Gutters:

1. Fabricate to cross section required, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required.
2. Fabricate in minimum 96 in. long sections. Fabricate expansion joints and accessories from same metal as gutters unless otherwise specified.
3. Fabricate gutters with built-in expansion joints and gutter-end expansion joints at walls.
4. Accessories: Continuous, removable leaf screen with sheet metal frame and hardware cloth screen.
5. Fabricate from:
 - a. Stainless Steel: 0.0156 in.

C. Downspouts:

1. Fabricate rectangular downspouts to dimensions specified in Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
2. Fabricated Hanger Style: Fig. 1-35A as specified in SMACNA's "Architectural Sheet Metal Manual."
3. Manufactured Hanger Style: Fig. 1-34A as specified in SMACNA's "Architectural Sheet Metal Manual."
4. Fabricate from:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.022 in. thick.

2.6 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing and Fascia Cap:

1. Fabricate in minimum 96 in. long, but not exceeding 12 ft long sections. Furnish with 6 in. wide, joint cover plates. Shop fabricate interior and exterior corners.

2. Joint Style: Overlapped, 4 in. wide.
 3. Fabricate from:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.028 in. thick.
- B. Copings:
1. Fabricate in minimum 96 in. long, but not exceeding 12 ft long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, fasten and seal watertight. Shop fabricate interior and exterior corners.
 2. Coping Profile: Fig. 3-4A specified in SMACNA's "Architectural Sheet Metal Manual."
 3. Joint Style: Butted with expansion space and 6 in. wide, concealed backup plate.
 4. Fabricate from:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.040 in. thick.
- C. Expansion-Joint Cover:
1. Shop fabricate interior and exterior corners.
 2. Fabricate roof and roof-to-wall transition expansion-joint cover from:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.034 in. thick.
- D. Base Flashing:
1. Shop fabricate interior and exterior corners.
 2. Fabricate from:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.028 in. thick.
- E. Counterflashing:
1. Shop fabricate interior and exterior corners.
 2. Fabricate from the following materials:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.022 in. thick.
- F. Flashing Receivers:
1. Aluminum-Zinc Alloy-Coated Steel: 0.022 in. thick.
- G. Roof-Penetration Flashing:
1. Aluminum-Zinc Alloy-Coated Steel: 0.028 in. thick.
- 2.7 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS
- A. Apron, Step, Cricket, and Backer Flashing:
1. Aluminum-Zinc Alloy-Coated Steel: 0.022 in. thick.
- B. Valley Flashing:
1. Aluminum-Zinc Alloy-Coated Steel: 0.028 in. thick.
- C. Drip Edges:
1. Aluminum-Zinc Alloy-Coated Steel: 0.022 in. thick.
- D. Eave, Rake, Ridge, and Hip Flashing:
1. Aluminum-Zinc Alloy-Coated Steel: 0.022 in. thick.
- E. Counterflashing:
1. Shop fabricate interior and exterior corners.
 2. Fabricate from:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.022 in. thick.
- F. Flashing Receivers:

1. Aluminum-Zinc Alloy-Coated Steel: 0.022 in. thick.

G. Roof-Penetration Flashing:

1. Aluminum-Zinc Alloy-Coated Steel: 0.028 in. thick.

2.8 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing:

1. Fabricate continuous flashings in minimum 96 in. long, but not exceeding 12 ft long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 in. beyond each side of wall openings; and form with 2 in. high, end dams.
2. Fabricate from:
 - a. Stainless Steel: 0.0156 in. thick.

B. Opening Flashings in Frame Construction:

1. Fabricate head, sill, jamb, and similar flashings to extend 4 in. beyond wall openings.
2. Form head and sill flashing with 2 in. high, end dams.
3. Fabricate from:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.022 in. thick.

C. Wall Expansion-Joint Cover:

1. Aluminum-Zinc Alloy-Coated Steel: 0.028 in. thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing:

1. Aluminum-Zinc Alloy-Coated Steel: 0.028 in. thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, as specified in requirements for installation tolerances, substrates, and other conditions affecting performance of the Work.
1. Verify compliance with requirements for installation tolerances of substrates.
 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 3. Verify that air- or water-resistant barriers have been installed over substrate to prevent air infiltration or water penetration.

3.2 INSTALLATION OF UNDERLAYMENT

A. Synthetic Underlayment:

1. Install synthetic underlayment, wrinkle free, as specified in manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
2. Lap horizontal joints not less than 4 in.
3. Lap end joints not less than 12 in.

B. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. As specified in temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.

4. Apply in shingle fashion to shed water, with end laps of not less than 6 in. staggered 24 in. between courses.
5. Overlap side edges not less than 3 1/2 in. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM, GENERAL

- A. Install sheet metal flashing and trim as specified in details and in recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise specified in Drawings.
 1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
 3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
 4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
 5. Install continuous cleats with fasteners spaced not more than 12 in. o.c.
 6. Space individual cleats not more than 12 in. apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
 8. Do not field cut sheet metal flashing and trim by torch.
 9. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection:
 1. Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
 2. Coat concealed side of uncoated-aluminum sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
 3. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
 1. Space movement joints at maximum of 10 ft with no joints within 24 in. of corner or intersection.
 2. Form expansion joints of intermeshing hooked flanges, not less than 1 in. deep, filled with sealant concealed within joints.
 3. Use lapped expansion joints only where specified in Drawings.
- D. Fasteners:
 1. Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
 1. Use sealant-filled joints unless otherwise specified.
 - a. Embed hooked flanges of joint members not less than 1 in. into sealant.

- b. Form joints to completely conceal sealant.
 - c. When ambient temperature at time of installation is between 40°F–70°F, set joint members for 50% movement each way.
 - d. Adjust setting proportionately for installation at higher ambient temperatures.
 - 1) Do not install sealant-type joints at temperatures below 40°F.
- 2. Prepare joints and apply sealants as specified in Section 07 92 00 – Joint Sealants.

G. Rivets:

- 1. Rivet joints in uncoated aluminum where necessary for strength.

3.4 INSTALLATION OF ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Install sheet metal roof-drainage items to produce complete roof-drainage system as specified in cited sheet metal standard unless otherwise specified. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters:

- 1. Join sections with joints sealed with sealant.
- 2. Provide for thermal expansion.
- 3. Attach gutters at eave or fascia to firmly anchor them in position.
- 4. Provide end closures and seal watertight with sealant.
- 5. Slope to downspouts.
- 6. Fasten gutter spacers to front and back of gutter.
- 7. Anchor and loosely lock back edge of gutter to continuous eave or apron flashing.
- 8. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 in. apart.
- 9. Anchor gutter with gutter brackets or straps spaced not more than 24 in. apart to roof deck unless otherwise specified, and loosely lock to front gutter bead.
- 10. Install gutter with expansion joints at locations specified in Drawings, but not exceeding, 50 ft. Install expansion-joint caps.
- 11. Install continuous gutter screens on gutters with noncorrosive fasteners, removable for cleaning gutters.

C. Built-in Gutters:

- 1. Join sections with joints sealed with sealant.
- 2. Provide for thermal expansion.
- 3. Slope to downspouts.
- 4. Provide end closures and seal watertight with sealant.
- 5. Install underlayment layer in built-in gutter trough and extend to drip edge at eaves and under underlayment on roof sheathing.
 - a. Lap sides minimum of 2 in. over underlying course.
 - b. Lap ends minimum of 4 in.
 - c. Stagger end laps between succeeding courses at least 72 in.
 - d. Fasten with roofing nails.
 - e. Install slip sheet over underlayment.
- 6. Anchor and loosely lock back edge of gutter to continuous eave or apron flashing.
- 7. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 18 in. apart.
- 8. Install gutter with expansion joints at locations specified in Drawings, but not exceeding, 50 ft apart. Install expansion-joint caps.

D. Downspouts:

- 1. Join sections with 1 1/2 in. telescoping joints.
- 2. Provide hangers with fasteners designed to hold downspouts securely to walls.
- 3. Locate hangers at top and bottom and at approximately 60 in. o.c.
- 4. Provide elbows at base of downspout to direct water away from building.

5. Connect downspouts to underground drainage system.

E. Expansion-Joint Covers:

1. Install expansion-joint covers at locations and of configuration specified on Drawings. Lap joints minimum of 4 in. in direction of water flow.

3.5 INSTALLATION OF SLOPED ROOF SHEET METAL FABRICATIONS

A. Install sheet metal flashing and trim as specified in performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings as specified in ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces as specified in recommendations in cited sheet metal standard unless otherwise specified. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3 in. centers.
3. Anchor to resist uplift and outward forces as specified in recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:

1. Install copings as specified in ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces as specified in recommendations in cited sheet metal standard unless otherwise specified.
 - a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24 in. centers.
 - b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24 in. centers.
3. Anchor to resist uplift and outward forces as specified in recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing:

1. Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 in. over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing:

1. Coordinate installation of counterflashing with installation of base flashing.
2. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
3. Extend counterflashing 4 in. over base flashing.
4. Lap counterflashing joints minimum of 4 in.
5. Secure in waterproof manner by means of snap-in installation and sealant unless otherwise specified.

F. Roof-Penetration Flashing:

1. Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL SHEET METAL FABRICATIONS

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture as specified in cited sheet metal standard unless otherwise specified. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction:
 - 1. Install continuous head, sill, jamb, and similar flashings to extend 4 in. beyond wall openings.
- C. Reglets:
 - 1. Installation is specified in Section 03 30 00 – Cast-in-Place Concrete and Section 04 20 00 – Unit Masonry.

3.7 INSTALLATION OF MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing:
 - 1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
 - 2. Weld or seal flashing with elastomeric sealant to equipment support member.
- B. Overhead-Piping Safety Pans:
 - 1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise specified in Drawings.
 - 2. Pipe and install drain line to plumbing waste or drainage system.

3.8 INSTALLATION TOLERANCES

- A. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 in. in 20 ft on slope and location lines specified in Drawings and within 1/8 in. offset of adjoining faces and of alignment of matching profiles.

3.9 CLEANING

- A. Clean and neutralize flux materials. Clean off excess solder.
- B. Clean off excess sealants.

3.10 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise specified in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION

SECTION 07 72 00 – ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Roof curbs
 - 2. Equipment supports

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. For each type of roof accessory indicated.
- C. Shop Drawings:
 - 1. For roof accessories.
- D. Samples:
 - 1. For each exposed product and for each color and texture specified.
- E. Coordination Drawings:
 - 1. Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items.
- F. Operation and maintenance data.

1.3 WARRANTY:

- A. Sample of special warranty.
- B. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet:
 - 1. ASTM A653, G90 (Z275) coating designation.
 - 2. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
 - 3. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
 - 4. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing NOT less than 70% PVDF resin by weight.
 - 5. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet:
 - 1. ASTM A792, AZ50 (AZM150) coated.

2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
3. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing NOT less than 70% PVDF resin by weight.
4. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat.

C. Aluminum Sheet:

1. ASTM B209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
2. Mill Finish: As manufactured.
3. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
4. Clear Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.
5. Color Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.
6. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 620; system consisting of primer and fluoropolymer color topcoat containing NOT less than 70% PVDF resin by weight.
7. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm).

D. Aluminum Extrusions and Tubes:

1. ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.

E. Stainless-Steel Sheet and Shapes:

1. ASTM A240 or ASTM A666, Type 304

F. Steel Shapes:

1. ASTM A36, hot-dip galvanized as specified in ASTM A123 unless otherwise indicated.

2.2 MISCELLANEOUS MATERIALS

A. General:

1. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Wood Nailers:

1. Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; NOT less than 1 1/2 in. (38 mm) thick.

C. Fasteners:

1. Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.

D. Sealants:

1. As recommended by roof accessory manufacturer for installation indicated.

2.3 ROOF CURBS

A. Roof Curbs:

1. Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, and integrally formed deck-mounting flange at perimeter bottom.
2. Manufacturers (Subject to requirements):
 - a. AES Industries, Inc.
 - b. Curbs Plus, Inc.
 - c. Custom Solution Roof and Metal Products
 - d. Greenheck Fan Corporation
 - e. LM Curbs
 - f. Metallic Products Corp.
 - g. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
 - h. Pate Company (The)
 - i. Roof Products, Inc.
 - j. Safe Air of Illinois
 - k. Thybar Corporation
 - l. Vent Products Co., Inc.
 - m. [Or Approved Equal.]

B. Material:

1. Zinc-coated (galvanized) 18-gauge steel sheet
2. Finish: Mill phosphatized
3. Insulation: Factory insulated with 1 1/2 in. (38 mm) thick glass-fiber board insulation.
4. Liner: 0.63 in. aluminum liner.
5. Factory-installed wood nailer at top of curb, continuous around curb perimeter.
6. Fabricate curbs to minimum height of 12 in. (300 mm) unless otherwise indicated.
7. Top Surface: Level around perimeter with roof slope accommodated by sloping the deck-mounting flange.
8. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.

2.4 EQUIPMENT SUPPORTS

A. Equipment Supports:

1. Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints and integrally formed deck-mounting flange at perimeter bottom.
2. Manufacturers (Subject to requirements):
 - a. AES Industries, Inc.
 - b. Curbs Plus, Inc.
 - c. Custom Solution Roof and Metal Products
 - d. Greenheck Fan Corporation
 - e. LM Curbs
 - f. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
 - g. Pate Company (The)
 - h. Roof Products, Inc.
 - i. Thybar Corporation
 - j. Vent Products Co., Inc.
 - k. Other Approved Equal.

- B. Material:
 - 1. Zinc-coated (galvanized) 18-gauge steel sheet
 - 2. Finish: Mill phosphatized
- C. Construction:
 - 1. Fabricate equipment supports to minimum height of 12 in. (300 mm) unless otherwise specified.
 - 2. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Verify dimensions of roof openings for roof accessories. Install roof accessories as specified in manufacturer's written instructions.
 - 2. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
 - 3. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 4. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 - 5. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection:
 - 1. Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
- C. Roofing Protection:
 - 1. Protect roofing using details approved by the roofing manufacturer.
 - 2. Roofing materials shall be continuous under equipment supports or terminate vertically NOT less than 8 in. above the roof surface.
 - 3. If mechanical units are of a size or weight that they will crush the insulation, then the insulation below the sleeper shall be replaced by wood blocking.
- D. Seal joints with sealant as required by roof accessory manufacturer.

3.2 REPAIR AND CLEANING

- A. Galvanized Surfaces:
 - 1. Clean field welds, bolted connections, and abraded areas and repair galvanizing as specified in ASTM A780.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting as specified in Division 9 – Finishes.
- C. Replace roof accessories that have been damaged or that can NOT be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 92 00 – JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Silicone joint sealants
 - 2. Urethane joint sealants
 - 3. Preformed joint sealants
- B. Related Sections:
 - 1. Section 04 20 00 – Unit Masonry

1.2 SUBMITTALS

- A. Product Data:
 - 1. For each joint-sealant product specified.
- B. Samples for Initial Selection:
 - 1. Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification:
 - 1. For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2 in. wide joints formed between two 6 in. long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule:
 - 1. Joint-sealant application, joint location, and designation
 - 2. Joint-sealant manufacturer and product name
 - 3. Joint-sealant formulation
 - 4. Joint-sealant color
- E. Qualification Data:
 - 1. For qualified Installer and testing agency.
- F. Product Certificates:
 - 1. For each kind of joint sealant and accessory, from manufacturer.
- G. Product Test Reports:
 - 1. Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
- H. Preconstruction Compatibility and Adhesion Test Reports:
 - 1. From sealant manufacturer, specifying:
 - a. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - b. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- I. Warranties:
 - 1. Sample of special warranties.

1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing:
 - 1. Submit to joint-sealant manufacturers, for testing specified below, samples of materials that shall contact or affect joint sealants.
 - 2. Use ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 3. Submit NOT fewer than three pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 - 4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 5. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
 - 6. Testing shall NOT be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, NOT older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations:
 - 1. Obtain each kind of joint sealant from single source from single manufacturer.
- C. Product Testing:
 - 1. Test joint sealants using a qualified testing agency.
 - a. Testing Agency Qualifications: An independent testing agency qualified as specified in ASTM C1021 to conduct the testing.
 - b. Test as specified in SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.
- D. Preinstallation Conference:
 - 1. Conduct conference at Project Site.

1.5 PROJECT CONDITIONS

- A. DO NOT proceed with installation of joint sealants under:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40°F;
 - 2. When joint substrates are wet;
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications specified;
 - 4. Where contaminants capable of interfering with adhesion have NOT yet been removed from joint substrates.

1.6 WARRANTY

- A. Special Installer's Warranty:
 - 1. Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that DO NOT comply with performance and other requirements specified in this section within specified warranty period.

2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty:
 1. Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that DO NOT comply with performance and other requirements specified in this section within specified warranty period.
 2. Warranty Period: Two years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from:
 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.
- D. See Section 01 78 36 – Warranties and Bonds for additional information.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility:
 1. Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Liquid-Applied Joint Sealants:
 1. See ASTM C920 and other requirements specified for each liquid-applied joint sealant specified, including those referencing ASTM C920 classifications for type, grade, class, and uses related to exposure and joint substrates.
 2. Suitability for Immersion in Liquids: Where sealants are indicated for Use I for joints that shall be continuously immersed in liquids, provide products that have undergone testing as specified in ASTM C1247. Liquid used for testing sealants is deionized water, unless otherwise specified.
- C. Colors of Exposed Joint Sealants:
 1. As specified by manufacturer's designations.

2.2 SILICONE JOINT SEALANTS

- A. One-Part Silicones: ASTM C920, Type S, Grade NS, Class 25
 1. 795 Silicone Structural Glazing, Glazing, and Weatherproofing Sealant, by Dow Corning (colors only)
 2. Construction 1200 Sealant, General Electric Company
 3. 999-A, Dow Corning
 4. 864 Architectural Silicone, by Pecora Corporation (colors only)

2.3 URETHANE JOINT SEALANTS

- A. Two-Part Urethane: Self-Leveling, ASTM C920, Type M, Grade P, Class 25
 1. Chem-Calk CC-550, by Bostik
 2. Vulkem 245, by Mameco
 3. Vulkem 255, Wide-Joint, by Mameco

4. NR-200 Urethane, by Pecora Corporation
 5. Sikaflex-2c NS/SL, by Sika Corporation
- B. Two-Part Urethane: Non-Sag, ASTM C920, Type M, Grade NS, Class 25
1. Chem-Calk 500, by Bostik
 2. Vulkem 227, by Mameco.
 3. Dynatrol II, by Pecora Corporation.
 4. Sikaflex-2c NS/SL, by Sika Corporation.
 5. Sonolastic NP 2, by Sonneborn Building Products, ChemRex Inc.
- C. One-Part Urethane: Self-Leveling, ASTM C920, Type S, Grade P, Class 25.
1. Vulkem 45, by Mameco
 2. Urethane NR-201, by Pecora Corporation
 3. Sonolastic SL1, by Sonneborn Building Products, ChemRex Inc.
 4. Sikaflex 1C-SL by Sika
- D. One-Part Urethane: Non-Sag, ASTM C920, Type S, Grade NS, Class 25
1. Chem-Calk 900, by Bostik
 2. Vulkem 116, by Mameco
 3. Sonolastic NP I, by Sonneborn Building Products, ChemRex Inc.
 4. Sikaflex 1A by Sika

2.4 PREFORMED JOINT SEALANTS

- A. Preformed Silicone Joint Sealants:
1. Manufacturer's standard sealant consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths specified, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.
 2. Available Manufacturers (Subject to requirements, Choose ONE):
 - a. Dow Corning Corporation; 123 Silicone Seal
 - b. GE Advanced Materials – Silicones; UltraSpan US1100
 - c. Pecora Corporation; Sil-Span

2.5 JOINT SEALANT BACKING

- A. General:
1. Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings:
1. ASTM C1330, Type C (closed-cell material with a surface skin) OR Type O (open-cell material), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

2.6 MISCELLANEOUS MATERIALS

- A. Primer:
1. Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces:
1. Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint

substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants to joint substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints:
 - 1. Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
 - 2. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 3. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
 - 4. Porous joint substrates include:
 - a. Concrete
 - b. Masonry
 - c. Exterior insulation and finish systems
 - 5. Remove laitance and form-release agents from concrete.
 - 6. Clean nonporous joint substrate surfaces with chemical cleaners or other means that DO NOT stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
 - 7. Nonporous joint substrates include:
 - a. Metal
- B. Joint Priming:
 - 1. Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; DO NOT allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General:
 - 1. See joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard:
 - 1. Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. DO NOT leave gaps between ends of sealant backings.
 - 2. DO NOT stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are NOT used between sealants and backs of joints.
- E. Sealant Installation:
 - 1. Use proven techniques where backings are installed.
 - 2. Place sealants so they directly contact and fully wet joint substrates.
 - 3. Completely fill recesses in each joint configuration.
 - 4. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Non-Sag Sealants:
 - 1. Immediately after sealant application and before skinning or curing begins, tool sealants as specified in subparagraphs below to form smooth, uniform beads of configuration specified; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 2. Remove excess sealant from surfaces adjacent to joints.
 - 3. Use tooling agents that are approved in writing by sealant manufacturer and that DO NOT discolor sealants or adjacent surfaces.
 - 4. Provide concave joint profile per Figure 8A in ASTM C1193, unless otherwise specified.
 - 5. Provide flush joint profile where specified per Figure 8B in ASTM C1193.
 - 6. Provide recessed joint configuration of recess depth and at locations specified per Figure 8C in ASTM C1193.
- G. Installation of Preformed Silicone-Sealant System:
 - 1. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of NOT less than 3/8 in. Hold edge of sealant bead 1/4 in. inside masking tape.
 - 2. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 - 3. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

3.4 FIELD QUALITY REQUIREMENTS

- A. Field-Adhesion Testing:
 - 1. Field test joint-sealant adhesion to joint substrates.
 - 2. Extent of Testing:
 - a. Test completed and cured sealant joints.
 - b. Perform 10 tests for the first 1,000 ft of joint length for each kind of sealant and joint substrate.
 - c. Perform 1 test for each 1,000 ft of joint length thereafter or 1 test per each floor per elevation.

3. Test Method:
 - a. Test joint sealants as specified in Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
 - b. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
4. Inspect tested joints and report on:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
5. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
6. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion Test Results:

1. Sealants NOT evidencing adhesive failure from testing or noncompliance with other specified requirements shall be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with specified requirements.

3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

DIVISION 8
OPENINGS

SECTION 08 90 00 – LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Combination, Drainable extruded-aluminum louvers.
 - 2. Stationary, Drainable extruded-aluminum louvers.
- B. Related sections:
 - 1. Section 07 92 00 – Joint Sealants

1.2 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades, i.e., the axes of the blades are horizontal.
- C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 - 1. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft. acting inward or outward.
- B. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.4 SUBMITTALS

- A. Product Data: For each type of louver indicated.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2, "Structural Welding Code - Aluminum."
 - 2. AWS D1.3, "Structural Welding Code - Sheet Steel."
 - 3. AWS D1.6, "Structural Welding Code - Stainless Steel."

- C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.
- D. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. Use screws for exposed fasteners unless otherwise indicated.
 - 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 - 3. For fastening stainless steel, use 300 series stainless-steel fasteners.
 - 4. For color-finished louvers, use fasteners with heads that match color of louvers.
- C. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E488, conducted by a qualified independent testing agency.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.2 FABRICATION, GENERAL

- A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
 - 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern.
 - 2. Horizontal Mullions: Provide horizontal mullions at joints.
- C. Maintain equal louver blade spacing to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but NOT more than recommended by manufacturer, or 72 inches o.c., whichever is less.
- G. Provide subsills made of same material as louvers or extended for recessed louvers.

- H. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.3 COMBINATION, DRAINABLE EXTRUDED-ALUMINUM LOUVERS

- A. Louver Construction and Operation: Provide operable louvers with extruded-aluminum frames and blades NOT less than 0.080-inch nominal thickness, and with operating mechanisms to suit louver sizes.
 - 1. Motor operation with 2-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch.
- B. Dual-Blade, Drainable-Blade, combination Louver: Fixed drainable blades and adjustable plain blades combined in single frame.
 - 1. Louver Depth 6 inches.
 - 2. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 STATIONARY, DRAINABLE EXTRUDED-ALUMINUM LOUVER

- A. Louver Construction: Provide stationary louver with extruded-aluminum frame and blades NOT less than 0.080-inch (2.0-mm) nominal thickness. Frame shall be integral flange type.
 - 1. Hinged frame: Continuous piano hinge
 - 2. Louver Depth: 4 inches (100 mm)

2.5 LOUVER SCREENS

- A. General: Provide screen at each exterior louver
 - 1. Screening Type: Insect screening.

2.6 EXTENDED SILLS

- A. General: Provide extended sills at each louver
 - 1. Extended Sills: Extruded aluminum, Alloy 6063-T5. Minimum nominal wall thickness 0.060 inch (1.5 mm).

2.7 INSTALLATION ANGLES

- A. General: Provide manufacturer's installation angles and fasteners for each louver.

2.8 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.9 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. Kynar 500 Fluoropolymer Coating:
 - 1. Conform to AAMA 605.2.
 - 2. Apply coating following cleaning and pretreatment.
 - 3. Cleaning: AA-C12C42R1X.
 - 4. Dry louvers before final finish application.
 - 5. Total Dry Film Thickness: Approximately 1.2 mils (0.03 mm), when baked at 450 degrees F (232 degrees C) for 10 minutes.

6. Color and Gloss: Match Architect's sample building color.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that can NOT be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- F. Protect unpainted galvanized and nonferrous-metal surfaces that shall be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00, JOINT SEALANTS for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.
- B. Clean exposed surfaces of louvers and vents that are NOT protected by temporary covering, to remove fingerprints and soil during construction period. DO NOT let soil accumulate during construction period.
- C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent NOT harmful to finishes. Thoroughly rinse surfaces and dry.

- D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

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 96 00.1 – High Performance Coating Systems Schedule.

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' 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 45 00 – Quality Control: 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 yr. 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 to 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 (Choose ONE):
- 1) Not Acceptable
 - 2) Or Approved Equal.
- k. Coal tar epoxy (Choose ONE):
- 1) Not Acceptable
 - 2) Or Approved Equal.
- 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.
 - 2) Coal tar shall not be allowed.
- m. Coal Tar Epoxy Substitute Manufacturer (Choose ONE):
- 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) O 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 (Choose ONE):
 - 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 or Novalac Epoxy:
 - 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 Novalac 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°):
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°):
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 (1000° – 1,400°):
 - 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 Section 03_01_03.
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
Ductile Iron and Steel Piping including Fittings, Valves, Couplings, Wall Pipes, Sleeves, and related items			
Submerged in Potable or Non-Potable Water	1	Factory Primed/Field Finished	
Submerged in Domestic Sewage	2	Factory Primed/Field Finished	
Exposed – Highly Corrosive	3	Factory Primed/Field Finished	
Exposed – Mildly Corrosive	4	Factory Primed/Field Finished	Storm pond blowers
PVC Piping, PVC surfaces, and FRP without an integral UV resistant gel coating			
Exterior Exposed	14	Factory Primed/Field Finished	
Structural Steel and related metals			
Submerged in Potable or Non-Potable Water	1	Factory Primed/Field Finished	
Submerged in Domestic Sewage	2	Factory Primed/Field Finished	
Exposed – Highly Corrosive	3	Factory Primed/Field Finished	Headworks Building Roof Trusses, UV Building Roof Trusses
Exposed – Mildly Corrosive	4	Factory Primed/Field Finished	
Buried	5	Factory Primed/Field Finished	
Aluminum Surfaces including Grating, Handrails, Checker Plate, Stairs, and related items			

SURFACES TO BE COATED	COATING SYSTEM	Field/Factory	NOTES
Aluminum grating in contact with dissimilar metals (other than stainless steel), or in contact with masonry, grout, or concrete	11	Factory Primed/Field Finished	
Aluminum checker plate	12	Factory Primed/Field Finished	
Handrail Bases	15	Factory Primed/Field Finished	
Aluminum in contact with concrete	15	Factory Primed/Field Finished	
Stair Connections to Concrete	15	Factory Primed/Field Finished	
Concrete			
Enclosed Structures holding wastewater in primary treatment, biological treatment, or solids treatment processes: Walls (entire height), floors, baffles, and ceiling	19	Field Coated	Headworks wet well

DIVISION 13
SPECIAL CONSTRUCTION

SECTION 13 23 88 – EXTRUDED FLAT COVERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Prefabricated Aluminum Covers
- B. Related Sections:
 - 1. Section 05 12 00 – Structural Steel
 - 2. Section 05 50 00 – Metal Fabrications
 - 3. Section 07 92 00 – Joint Sealants
 - 4. Section 09 96 00 – High Performance Coatings

1.2 REFERENCES

- A. ASTM International:
 - 1. C864-90 – Standard Specifications for Preformed Gasket and Sealing Material.
 - 2. F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- B. AA (Aluminum Association):
 - 1. Specifications for Aluminum Structures.
 - 2. Aluminum Design Manual; Specifications and Guidelines for Aluminum Structures.
- C. ASCE:
 - 1. 8-90 – Specification for the Design of Cold-Formed Stainless Steel Structural Members.
- D. AASHTO:
 - 1. Division 2 Section 25 – Elastomeric Bearings.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Dimensions, sizes, thicknesses, gauges, materials, finishes.
 - 2. Attachment and erection procedures.
 - 3. Number and location of penetrations.
 - 4. Penetration details.
 - 5. Access hatch locations.
 - 6. Special details NOT specified in Drawings.
- C. Product Data:
 - 1. Include standard details and sections.
- D. Calculations:
 - 1. Include for flat cover, signed by an Oklahoma Registered Structural Engineer.
- E. Evidence of Manufacturer Qualifications:
 - 1. Include personnel experience, physical facilities, management capacity and minimum five letters of reference from owners of wastewater facilities like the Project.

1.4 DESIGN CRITERIA

- A. The entire flat cover shall be designed to sustain the loads specified in this section, within the stress limitations of the AA Specifications for Aluminum Structures.
- B. The load cases to be considered shall be those described below:
 - 1. Dead Load: The dead load shall be defined as the weight of the structure and all material permanently attached to and supported by the structure.
 - 2. Panel Design Live Load: In addition to the above-mentioned loads, the aluminum panels shall be designed for a 400 lb. load distributed over 6" by 6" at any location and a 50 psf load distributed over the entire area of any given panel. These loads are to be taken as acting separately from one another and NOT simultaneously with other design loads.
 - 3. Wind Load: As specified in 01 10 00 Summary.
 - 4. Vacuum/Pressure Load: 1 in. water column vacuum.
 - 5. Load Combinations:
 - a. Dead Load.
 - b. Dead Load, Uniform Live Load, and Vacuum Load.
 - c. Dead Load, Unbalanced Live Load, and Vacuum Load.
 - d. Dead Load, Wind Load, and Pressure Load.
 - e. Dead Load, Uniform Live Load, and Wind Load.
 - f. Dead Load, Unbalanced Live Load, and Wind Load.
 - 6. Deflections:
 - a. For the above loads and load combinations, the deflection of all components (structural and cladding) shall NOT exceed U240 with L equal to the short span of the component.
 - b. This deflection limit applies NOT only to the flat cover, but also to the skin of the cover spanning between the supporting edges of each panel or module.
 - 7. Temperature:
 - a. The load combinations listed above shall be considered for a temperature change of 100°F below the installation temperature and 100°F above the installation temperature and for a material temperature range of (-40)°F–160°F.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Manufacturer of aluminum covers for minimum 5 years with minimum five installations under satisfactory operation at wastewater treatment facilities for minimum 3 years.
- B. Erector Qualifications:
 - 1. Mechanics skilled and experienced in fabrication and erection of aluminum structures with minimum five installations under satisfactory operation.
- C. The flat cover manufacturer shall warrant that the work described in this section shall be free from defects, workmanship, and material. The flat cover manufacturer shall replace, or repair only faulty workmanship or defective material furnished by it that is reported to it within 1 year. from the date of completion of this scope of work.

1.6 WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Aluminum Cover Manufacturers (Choose ONE):

1. CST Industries
2. Hallsten
3. Or Approved Equals.

2.2 MATERIALS

A. Bolts and Fasteners:

1. All bolts and fasteners shall be 2024-T4 or 7075-T73 aluminum, or Series 300 stainless steel.

B. Structural Shapes:

1. Aluminum structural shapes shall be alloy 6061-T6, 6005A-T6 or 6063-T6. Load supporting surfaces shall be 0.1 in. minimum thickness.

C. Miscellaneous Shapes:

1. Miscellaneous aluminum shapes shall be alloy 6061-T6, 6005A-T6, or 6063-T6.

D. Gaskets:

1. Shall be Neoprene as specified in ASTM C864-90, resistant to ozone, and shielded from exposure to ultraviolet light.

E. Sealant:

1. Shall be resistant to ozone and ultraviolet light and as specified Federal Specification IT-S-00230C.

F. Access Hatch Door and Frame Materials:

1. Same as for cover panels.

G. Access Hatch Hinges, Handles, Prop Rods, and Latches:

1. Type 316 stainless steel.

H. Handrail:

1. Removable, aluminum, able to prevent accidental entry into hatch opening, as specified in Section 05 50 00 – Metal Fabrications.

I. Nameplates, Manufacturer's Name, or Other Identifications:

1. Maximum 6 in. by 6 in. in size.

2.3 FABRICATION

- A. The flat cover shall be clear-span and self-supporting from the peripheral structure. The use of structural members in contact with the contents of the tank is expressly prohibited. The flat cover shall consist of removable panels each weighing no more than 150 lbs. The required lifting force per panel shall NOT exceed the dead weight of the panel. Each panel shall be able to be removed without needing to remove more than the two adjacent panels. The need for removing flashing or "hold-down" extrusions longer than the width of the panel is prohibited. The flat cover shall have an integral bidirectional slip resistant surface which extends a minimum of 0.1 in. above the panel surface. Raised surfaces without the use of texturing to achieve slip resistance is NOT acceptable. The use of checkered plate, paint, tape, sandblasting, or other applied systems to achieve the slip resistant surface is expressly prohibited. All metal

components of the flat cover structure shall be aluminum or 300 series stainless steel. No galvanized, painted, or plated steel shall be used. Dissimilar materials in the supporting structure shall be isolated from the aluminum flat cover by means of a compatible elastomeric gasket.

- B. The design shall prevent water pooling which may result in over-stressing the flat cover.
- C. The removable closure panels shall be attached continuously along their edges to the structural members using an interlocking joint. Elastomeric weatherseal gasket shall form a continuous watertight seal along all panel edges. The gaskets shall be fully enclosed to prevent ultraviolet exposure.
- D. Access Hatches:
 - 1. Reinforcement: Aluminum structural members able to prevent bowing, warping, or other distortions.
 - 2. Doors: Able to be lifted and locked open by one person.
 - 3. Mounting: Curb mounted and flashed.
 - 4. Curbs: Minimum 3/16 in. thick with welded corners.
 - 5. Door Seal: Gasket against curb.
 - 6. Provide hatches where specified in Drawings.
- E. Penetration Reinforcement:
 - 1. Minimum 1/4 in. thick aluminum stiffeners, able to prevent bowing, sagging, warping, or other distortions.
- F. Penetration Flashing and Sealant:
 - 1. Manufacturer's standard, able to prevent intrusion of air and allow for removal of covers with minimum disassembly of equipment, piping, or duct.
- G. Pressure and Vacuum Relief:
 - 1. By unlatching access hatches, able to open and allow escape of water or air when covered areas become pressurized.
- H. Cable Retainer System:
 - 1. Provided on one end of covers, able to prevent covers from falling in tanks during earthquakes, composed of:
 - a. Retainer:
 - 1) Aluminum
 - 2) Welded to cover
 - 3) Able to withstand stress caused by hanging full weight of cover section from cable with safety factor of 3.0.
 - b. Cable:
 - 1) Stainless steel
 - 2) 3/8 in. diameter
 - 3) Run through retainer
 - 4) With additional 3 ft long coiled section to allow movement of covers during seismic-induced sloshes.

PART 3 - EXECUTION

3.1 ERECTION

- A. Erect covers as specified in manufacturer's instructions.
- B. Plumb and erect flat covers in proper alignment.

- C. Isolate panel bearing ends, closure flashing, and other aluminum from concrete and dissimilar metals with bitumastic coating.

END OF SECTION

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 96 00 – High-Performance 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 23
HVAC

SECTION 23 05 00 – COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Concrete bases.
 - 11. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces:
 - 1. Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations:
 - 1. Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations:
 - 1. Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations:
 - 1. Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations:
 - 1. Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. Industry Abbreviations for Plastic Materials:
 - 1. PE: Polyethylene plastic.
 - 2. PVC: Polyvinyl chloride plastic.
- G. Industry Abbreviations for Rubber Materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.

- B. Product Data:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.

- C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding:
 - 1. Qualify processes and operators as specified in AWS D1.1, "Structural Welding Code – Steel."
- B. Electrical Characteristics for mechanical Equipment:
 - 1. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment as specified in requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.6 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the requirements apply for product selection:
 - 1. Manufacturers: Subject to requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. See Division 40 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads:
 - 1. ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. See Division 33 piping Sections for special joining materials NOT listed below.
- B. Pipe-Flange Gasket Materials:

1. Suitable for chemical and thermal conditions of piping system contents.
2. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8 in. maximum thickness unless thickness or specific material is specified.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
3. AWWA C110, rubber, flat face, 1/8 in. thick, unless otherwise specified; and full-face or ring type, unless otherwise specified.

C. Flange Bolts and Nuts:

1. ASME B18.2.1, carbon steel, unless otherwise specified.

D. Solder Filler Metals:

1. ASTM B32, lead-free alloys. Include water-flushable flux as specified in ASTM B813.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Adaptors:

1. One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

B. Plastic-to-Metal Transition Unions:

1. MSS SP-107, Four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

2.5 DIELECTRIC FITTINGS

A. Description:

1. Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material:

1. Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Factory-fabricated, union assembly, for 250 psig minimum working pressure at 180°F.
2. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges:

1. Factory-fabricated, companion-flange assembly, for 150 psig or 300 minimum working pressure as required to suit system pressures.
2. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits:

1. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 2. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 3. Separate companion flanges and steel bolts and nuts shall have 150 psig or 300 psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings:
1. Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300 psig minimum working pressure at 225°F.
 2. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples:
1. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300 psig minimum working pressure at 225°F.
 2. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

- A. Description:
1. Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 2. Manufacturers:
 - a. PSI – Thunderline / Link-Seal®
 3. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Provide silicone (ASTM D2000 MI GE505) for fire seal applications. Include type and number required for pipe material and size of pipe.
 4. Pressure Plates: Reinforced nylon polymer. Include two for each sealing element.
 5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- A. Galvanized-Steel Sheet:
1. 0.0239 in. minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe:
1. ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron:
1. Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise specified.
- D. Stack Sleeve Fittings:

1. Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
2. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

- A. Description:
 1. Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type:
 1. Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type:
 1. With set screw.
 2. Finish: Polished chrome-plated
- D. Split-Casting, Cast-Brass Type:
 1. With concealed hinge and set screw.
 2. Finish: Polished chrome-plated
- E. One-Piece, Floor-Plate Type:
 1. Cast-iron floor plate.
- F. Split-Casting, Floor-Plate Type:
 1. Cast brass with concealed hinge and set screw.

2.9 GROUT

- A. Description:
 1. ASTM C1107, Grade B, non-shrink, and nonmetallic, dry hydraulic-cement grout.
 2. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 3. Design Mix: 5000 psi, 28 day compressive strength.
 4. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Install piping as specified in requirements and Division 33 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams specify general location and arrangement of piping systems. Specified locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as specified unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise specified and except in equipment rooms and service areas.
- D. Install piping specified to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specified otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

- F. Install piping to permit valve servicing.
- G. Install piping at specified slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations: One-piece cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 in. above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4 in. annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 in. above finished floor level.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. See Section 07 92 00 – Joint Sealers for materials and installation.
- N. Aboveground, Exterior-Wall Pipe Penetrations:
 - 1. Seal penetrations using sleeves and weatherproof sealant. Select sleeve size to allow proper clear space between pipe and sleeve for.
 - 2. Install steel pipe for sleeves smaller than 6 in. in diameter.
 - 3. Install cast-iron "wall pipes" for sleeves 6 in. and larger in diameter.
- O. Underground, Exterior-Wall Pipe Penetrations:

1. Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1 in. annular clear space between pipe and sleeve for installing mechanical sleeve seals.
2. Mechanical Sleeve Seal Installation:
 - a. Select type and number of sealing elements required for pipe material and size.
 - b. Position pipe in center of sleeve.
 - c. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve.
 - d. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Verify final equipment locations for roughing-in.

Q. See equipment specifications in other sections for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings as specified in requirements and Division 33 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints:

1. See ASTM B813, water-flushable flux, unless otherwise specified, to tube end.
2. Construct joints as specified in ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy as specified in ASTM B32.

E. Threaded Joints:

1. Thread pipe with tapered pipe threads as specified in ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves.
2. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
3. Damaged Threads: DO NOT use pipe or pipe fittings with threads that are corroded or damaged. DO NOT use pipe sections that have cracked or open welds.

F. Flanged Joints:

1. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.
2. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections as specified, unless otherwise specified:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2 1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are NOT specified.
- B. Install equipment level and plumb, parallel, and perpendicular to other building systems and components in exposed interior spaces, unless otherwise specified.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 CONCRETE BASES

- A. Concrete Bases:
 - 1. Anchor equipment to concrete base as specified in equipment manufacturer's written instructions and as specified in seismic codes at Project.
 - 2. Construct concrete bases of dimensions specified, but NOT less than 4 in. larger in both directions than supported unit.
 - 3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise specified, install dowel rods on 18 in. centers around the full perimeter of the base.
 - 4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 6. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 7. Install anchor bolts as specified in anchor-bolt manufacturer's written instructions.
 - 8. Use 3000 psi, 28 day compressive-strength concrete and reinforcement as specified in Division 03.

3.6 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will encounter grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

SECTION 23 05 02 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings
 - 3. Dielectric fittings
 - 4. Mechanical sleeve seals
 - 5. Sleeves
 - 6. Escutcheons
 - 7. Grout
 - 8. Mechanical Demolition.
 - 9. Equipment installation requirements common to equipment sections
 - 10. Painting and Finishing
 - 11. Concrete Bases
 - 12. Supports and Anchorages
 - 13. Access Panels
 - 14. Piping Seals

1.2 REFERENCES

- A. Clean Air Act 1990
- B. Refrigeration Service Engineers Society

1.3 DEFINITIONS

- A. Finished Spaces:
 - 1. Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations:
 - 1. Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations:
 - 1. Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations:
 - 1. Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations:
 - 1. Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. Industry Abbreviations for Plastic Materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.

3. PE: Polyethylene plastic.
 4. PVC: Polyvinyl chloride plastic.
- G. Industry Abbreviations for Rubber Materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
1. Transition Fittings
 2. Dielectric Fittings
 3. Mechanical Sleeve Seals
 4. Escutcheons
 5. Access Panels
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding:
1. Qualify processes and operators as specified in AWS D1.1, "Structural Welding Code – Steel."
- B. Steel Pipe Welding:
1. Qualify processes and operators as specified in ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 2. See provisions in ASME B31 Series, "Code for Pressure Piping."
 3. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment:
1. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall be as specified in requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to requirements, manufacturers offering products that may be incorporated into the Work include, but are NOT limited to, the manufacturers specified.
 - 2. Manufacturers: Subject to requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. See Division 33 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads:
 - 1. ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. See Division 33 piping sections for special joining materials NOT listed below.
- B. Pipe-Flange Gasket Materials:
 - 1. Suitable for chemical and thermal conditions of piping system contents.
 - 2. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8 in. maximum thickness unless thickness or specific material is specified.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 3. AWWA C110, rubber, flat face, 1/8 in. thick, unless otherwise specified; and full-face or ring type, unless otherwise specified.
- C. Flange Bolts and Nuts:
 - 1. ASME B18.2.1, carbon steel, unless otherwise specified.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts:
 - 1. Type and material recommended by piping system manufacturer, unless otherwise specified.
- E. Solder Filler Metals:
 - 1. ASTM B32, lead-free alloys. Include water-flushable flux as specified ASTM B813.
- F. Brazing Filler Metals:
 - 1. AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise specified; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise specified.
- G. Welding Filler Metals:
 - 1. See AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

- H. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D2235.
 - 2. CPVC Piping: ASTM F493.
 - 3. PVC Piping: ASTM D2564. Include primer as specified in ASTM F656.
 - 4. PVC to ABS Piping Transition: ASTM D3138.
- I. Fiberglass Pipe Adhesive:
 - 1. As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings:
 - 1. Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 2. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries
 - e. Smith-Blair, Inc.
 - f. Viking Johnson
 - 3. Underground Piping NPS 1 1/2 and Smaller: Manufactured fitting or coupling.
 - 4. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 - 5. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings:
 - 1. CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 2. Manufacturers:
 - a. Elson Thermoplastics
- C. Plastic-to-Metal Transition Adaptors:
 - 1. One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 2. Manufacturers:
 - a. Thompson Plastics, Inc.
- D. Plastic-to-Metal Transition Unions:
 - 1. MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 2. Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.
- E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping:
 - 1. ASTM C1173 with elastomeric sleeve ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - 2. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company
 - d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

- A. Description:
 - 1. Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material:
 - 1. Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions:
 - 1. Factory-fabricated, union assembly, for 250 psig minimum working pressure at 180°F.
 - 2. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges:
 - 1. Factory-fabricated, companion-flange assembly, for 150 minimum working pressure as required to suit system pressures.
 - 2. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits:
 - 1. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 2. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company
 - d. Pipeline Seal and Insulator, Inc.
 - 3. Separate companion flanges and steel bolts and nuts shall have 150 minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings:
 - 1. Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300 psig minimum working pressure at 225°F.
 - 2. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples:
 - 1. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300 psig minimum working pressure at 225°F.
 - 2. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America

2.6 MECHANICAL SLEEVE SEALS

- A. Description:
 - 1. Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 2. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 3. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 4. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- A. Galvanized-Steel Sheet:
 - 1. 0.0239 in. minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe:
 - 1. ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron:
 - 1. Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise specified.
- D. Stack Sleeve Fittings:
 - 1. Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 2. Under deck Clamp: Clamping ring with set screws.
- E. Molded PVC:
 - 1. Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe:
 - 1. ASTM D1785, Schedule 40.
- G. Molded PE:
 - 1. Reusable, PE, tapered-cup shaped and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

- A. Description:
 - 1. Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type:
 - 1. Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.

- D. Split-Casting, Cast-Brass Type:
 - 1. With concealed hinge and set screw.
 - 2. Finish: Polished chrome-plated.
- E. One-Piece, Floor-Plate Type:
 - 1. Cast-iron floor plate.
- F. Split-Casting, Floor-Plate Type:
 - 1. Cast brass with concealed hinge and set screw.

2.9 GROUT

- A. Description:
 - 1. ASTM C1107, Grade B, non-shrink, and nonmetallic, dry hydraulic-cement grout.
 - 2. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 3. Design Mix: 5,000 psi, 28-day compressive strength.
 - 4. Packaging: Premixed and factory packaged.

2.10 ACCESS PANELS

- A. Access panels shall have welded steel frame, one-piece doors, and self-latching door locks.
- B. Panels shall be Milcor, CESCO, Karp or prior approved equal. Milcor model numbers are cited as examples.

Construction or Material Surface	Model No.
Fire rated walls or ceiling 1 1/2 hr, B-Label 16 ga frame, 20 ga door	Fire Rated-Primer Finish
Drywall walls and ceilings 16 ga frame, 14 ga door panel	DW primer finish
Plaster walls and ceilings 16 ga frame, 14 ga door	K – primer finish
Masonry and Tile	M – primer finish MS – stainless steel

- C. Locks:
 - 1. Standard locks shall be screw driver operated with case hardened steel cam. Cylinder lock shall be furnished in psychiatric areas, secure areas or other sensitive area. Provide two keys per panel.

2.11 MISCELLANEOUS STEEL

- A. ASTM A36 Structural Steel.

2.12 VALVE TAG AND CHART

- A. Valve tags shall be Seton 250-BL with heavy brass chain. One valve number shall be stamped on each tag. Identify each valve tag for the utility it serves, such as "CW" for cold water, HW for hot water, etc. Valve charts shall be Seton A-11P.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

- A. See Section 01 70 00 – Execution Requirements, and Section 02 41 00 – Demolition for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove mechanical systems, equipment, and components specified to be removed.
 - 1. Piping to Be Removed: Remove portion of piping specified to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts specified to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Install piping as specified in requirements and Division 40 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams specify general location and arrangement of piping systems. Specified locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as specified unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise specified and except in equipment rooms and service areas.
- D. Install piping specified to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specified otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at specified slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.

- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors as specified:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - i. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - 2. Existing Piping:
 - a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with rough-brass finish.
 - f. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
 - g. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
 - h. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- M. Sleeves are NOT required for core-drilled holes.
- N. Permanent sleeves are NOT required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 in. above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4 in. annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

- c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 in. above finished floor level. See Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. See Section 07 92 00 – Joint Sealants for materials and installation.
 - Q. Aboveground, Exterior-Wall Pipe Penetrations:
 - 1. Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1 in. annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 2. Install steel pipe for sleeves smaller than 6 in. in diameter.
 - 3. Install cast-iron "wall pipes" for sleeves 6 in. and larger in diameter.
 - 4. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - R. Underground, Exterior-Wall Pipe Penetrations:
 - 1. Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1 in. (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 2. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - S. Fire-Barrier Penetrations:
 - 1. Maintain specified fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials.
 - T. Verify final equipment locations for roughing-in.
 - U. See equipment specifications in other sections for roughing-in requirements.
- 3.3 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings as specified in requirements and Division 40 Sections specifying piping systems.
 - B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - D. Soldered Joints:
 - 1. Apply ASTM B813, water-flushable flux, unless otherwise specified, to tube end. Construct joints as specified in ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy as specified in ASTM B32.
 - E. Brazed Joints:

1. Construct joints as specified in AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal as specified in AWS A5.8.
- F. Threaded Joints:
1. Thread pipe with tapered pipe threads as specified in ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID.
 2. Join Pipe Fittings and Valves:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: DO NOT use pipe or pipe fittings with threads that are corroded or damaged. DO NOT use pipe sections that have cracked or open welds.
- G. Welded Joints:
1. Construct joints as specified in AWS D10.12, using qualified processes and welding operators as specified in Paragraph 1.5 QUALITY ASSURANCE.
- H. Flanged Joints:
1. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints:
1. Clean and dry joining surfaces.
 2. Join pipe and fittings as specified:
 - a. See ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - b. ABS Piping: Join as specified ASTM D2235 and ASTM D2661 Appendixes.
 - c. CPVC Piping: Join as specified ASTM D2846 Appendix.
 - d. PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings as specified in ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings as specified in ASTM D2855.
 - e. PVC Non-pressure Piping: Join as specified in ASTM D2855.
 - f. PVC to ABS Non-pressure Transition Fittings: Join as specified in ASTM D3138 Appendix.
- J. Plastic Pressure Piping Gasket Joints:
1. Join as specified in ASTM D3139.
- K. Plastic Non-pressure Piping Gasket Joints:
1. Join as specified in ASTM D3212.
- L. PE Piping Heat-Fusion Joints:
1. Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join as specified in ASTM D2657.
 2. Plain-End Pipe and Fittings: Use butt fusion.
 3. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints:
1. Prepare pipe ends and fittings, apply adhesive, and join as specified in pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

- A. Make connections as specified, unless otherwise specified:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2 1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are NOT specified.
- B. Install equipment level and plumb, parallel, and perpendicular to other building systems and components in exposed interior spaces, unless otherwise specified.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

- A. Painting of mechanical systems, equipment, and components is specified in Division 9 – Finishes.
- B. Damage and Touchup:
 - 1. Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

- A. Concrete Housekeeping Pads:
 - 1. Provide concrete housekeeping pads under all floor mounted equipment, pipe support and duct supports and where specified.
 - 2. Housekeeping pads shall be NOT less than 6 in. thick, sized at least 8 in. larger than the equipment.
 - 3. Pads shall be doweled to floor with NOT less than 4 No. 4 bars grouted in place.
 - 4. Pads shall have chamfered edges.
 - 5. Pads shall receive a broom finish.
 - 6. NOTE: Anchor bolts for equipment shall be poured integral with the pad.
 - 7. Pads shall be reinforced with at least one No. 4 bar (stirrups).

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. See Section 05 50 00 – Metal Fabrications for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

- C. Field Welding:
 - 1. See AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
- B. Select fastener sizes that shall NOT penetrate members if opposite side shall be exposed to view or shall receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.10 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.11 ACCESS PANELS

- A. Provide access panels in walls and ceilings as needed to allow access to valves, equipment, shock absorbers, trap primers, etc. and where noted.
- B. Access doors shall be selected for the type of wall or ceiling where needed. All locking access panels shall be keyed alike.

3.12 FIRE STOPPING AND SOUND STOPPING

- A. Provide penetrations for piping through floors and walls for work under this contract.
- B. Penetrations through floors and fire resistant walls shall be sealed to the rated fire resistance equal to the wall. Installation shall be done by a qualified installer, approved by the manufacturer.
- C. Provide sound proofing through nonrated walls.
- D. In an existing building all penetrations through floors and fire-resistant walls shall be sealed at the end of each working day. These closures shall have an equal fire resistance rating to the floor or wall.

3.13 EXCAVATION, SHORING AND BACKFILL

- A. Provide any excavation required for work in this Division. See soil borings for type of subgrade materials.
- B. Provide separate trench for each utility.
- C. Provide bracing, shoring, sheet piling to protect sides of excavation, workers and adjacent structures. Provide site dewatering systems where water level is above bottom of trench.
- D. Provide barricades and lights to protect open excavations. Provide pedestrian bridges for foot traffic across excavation.
- E. Provide steel plates over excavations for automobile and truck traffic across excavations.
- F. Remove all timber and foreign material from excavation before backfilling. Backfill simultaneously on both sides of tanks, piping, etc. Backfill materials shall be approved clay or chert, free of debris, rock larger than 1 1/2 in. or other harmful material.
- G. Backfilling shall be done in 12 in. lifts or layers. All backfilling shall be compacted to the Modified Proctor Density (ASTM D1557) listed below:

90 Percent	95 Percent
Under sidewalks	Paved areas
Grassed areas	Under structures
	Building slabs

- H. Restore existing pavement, curbs, sidewalks, sodding, etc. removed or damaged by work in this Division.

3.14 ANCHORS

- A. Mount all equipment, brackets, hangers, anchors, etc. to safely resist the vibration or thrust forces and support the unit's weight.
- B. Floor mounted rotating or vibrating equipment shall be anchored to the floor using grouted-in-place or cast-in-place anchor bolts with 3 in. hook and sleeve. Anchor bolts shall be of the size recommended by the manufacturer.
- C. Floor mounted static items, wall and ceiling mounted equipment bracket and hangers shall be installed using drilled anchors. Anchors shall be Phillips Drill Company "Red Head" or Multi-Set II. Size anchors for four times the applied load. Bolts used outdoors or in a wet environment shall be hot dip galvanized.

3.15 SOUND LEVELS

- A. Select diffusers, grilles, terminal boxes, and equipment so as NOT to exceed the NC curve rating for the various areas. Equipment and materials furnished shall be rated as specified in the sound power tests measured as specified in ASHRAE Standard 36B-63. Room attenuation and ceiling transmission loss shall depend on the spaces and architectural finishes.
- B. Attenuation Allowances, Unless Scheduled Otherwise:
 - 1. Acoustical Tile -4 dB
 - 2. Plaster Ceiling -1 dB

- 3. 5/8 in. Gypsum Ceiling -1 dB
- 4. Room Attenuation Effect -8 dB

C. Air performance tests shall be conducted as specified in Air Diffusion Council (ADC) Equipment Test Code 1062 RI and ratings approved by the ADC.

D. Maximum sound pressure levels for installed material and equipment:

- 1. Area NC Curve Range
- 2. All Areas 30 – 35

3.16 FLASHING

A. Provide flashing at piping and duct penetrations through roof and roof mounted structures furnished under this Division. Flash as specified Roofing manufacturer's details.

B. Flashing Materials:

- 1. As specified in the roofing manufacturers system.

C. Provide flashing at pipes passing through floors with waterproof membrane. Flashing shall be as specified in waterproofing manufacturer's details.

3.17 ROOF TOP WORK

A. Protect roof surface by using plywood walkouts, work platforms, and cribbing during construction.

B. Provide counter flashing unless specifically included in the work of another Division. Counter flashing as specified in roof manufacturer's instructions such that roof warranty is maintained.

C. Provide a certificate of inspection from the roof manufacturer stating that the roof has been repaired as specified in their specifications and that the warranty remains in effect.

3.18 PIPE IDENTIFICATION

A. Provide pipe markers and directional arrows on pipes at both sides of partitions and floors slabs, at branch line takeoffs, at valves, at intermediate intervals NOT in excess of 20 ft. and at connections to equipment.

B. Tape color band identifying markers and arrows on each pipe, both insulated and bare pipes. Pipe markers and arrows shall be located where readily visible and on lower quadrants of overhead pipes.

C. Submit schedule of pipe markers, with legend and background colors for approval by the Architect.

3.19 REFRIGERANT RECOVERY

A. All work on refrigerant systems shall employ service techniques that prevent release of refrigerants to the atmosphere.

B. Remove all refrigerant. Place refrigerant in DOT approved containers for recycling/reuse.

3.20 WORKMANSHIP

A. Pipe size changes shall be made at reducing fittings. Bushings shall NOT be used.

- B. Provide drain valves at points where water is trapped in piping.
- C. Install pipe to prevent noise or water hammer.
- D. Blowout or flush out all lines prior to final connection or startup, to remove foreign matter.
- E. Make allowance in piping for expansion and contraction, for installation of insulation and to avoid air pockets.
- F. DO NOT tap small pipes into larger pipes. Provide fittings or reinforced branch connections.
- G. Cut pipes ends square, ream and deburr. Cut threads clean and sharp. Pipe threads shall conform to ANSI B 2.1.
- H. Pull up threaded fittings to a tight fit with an approved good quality pipe joint compound applied to male threads.
- I. Inspect screwed joints for leakage and remake each joint that appears to be faulty. DO NOT wait for rust to form. Clean threads on both parts apply compound and remake joints.
- J. Clean piping strainers after startup by removing strainer screen and wire brushing.
- K. Conceal pipes in pipe shafts, partitions, and furred spaces except where otherwise distinctly specified in Drawings. Each riser shall be separately valved.
- L. Every branch pipe shall be controlled by a valve where it connects to the supply main or riser.
- M. Valves shall be easily accessible, with proper clearance for maintenance. Valves inside furred spaces, behind access doors shall be grouped to keep the number of access doors and their sizes to a minimum.
- N. Provide drain valves at the base of each riser.
- O. Provide drain valves and drain lines from pumps, heaters, water cooled equipment, relief valves, etc., and pipe to floor drains.
- P. Tighten flanges and packing glands after the system has been placed in operation. Replace gaskets in flanges that show any signs of leakage after tightening.
- Q. Install NO piping in electrical switchgear room, transformer vaults, telephone rooms or electrical closets. Provide drip pans under drain piping above electrical switchgear in mechanical rooms.
- R. Install piping in alignment with and parallel to the walls of the building. All risers shall be plumb.
- S. No cross connections shall be installed between potable water systems and polluted supply or waste systems.
- T. Provide valves and unions or flanges at equipment such as pumps, coils, tanks, automatic valves, heat exchangers, etc. Provide valves on capped branches for extension by other Contractors.
- U. Support piping at the proper intervals. Adjust pipe hangers and supports for correct pitch and alignment. Brace piping systems which sway.

- V. Remove rust, scale, and foreign materials from equipment and renew any defaced surfaces. If equipment is marred, provide new materials.
- W. Protect insulation. Repair insulation that is damaged. Keep it dry and free of tears. Allow no punctures in vapor barrier. Insure good tape adhesion. Provide smooth surfaces in finished areas.
- X. Pitch sanitary and storm lines: pipes 3 in. and larger NOT less than 1/8 in/ft, pipes 2 in. and smaller NOT less than 1/4 in/ft. Make changes in grade or direction by "Y" branches.
- Y. Pitch vent piping to free themselves of water and condensation. Install vent branches NOT less than 42 in. above floor. Clean fixtures of labels and stains with whiting and alcohol. Clean copper tubing and fittings with steel wool to remove traces of oxidation.
- Z. Install ductwork to allow adequate clearance for maintenance. Locate fire dampers and access doors to allow replacement of fusible links. All dampers shall be accessible.
- AA. All copper tubing shall be hard drawn unless noted otherwise. Annealed tubing where used shall be stretched, and installed with tool formed bends.

END OF SECTION

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR MECHANICAL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Hangers and supports for mechanical system piping and equipment:
 - a. Steel pipe hangers and supports
 - b. Trapeze pipe hangers

1.2 DEFINITIONS

- A. MSS:
 - 1. Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology:
 - 1. As specified in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Steel pipe hangers and supports.

1.4 QUALITY ASSURANCE

- A. Welding:
 - 1. Qualify procedures and personnel as specified in AWS D1.1, "Structural Welding Code – Steel."

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description:
 - 1. MSS SP-58, Types 1 – 58, factory-fabricated components. See Paragraph 3.1 – HANGER AND SUPPORT APPLICATIONS Article for where to use specific hanger and support types.
- B. Galvanized, Metallic Coatings:
 - 1. Pre-galvanized or hot dipped.

2.2 TRAPEZE PIPE HANGERS

- A. Description:
 - 1. MSS SP-69, Type 59, shop-fabricated or field-fabricated pipe-support assembly made from structural steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 MISCELLANEOUS MATERIALS

- A. Structural Steel:
 - 1. ASTM A36, steel plates, shapes, and bars; black and galvanized.

- B. Grout:
 - 1. ASTM C1107, factory-mixed and packaged, dry, hydraulic-cement, non-shrink, and nonmetallic grout; suitable for interior and exterior applications.
 - 2. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 3. Design Mix: 5000 psi, 28 day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified the Structural Drawings and Standard Details.
- B. See MSS SP-69 for pipe hanger selections and applications NOT specified in the Structural Drawings and Standard Details.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that shall NOT have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports:
 - 1. Install:
 - a. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - b. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2 1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
- G. Vertical-Piping Clamps:
 - 1. Install:
 - a. Carbon or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments:
 - 1. Install:
 - a. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 in. for heavy loads.
- I. Building Attachments:
 - 1. Install:
 - a. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 - b. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - c. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - d. C-Clamps (MSS Type 23): For structural shapes.
- J. Saddles and Shields:
 - 1. Install:
 - a. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

- K. See MSS SP-69 for trapeze pipe hanger selections.
- L. See MFMA-102 for metal framing system selections and applications.
- M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation:
 - 1. See 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. See 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. Metal Framing System Installation:
 - 1. Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type:
 - a. Assemble components and mount on smooth roof surface.
 - b. DO NOT penetrate roof membrane.
- E. Fabricate from welded-structural steel shapes.
- F. 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.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Load Distribution:
 - 1. Install hangers and supports so piping live and dead loads and stresses from movement shall NOT be transmitted to connected equipment.
- I. Pipe Slopes:
 - 1. Install hangers and supports to provide specified 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.
- J. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

- c. DO NOT exceed pipe stress limits as specified in 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 specified. Fill interior voids with insulation that matches adjoining insulation.
- 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
- 4. Shield Dimensions for Pipe shall NOT be less than:
 - a. NPS 1/4 – NPS 3 1/2: 12 in. long and 0.048 in. thick.
 - b. NPS 4: 12 in. long and 0.06 in. thick.
- 5. Insert Material: Minimum length same as protective shield.

3.3 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.

3.4 PAINTING

- A. Touch Up:
 - 1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. See SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 2. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up:
 - 1. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 – Finishes.
- 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 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Warning tags.

1.2 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing ceilings or other concealment.

1.3 WARRANTY

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032 in, Stainless steel, 0.025 in, Aluminum, 0.032 in, or anodized aluminum, 0.032 in. minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but NOT less than 2 1/2 in. by 3/4 in.
 - 3. Minimum Letter Size: 1/4 in. for name of units if viewing distance is less than 24 in, 1/2 in. for viewing distances up to 72 in, and proportionately larger lettering for greater viewing distances. Include secondary lettering 2/3 – 3/4 the size of principal lettering.
 - 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 in. thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color:
 - a. Black.
 - 4. Maximum Temperature:
 - a. Able to withstand temperatures up to 160°F.
 - 5. Minimum Label Size:
 - a. Length and width vary for required label content, but NOT less than 2 1/2 in. by 3/4 in.
 - 6. Minimum Letter Size:

- a. 1/4 in. for name of units if viewing distance is less than 24 in, 1/2 in. for viewing distances up to 72 in, and proportionately larger lettering for greater viewing distances. Include secondary lettering 2/3 – 3/4 the size of principal lettering.
- 7. Fasteners:
 - a. Stainless-steel rivets or self-tapping screws.
- 8. Adhesive:
 - a. Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content:
 - 1. Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is specified (plans, details, and schedules).

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness:
 - 1. Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 in. thick, and having predrilled holes for attachment hardware.
- B. Letter Color:
 - 1. Black.
- C. Background Color:
 - 1. Yellow.
- D. Maximum Temperature:
 - 1. Able to withstand temperatures up to 160°F.
- E. Minimum Label Size:
 - 1. Length and width vary for required label content, but NOT less than 2 1/2 in. by 3/4 in.
- F. Minimum Letter Size:
 - 1. 1/4 in. for name of units if viewing distance is less than 24 in, 1/2 in. for viewing distances up to 72 in, and proportionately larger lettering for greater viewing distances. Include secondary lettering 2/3 – 3/4 the size of principal lettering.
- G. Fasteners:
 - 1. Stainless-steel rivets or self-tapping screws.
- H. Adhesive:
 - 1. Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content:
 - 1. Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels:
 - 1. Preprinted, color-coded, with lettering specifying service, and showing flow direction.
- B. Pretensioned Pipe Labels:
 - 1. Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels:
 - 1. Printed plastic with contact-type, permanent-adhesive backing.

- D. Pipe Label Contents:
1. Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow specifying flow direction.
 2. Flow-Direction Arrows:
 - a. Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to specify flow direction.
 3. Lettering Size:
 - a. At least 1 1/2 in. high.

2.4 WARNING TAGS

- A. Warning Tags:
1. Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 2. Size:
 - a. 3 in. by 5 1/4 in. minimum.
 3. Fasteners:
 - a. Brass grommet and wire.
 4. Nomenclature:
 - a. Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 5. Color:
 - a. Yellow background with black lettering.

PART 3 - EXECUTION

3.1 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.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is NOT obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 ft along each run. Reduce intervals to 25 ft in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Pipe Label Color Schedule:

1. Refrigerant Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White.

3.4 WARNING—TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 23 05 96 – TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Balancing Air Systems:
 - a. Ducted heating/cooling HVAC systems.
 - 1) Makeup air unit at Headworks building.
 - 2) Packaged air conditioner at North Pond Electrical building.
 - b. Exhaust fans.
 - 1) Ventilation system at UV and Effluent Pump Station building.

1.2 DEFINITIONS

- A. AABC:
 - 1. Associated Air Balance Council.
- B. NEBB:
 - 1. National Environmental Balancing Bureau.
- C. TAB:
 - 1. Testing, adjusting, and balancing.
- D. TABB:
 - 1. Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist:
 - 1. An entity engaged to perform TAB Work.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Certified TAB reports.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications:
 - 1. Engage a TAB entity certified by AABC NEBB or TABB.
- B. TAB Report Forms:
 - 1. Use standard TAB Contractor's forms approved by Owner.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration:
 - 1. As described in ASHRAE 111, Section 5, "Instrumentation."

1.5 COORDINATION

- A. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems – Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- J. Examine operating safety interlocks and controls on HVAC equipment.
- K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from specified values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke, and fire dampers are open.
 - 5. Isolating and balancing valves are open and control valves are operational.

6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
7. Windows and doors can be closed so specified conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system as specified in the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish as specified in Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in in-lb units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- C. Check airflow patterns from the outdoor-air louvers and dampers and the return-air and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- D. Locate START-STOP and disconnect switches, electrical interlocks, and motor starters.
- E. Verify that motor starters are equipped with properly sized thermal protection.
- F. Check dampers for proper position to achieve desired airflow path.
- G. Check for airflow blockages.
- H. Check condensate drains for proper connections and functioning.
- I. Check for proper sealing of air-handling-unit components.
- J. Verify that air duct system is sealed as specified in Section 23 31 13 – Metal Ducts.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total specified airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.

- a. Where sufficient space in ducts is unavailable for Pilot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 2. Measure fan static pressures to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - e. For non-ducted fans, install temporary duct at fan inlet.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 6. Obtain approval from Engineer for adjustment of fan speed higher or lower than specified speed. See Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve specified air-handling-unit performance.
 7. DO NOT make fan speed adjustments that result in motor overload. Consult equipment manufacturers about fan speed safety factors. Modulate dampers and measure fan motor amperage to ensure that no overload shall occur. Measure amperage in full cooling, full heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to specified airflows within specified tolerances.
 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to specified airflows within specified tolerances.
- C. Measure air outlets and inlets without adjusting.
 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to specified airflows within specified tolerances of specified values. Adjust using branch volume dampers rather than extractors and the dampers at air terminals.
 1. Adjust each outlet in same room or space to within specified tolerances of specified quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger:

1. Test at final balanced conditions and record:
 - a. Manufacturer's name, model number, and serial number.
 - b. Motor horsepower rating.
 - c. Motor rpm.
 - d. Efficiency rating.
 - e. Nameplate and measured voltage, each phase.
 - f. Nameplate and measured amperage, each phase.
 - g. Starter thermal-protection-element rating.

3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering-air and leaving-air temperatures.
- C. Record compressor electrical data.

3.8 TOLERANCES

- A. Set HVAC system's air flow rates within:
 1. Supply, Return, and Exhaust Fans and Equipment with Fans:
 - a. Plus or minus 10%.
 2. Air Outlets and Inlets:
 - a. Plus or minus 10%.

3.9 FINAL REPORT

- A. General:
 1. Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 2. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing Engineer.
 3. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents:
 1. In addition to certified field-report data, include:
 - a. Fan curves.
 - b. Manufacturers' test data.
 - c. Field test reports prepared by system and equipment installers.
 - d. Other information relative to equipment performance; DO NOT include Shop Drawings and product data.
- C. General Report Data:
 1. In addition to form titles and entries, include:
 - a. Title page.
 - b. Name and address of the TAB Contractor.
 - c. Project name.
 - d. Project location.
 - e. Engineer's name and address.
 - f. Contractor's name and address.
 - g. Report date.
 - h. Signature of TAB supervisor who certifies the report.
 - i. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - j. Summary of Contents:

- 1) Specified versus final performance.
 - 2) Notable characteristics of systems.
 - 3) Description of system operation sequence if it varies from the Contract Documents.
 - k. Nomenclature sheets for each item of equipment.
 - l. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - m. Notes to explain why certain final data in the body of reports vary from specified values.
 - n. Test conditions for fans performance forms including:
 - 1) Settings for outdoor, return, and exhaust-air dampers.
 - 2) Conditions of filters.
 - 3) Cooling coil, wet and dry bulb conditions.
 - 4) Face and bypass damper settings at coils.
 - 5) Fan drive settings including settings and percentage of maximum pitch diameter.
 - 6) Inlet vane settings for variable air-volume systems.
 - 7) Settings for supply-air, static-pressure controller.
 - 8) Other system operating conditions that affect performance.
- D. Air-Handling-Unit Test Reports:
1. For air-handling units with coils, include:
 - a. Unit Data:
 - 1) Unit identification.
 - 2) Location.
 - 3) Make and type.
 - 4) Model number and unit size.
 - 5) Manufacturer's serial number.
 - 6) Unit arrangement and class.
 - 7) Discharge arrangement.
 - 8) Sheave make, size in inches, and bore.
 - 9) Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 10) Number, make, and size of belts.
 - 11) Number, type, and size of filters.
 - b. Motor Data:
 - 1) Motor make, and frame type and size.
 - 2) Horsepower and rpm.
 - 3) Volts, phase, and hertz.
 - 4) Full-load amperage and service factor.
 - 5) Sheave make, size in inches, and bore.
 - 6) Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - c. Test Data (Specified and Actual Values):
 - 1) Total air flow rate in cfm.
 - 2) Total system static pressure in inches wg.
 - 3) Fan rpm.
 - 4) Discharge static pressure in inches wg.
 - 5) Filter static-pressure differential in inches wg.
 - 6) Preheat-coil static-pressure differential in inches wg.
 - 7) Cooling-coil static-pressure differential in inches wg.
 - 8) Heating-coil static-pressure differential in inches wg.
 - 9) Outdoor airflow in cfm.
 - 10) Return airflow in cfm.
 - 11) Outdoor-air damper position.
 - 12) Return-air damper position.
 - 13) Vortex damper position.

E. Fan Test Reports:

1. For supply, return, and exhaust fans, include:
 - a. Fan Data:
 - 1) System identification.
 - 2) Location.
 - 3) Make and type.
 - 4) Model number and size.
 - 5) Manufacturer's serial number.
 - 6) Arrangement and class.
 - 7) Sheave make, size in inches, and bore.
 - 8) Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - b. Motor Data:
 - 1) Motor make, and frame type and size.
 - 2) Horsepower and rpm.
 - 3) Volts, phase, and hertz.
 - 4) Full-load amperage and service factor.
 - 5) Sheave make, size in inches, and bore.
 - 6) Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 7) Number, make, and size of belts.
 - c. Test Data (Specified and Actual Values):
 - 1) Total airflow rate in cfm.
 - 2) Total system static pressure in inches wg.
 - 3) Fan rpm.
 - 4) Discharge static pressure in inches wg.
 - 5) Suction static pressure in inches wg.

F. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.10 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating as specified in the final test and balance readings documented in the final report.
2. Check for each system:
 - a. Measure airflow of at least 10% of air outlets.
 - b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - c. Verify that balancing devices are marked with final balance position.
 - d. Note deviations from the Contract Documents in the final report.

B. TAB Work shall be considered defective if it does NOT pass inspections. If TAB Work fails:

1. Recheck all measurements and adjust. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB Contractor to complete TAB Work as specified in the Contract Documents and deduct the cost of the services from the original TAB Contractor's final payment.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 23 07 00 – DUCTWRAP INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work for furnishing all labor, equipment, materials, and accessories, and performing all operations required, for the correct fabrication and installation of thermal or acoustic insulation applied to systems, piping, equipment, and ductwork.

1.2 DEFINITIONS

- A. Exposed piping and ductwork:
 - 1. That which can be seen when the building is complete without opening or removing access door panels, or ceilings tiles. This also includes all mechanical equipment rooms and pipe tunnels.
- B. Concealed piping and ductwork:
 - 1. Elements above ceilings, in chases, interstitial space and pipe spaces. Other piping and ductwork is considered to be exposed.
- C. Exterior piping and ductwork:
 - 1. That which is exposed to the weather and/or outside the building envelope. Piping and ductwork protected by overhangs, areaways, etc., exterior to the building envelope are considered exterior.
- D. ASJ:
 - 1. All service jacket, white finish facing or jacket.
- E. Airconditioned space:
 - 1. Space directly supplied with heated or cooled air.
- F. Cold:
 - 1. Equipment, ductwork or piping handling media at design temperature of 60°F or below.
- G. FRK:
 - 1. Foil reinforced kraft facing.
- H. FSK (Foil scrim kraft):
 - 1. Foil-scrim-kraft facing.
- I. Hot:
 - 1. Ductwork handling air at design temperature above 60°F; equipment or piping handling media above 105°F.
- J. Pcf:
 - 1. Density, pounds per cubic foot.
- K. Runout:
 - 1. Branch pipe connection up to 1 in. nominal size to a one terminal piece of equipment (fan coil, terminal box).
- L. Thermal Conductance:
 - 1. Heat flow rate through materials.

2. Flat surface: BTU per hour per square foot.
3. Pipe or cylinder: BTU per hour per linear foot.
4. Thermal conductivity (k): BTU per inch thickness, per hour, per square foot, per degree Fahrenheit temperature difference.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Submittals shall include all materials used:
 1. Insulation
 2. Jacketing
 3. Tapes
 4. Hardware
 5. Mastics
 6. Adhesives
- C. Submittals shall be formatted to include a list of materials for each service.
- D. Submittals shall use pages from Midwest Insulation Contractors Association – “Commercial and Industrial Insulation Standards” for defining how insulation materials shall be applied.

1.4 QUALITY ASSURANCE

- A. Products of the manufacturers specified in this section shall be acceptable for use for the specific functions noted. All materials shall be compatible with the materials to which they are applied, and shall NOT corrode, soften, or otherwise attack such materials in either the wet or dry state.
- B. Materials shall be applied subject to their temperature limits. Any methods of application of insulation materials or finishes NOT specified in detail of this section shall be as specified in the Manufacturer's published recommendations.
- C. Insulation shall be applied by experienced workers regularly employed for this type of work.

1.5 RATING

- A. All insulation shall have composite surface burning characteristic rating as specified in ASTM E84, UL 723, or NFPA 255 NOT exceeding:
 1. Flame Spread: 25
 2. Smoke Developed: 50
- B. Composite shall include insulation, jacketing and adhesive used to secure jacketing or facing. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement, tape and cloth shall have the same component rating as specified above.

1.6 STANDARDS

- A. ASHRAE Standard 90.1 – “Energy Efficient Design of New Buildings”.
- B. Midwest Insulation Contractors Association “Commercial and Industrial Insulation Standards” – Third Edition.

1.7 WARRANTY

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

PART 2 - PRODUCTS

2.1 INSULATION

- A. Ductwork (Insulation):
 - 1. Insulation shall be rigid 2" thick polyisocyanurate. Minimum R-value = 11.
 - a. Flame spread less than 25.
 - b. Moisture Vapor Transmission less than 0.3 in accordance with ASTM E96.
 - c. Compressive Strength Grade 3 in accordance with ASTM C1289.
 - d. Water Absorption less than 1% by volume in accordance with ASTM C209.
 - e. Service temperatures -100 degrees F to 250 degrees F.
 - 2. Duct Wrap (not allowed on exterior applications):
 - a. 2 in. thick, 1.0 PCF with aluminum or FRK facing
 - b. Maximum vapor transmission of .02 perms.
 - c. Minimum installed "R" value shall be 5.6 with 25% compression

2.2 FINISHES

- A. Metal jacketing, smooth .016 in. thick, type T 3003 aluminum with laminated moisture barrier. Jacketing shall be Childers, aluminum roll jacketing with Polykraft moisture barrier. Jacketing shall be embossed "No Asbestos" on a 6 in. spacing.
- B. Metal fitting covers shall be two-piece aluminum. Covers shall be Ell-Jac.
- C. FSK jacket, flame retardant vapor barrier. Jacket shall be Alpha Temp 10651, all service jackets.

2.3 MISCELLANEOUS

- A. Adhesives:
 - 1. Glass & Mineral Fiber:
 - a. Foster 85-20 / Vimasco 795.
 - 2. Polyurethane:
 - a. Foster 81-33.
 - 3. Cellular Glass:
 - a. Pittcote 300 / Childers CP-30.
 - 4. Polystyrene:
 - a. Foster 97-13 / Childers CP-96.
- B. Mastic (Weather Barrier):
 - 1. Foster 35-00 Mastic / Vimasco.
 - 2. Childers Vi-Cryl CP10/11.
 - 3. Vimasco WC-5.
- C. Coatings:
 - 1. Foster:
 - a. Monolar Coating / Vimasco
 - 2. Foster Sealfas 30-36 / Vimasco
 - 3. Foster Tite-Fit 30-56 / Vimasco
 - 4. Pittcote 300

- D. Vapor Barrier Sealant:
 - 1. Foster Flextra 95-50
- E. FSK tape 3 in. wide, equal to Nashua FSK.
- F. Insulpins:
 - 1. Roll on Corner bead (2 in. by 2 in., 26 ga. galvanized steel).
 - 2. Fiber reinforced tape:
 - a. Nashua 357, or 398.
 - 3. Insulation protection shields:
 - a. Grinnell fig 167.
 - 4. Rigid insulation inserts:
 - a. Hamfab.
 - 5. Reinforcing Cloth:
 - a. Vimasco, Elastafab 894, conforming to ASTM D1668.
 - 6. Bands:
 - a. 0.020 in., aluminum, 2 in. wide, embossed continuously with the legend "No Asbestos".
 - 7. Hexagonal Wire Netting:
 - a. 1 in. mesh, 22 GA galvanized steel.

PART 3 - EXECUTION

3.1 GENERAL

- A. Insulation shall be applied to clean and dry surfaces after tests and approvals required by this specification have been completed.
- B. On cold surfaces where a vapor barrier shall be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.
- C. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.
- D. All duct insulation shall be continuous through walls, ceiling or floor openings, or sleeves; except where fire stop or fire safeing materials are required.
- E. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed as required between the pipe and the insulation shields. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required.
- F. Size insulation to cover electric heat tracing on piping where it is specified.
- G. All clevis type pipe supports shall be sized to fit the outside diameter of the insulation.
- H. Insulate valves, fittings, flanges etc. with the same thickness of insulation as specified for piping.
- I. Install longitudinal jacketing laps to shed rainwater.
- J. Insulate items mounted in ductwork with the same thickness of insulation as specified for ductwork:
 - 1. Including air measuring stations, smoke dampers, and automatic dampers.

- K. Repair insulation damaged by work under this contract to match existing work or replace damaged portion with insulation specified for new work.
- L. Standing seams and other projections in ductwork or casings shall have insulation applied so that at least 2 in. of insulation shall cover such projections.
- M. Where ductwork is lined, no thermal insulation is required.
- N. Where unlined and lined duct connect, the insulation shall overlap lined section at least 6 in.
- O. Piping and ductwork covered with metal or PVC jacketing systems shall have the joints made to shed water. Laps shall be positioned in the bottom quadrant on horizontal pipe and ductwork.

3.2 HVAC SYSTEMS

- A. Exposed Interior Ductwork (Rectangular):
 - 1. Apply insulation board with FRK facing to all exposed ductwork providing conditioned air, or outside air. Insulate return ductwork.
 - 2. Secure insulation with insulation pins (all surfaces) welded to duct on 12 to 18 in. centers and with clips slipped over pins. Seams and joints shall be vapor sealed with 3 in. wide FSK tape. Corners and edges of ductwork shall be reinforced with roll on corner bead.
 - 3. Seal all break and punctures with vapor barrier sealant and FSK tape.
 - 4. Insulation Thickness:
 - a. Inside Thermal Envelope:
 - b. Supply ductwork - 2 in. thick
 - c. Outside air ductwork - 2 in. thick
 - d. Return air ductwork - 2 in. thick
- B. Exposed Exterior Ductwork (Rectangular):
 - 1. Apply commercial rigid polyisocyanurate board insulation to all exposed ductwork providing conditioned air or outside air.
 - 2. Secure insulation to ductwork using adhesive. Tightly butt insulation sections together. Longitudinal joint shall be lapped 2 in., stapled and taped. Tape circumferential joints with FSK tape at a 50 percent overlap. Tape entire girth at mid point between joints.
 - 3. Secure insulation with pins on vertical ductwork and the bottom surface of ductwork. Pins shall be spaced on 12 to 18 in. centers with clips slipped over the pins.
 - 4. Insulation Thickness:
 - a. Outside Thermal Envelope:
 - b. Supply ductwork - 2 in. thick
 - c. Outside air ductwork - 2 in. thick
 - d. Return air ductwork - 2 in.
- C. Finishes:
 - 1. Metal Jacketing (aluminum):
 - a. Insulated ductwork installed outdoors and interior insulated ductwork within 8 ft. of the finished floor. Covering shall be hemmed and flanged. Secure with self-tapping screws on 8 in. centers. DO NOT puncture vapor barrier.

END OF SECTION

SECTION 23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Control equipment for HVAC systems and components, including control components for terminal heating and cooling units NOT supplied with factory-wired controls.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-In-Place Concrete
 - 2. Section 23 33 00 – Air Duct Accessories
 - 3. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
 - 4. Section 26 05 33 – Raceway and Boxes for Electrical Systems
 - 5. Section 23 05 53 – Identification for HVAC Piping and Equipment
 - 6. Section 26 24 16 – Panelboards

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Include manufacturer's technical literature for each control device. Specify dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product specified.
- C. Shop Drawings:
 - 1. Detail equipment assemblies and specify dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Bill of materials of equipment specifying quantity, manufacturer, and model number.
 - 3. Schematic flow diagrams specifying fans, pumps, coils, dampers, valves, and control devices.
 - 4. Wiring Diagrams: Power, signal, and control wiring.
 - 5. Details of control panel faces, including controls, instruments, and labeling.
 - 6. Written description of sequence of operation.
 - 7. Schedule of dampers including size, leakage, and flow characteristics.
 - 8. Schedule of valves including flow characteristics.
- D. Qualification Data:
 - 1. For Installer and manufacturer.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data:
 - 1. For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals.
 - 2. See Section 01 77 00 – Closeout Procedures.
 - 3. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 - 4. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 5. Keyboard illustrations and step-by-step procedures indexed for each operator function.

6. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
7. Calibration records and list of set points.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. 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.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components:
 1. Control devices specified in this section are to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

1.5 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Section 26 24 16 – Panelboards to achieve compatibility with starter coils and annunciation devices.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03 30 00 – Cast-In-Place Concrete.

1.6 WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, manufacturers are subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 THERMOSTATS

- A. Available Manufacturers:
 1. Erie Controls
 2. Danfoss Inc.; Airconditioning and Refrigeration Div.
 3. Heat-Timer Corporation
 4. Sauter Controls Corporation
 5. tekmar Control Systems, Inc.
 6. Theben AG – Lumilite Control Technology, Inc.
- B. Combination Thermostat and Fan Switches:
 1. Line-voltage thermostat with push-button or lever-operated fan switch.

2. Label switches "FAN ON/OFF/AUTO"
 3. Mount on single electric switch box.
- C. Low-Voltage, ON-OFF Thermostats:
1. NEMA DC 3, 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 55–85°F (13–30°C) setpoint range, and 2°F (1°C) maximum differential.
- D. Line-Voltage, ON-OFF Thermostats:
1. Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed setpoint adjustment, 55–85°F (13–30°C) setpoint range, and 2°F (1°C) maximum differential.
 2. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 3. Selector Switch: Integral, manual On-Off-auto.
- 2.3 HUMIDISTATS
- A. Available Manufacturers:
1. MAMAC Systems, Inc.
 2. ROTRONIC Instrument Corp.
- B. Humidistats:
1. Electric insertion, 2-position type with adjustable, 2% throttling range, 20–80% operating range, and single-pole or double-pole contacts.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices as specified in Drawings.
- D. Install automatic dampers as specified in Section 23 33 00 – Air Duct Accessories.
- E. Install damper motors on outside of duct in warm areas, NOT in locations exposed to outdoor temperatures.
- F. Install labels and nameplates to identify control components as specified in Section 23 05 53 – Identification for HVAC Piping and Equipment.
- G. Install duct volume-control dampers as specified in Division 23 – HVAC specifying air ducts.

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets as specified in Section 26 05 33 – Raceway and Boxes for Electrical Systems.
- B. Install building wire and cable as specified in Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

3.3 FIELD QUALITY REQUIREMENTS

- A. Manufacturer's Field Service:
 - 1. Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections.
- B. Perform field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 4. Test each system for compliance with sequence of operation.
 - 5. Test interlocks.
- C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 ADJUSTING

- A. Calibrating and Adjusting:
 - 1. Calibrate instruments.
 - 2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
 - 3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 - 4. Stroke and adjust dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100% open and closed.
 - 5. Provide diagnostic and test instruments for calibration and adjustment of system.
 - 6. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments:
 - 1. When requested within 12 months of date of Substantial Completion, provide onsite assistance in adjusting system to suit actual occupied conditions.
 - 2. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.
- B. See Section 01 75 00 – Startup Testing and Training.

END OF SECTION

SECTION 23 31 13 – METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Rectangular ducts and fittings.
 - 2. Sheet metal materials.
 - 3. Sealants and gaskets.
 - 4. Hangers and supports.
- B. Related Sections:
 - 1. Section 23 05 96 – Testing, Adjusting, and Balancing

1.2 REFERENCES

- A. ASTM International:
 - 1. A36
 - 2. A653
 - 3. C534
- B. CFR:
 - 1. 40 CFR 59, Subpart D (EPA Method 24).
- C. NFPA:
 - 1. 90A
 - 2. 90B
- D. NADCA:
 - 1. 1992
- E. SMACNA:
 - 1. "HVAC Duct Construction Standards – Metal and Flexible"
- F. UL:
 - 1. 723

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design:
 - 1. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall be as specified in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," as well as the performance requirements and design criteria specified in "Duct Schedule" Article.
- B. Structural Performance:

1. Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible".

C. Airstream Surfaces:

1. Surfaces in contact with the airstream shall be as specified in ASHRAE 62.1.

1.5 WARRANTY

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

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements:

1. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" based on maximum static-pressure class based on fan total static pressure unless otherwise specified.

B. Transverse Joints:

1. Select joint types and fabricate as specified in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."

C. Longitudinal Seams:

1. Select seam types and fabricate as specified in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 1-5, "Longitudinal Seams – Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction:

1. Select types and fabricate as specified in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."

2.2 SHEET METAL MATERIALS

A. General Material Requirements:

1. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise specified. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Aluminum Ducts:

1. Material: ASTM B209 aluminum sheet Alloy 3003-H14.
2. Connectors and Bar Stock: Aluminum Alloy 6061-T6 or equivalent strength.

C. Stainless Sheet Ducts:

1. See ASTM A240

2. Type 304

D. Reinforcement Shapes and Plates:

1. ASTM A240, steel plates, shapes, and bars

E. Tie Rods:

1. Stainless steel, 1/4 in. minimum diameter for lengths 36 in. or less; 3/8 in. minimum diameter for lengths longer than 36 in.

2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements:

1. Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested as specified in UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65%.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 in. wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant:

1. See ASTM C920.
2. General: Single-component, acid-curing, silicone, elastomeric.
3. Type: S.
4. Grade: NS.
5. Class: 25.
6. Use: O.
7. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated as specified in 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets:

1. Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments:

1. Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments:

1. Stainless steel rods and nuts

C. Strap and Rod Sizes:

1. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Duct Attachments:

1. Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- E. Trapeze and Riser Supports:
 1. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams specify general location and arrangement of duct system. Specified duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as specified unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts as specified in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" unless otherwise specified.
- C. Install ducts with fewest possible joints.
- D. Install factory-fabricated or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise specified, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts as high as practical, close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
 1. Install ducts with a clearance of 1 in, plus allowance for insulation thickness.
- G. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures:
 1. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1 1/2 in.
- H. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. See the local codes for fire and smoke dampers.
- I. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. See SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged; furnish ductwork free of visual imperfections, ready for field applied painting.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. DO NOT use tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that are NOT as specified in these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article as specified in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."
- B. Seal ducts to the pressure classes as specified in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible":
 - 1. Ductwork in conditioned spaces (including return air plenums):
 - a. Supply air ducts: seal traverse joints and duct wall penetrations.
 - b. Return air ducts: seal traverse joints and duct wall penetrations.
 - c. Exhaust air ducts: seal traverse joints, longitudinal seams, and duct wall penetrations.
 - d. Outside air ducts: seal traverse joints and duct wall penetrations.
 - 2. Ductwork in unconditioned spaces:
 - a. Supply air ducts: seal traverse joints, longitudinal seams, and duct wall penetrations.
 - b. Return air ducts: seal traverse joints, longitudinal seams, and duct wall penetrations.
 - c. Exhaust air ducts: seal traverse joints, longitudinal seams, and duct wall penetrations.
 - d. Outside air ducts: seal traverse joints, longitudinal seams, and duct wall penetrations.
 - 3. Ductwork located outdoors:
 - a. Supply air ducts: seal traverse joints, longitudinal seams, and duct wall penetrations.
 - b. Return air ducts: seal traverse joints, longitudinal seams, and duct wall penetrations.
 - c. Exhaust air ducts: seal traverse joints, longitudinal seams, and duct wall penetrations.
 - d. Outside air ducts: seal traverse joints, longitudinal seams, and duct wall penetrations.

3.4 HANGER AND SUPPORT INSTALLATION

- A. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments:
 - 1. Structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 2. Where practical, install concrete inserts before placing concrete.
- C. Hanger Spacing:
 - 1. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 in. of each elbow and within 48 in. of each branch intersection.

- D. Hangers Exposed to View:
 1. Threaded rod and angle or channel supports. Install swiveling attachment devices or field fabricated attachments to provide threaded rods vertical installation.
 2. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 ft.
- E. Install upper attachments to structures. Select and size upper attachments with pullout, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors.
- B. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Prime and paint exterior of metal ducts located outdoors; color to match building color.

3.7 DUCT CLEANING

- A. Clean duct systems before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Clean the components below by removing surface contaminants and deposits:
 1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 7. Dedicated exhaust and ventilation components and makeup air systems.
- D. Mechanical Cleaning Methodology:
 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts or duct accessories.

4. Clean coils and coil drain pans as specified in NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
5. Provide drainage and cleanup for wash-down procedures.
6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents as specified in manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

- A. Air Balance:
 1. See Section 23 05 96 – Testing, Adjusting, and Balancing.

3.9 DUCT SCHEDULE

- A. Fabricate ducts with aluminum at Facility 67 - Electrical Building and Facility 70 - UV and Effluent Pump Station.
- B. Fabricate ducts with stainless steel at Facility 10 - Headworks.
- C. Elbow Configuration:
 1. Rectangular Duct:
 - a. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - b. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - c. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - d. Mitered Type RE 2 with vanes as specified in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- D. Branch Configuration:
 1. Rectangular Duct:
 - a. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 2-6, "Branch Connections."
 - b. Rectangular Main to Rectangular Branch: 45-degree entry.
 - c. Rectangular Main to Round Branch: 45-degree lead in.
 2. Round and Flat Oval:
 - a. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
 - b. 45 degree lateral.

END OF SECTION

SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Manual volume dampers.
 - 2. Flange connectors.
 - 3. Turning vanes.
 - 4. Flexible connectors.
 - 5. Flexible ducts.
 - 6. Duct accessory hardware.
- B. Related Sections:
 - 1. Section 23 05 53 – Identification for HVAC Piping and Equipment

1.2 REFERENCES

- A. ASTM:
 - 1. A480
 - 2. A653
 - 3. B209
 - 4. B221
- B. AMCA:
 - 1. 500-D
- C. NAIMA:
 - 1. AH116 – "Fibrous Glass Duct Construction Standards"
- D. NFPA:
 - 1. 90A – "Installation of Air Conditioning and Ventilating Systems"
 - 2. 90B – "Installation of Warm Air Heating and Air Conditioning Systems"
- E. UL:
 - 1. 181
- F. SMACNA:
 - 1. "HVAC Duct Construction Standards – Metal and Flexible"

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.
- C. Operation and Maintenance Data:
 - 1. For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. See NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

- B. See AMCA 500-D testing for damper rating.

1.5 WARRANTY

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise specified. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel:
 - 1. See ASTM A653.
 - 2. Galvanized Coating Designation: G90.
 - 3. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets:
 - 1. See ASTM A480, Type 304, and having a No. 2 finish for concealed ducts and exposed ducts.
- D. Aluminum Sheets:
 - 1. See ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum:
 - 1. See ASTM B221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates:
 - 1. Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods:
 - 1. Galvanized steel, 1/4 in. (6 mm) minimum diameter for lengths 36 in. (900 mm) or less; 3/8 in. (10 mm) minimum diameter for lengths longer than 36 in. (900 mm).

2.2 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers (Subject to requirements):
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster USA, Inc.
 - d. McGill AirFlow LLC.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Pottorff; a division of PCI Industries, Inc.
 - h. Ruskin Company.
 - i. Trox USA Inc.
 - j. Vent Products Company, Inc.
 - k. Other Approved Manufacturers.
 - 2. Standard leakage rating.

3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064 in. (1.62 mm) minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel-blade or opposed-blade design.
 - c. Stiffen damper blades for stability. Galvanized-steel, 0.064 in. thick.
6. Blade Axles: Galvanized steel.
7. Bearings: Oil-impregnated bronze.
 - a. Dampers in ducts with pressure classes of 3 in. wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

2.3 FLANGE CONNECTORS

- A. Manufacturers (Subject to requirements):
 1. Ductmate Industries, Inc.
 2. Nexus PDQ; Division of Shilco Holdings Inc.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
 4. Other Approved Equal.
- B. Description:
 1. Factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material:
 1. Galvanized steel.
- D. Gage and Shape:
 1. Match connecting ductwork.

2.4 TURNING VANES

- A. General Requirements:
 1. See SMACNA's "HVAC Duct Construction Standards – Metal and Flexible"; Figures 4-3, "Vaness and Vane Runners," and 4-4, "Vane Support in Elbows."
- B. Vane Construction:
 1. Single wall for ducts up to [48 in. (1200 mm)] wide and double wall for larger dimensions.

2.5 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors:
 1. Fabricate access panels as specified in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible"; Figures 7-2 "Duct Access Doors and Panels," and 7-3, "Access Doors – Round Duct."
 2. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as specified for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1 in. by 1 in. (25 mm by 25 mm) butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.

3. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
4. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 in. Square: No hinges and two sash locks.
 - b. Access Doors up to 18 in. Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 in. by 48 in.: Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 in. by 48 in.: Four hinges and two compression latches with outside and inside handles.

2.6 FLEXIBLE CONNECTORS

- A. Available Manufacturers (Subject to Requirements):
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
 5. Other Approved Equal.
- B. Materials:
 1. Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives:
 1. See UL 181, Class 1.
- D. Metal-Edged Connectors:
 1. Factory fabricated with a fabric strip [3 1/2 in. (89 mm)] [5 3/4 in. (146 mm)] wide attached to two strips of 2 3/4 in. (70 mm) wide, 0.028 in. (0.7 mm) thick, galvanized sheet steel or 0.032 in. (0.8 mm) thick aluminum sheets. Provide metal compatible with connected ducts.

2.7 FLEXIBLE DUCTS

- A. Manufacturers (Subject to requirements):
 1. Flexmaster USA, Inc.
 2. McGill AirFlow LLC.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
 4. Other Approved Equal.
- B. Insulated, Flexible Duct:
 1. UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 2. Pressure Rating: 10 in. wg positive and 1.0 in. wg negative.
 3. Maximum Air Velocity: 4000 fpm.
 4. Temperature Range: (-10)°F – 160°F.
 5. Insulation R-value: See ASHRAE/IESNA 90.1.
- C. Flexible Duct Connectors:
 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 in. – 18 in., to suit duct size.
 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.8 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes:

1. Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives:
 1. High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories as specified in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 1. Install steel volume dampers in steel ducts.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as specified.
- F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. On both sides of duct coils.
 2. Upstream from filters.
 3. At outdoor-air intakes and mixed-air plenums.
 4. Elsewhere as specified.
- G. Install access doors with swing against duct static pressure.
- H. Access Door Sizes:
 1. One-Hand or Inspection Access: 8 in. by 5 in..
 2. Two-Hand Access: 12 in. by 6 in..
 3. Head and Hand Access: 18 in. by 10 in..
 4. Head and Shoulders Access: 21 in. by 14 in..
- I. Label access doors as specified in Section 23 05 53 – Identification for HVAC Piping and Equipment to specify the purpose of access door.
- J. Install flexible connectors to connect ducts to equipment.
- K. For fans developing static pressures of 5 in. wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- L. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

- M. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY REQUIREMENTS

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Inspect turning vanes for proper and secure installation.

END OF SECTION

SECTION 23 34 23 – FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Type 1 – Down-blast centrifugal roof exhausters
 - 2. Type 2 – Up-blast centrifugal roof exhausters
 - 3. Type 3 – Filtered centrifugal roof supply fans
 - 4. Type 4 – Sidewall propeller fans
 - 5. Type 5 – Centrifugal ceiling exhaust fans
 - 6. Type 6 – Centrifugal in-line cabinet fans
 - 7. Type 7 – Square in-line centrifugal fans
 - 8. Type 8 – Laboratory fume hood exhaust fans
 - 9. Type 9 – Hooded axial roof ventilators
 - 10. Type 10 – Circular hood axial supply fans
 - 11. Type 11 – Tube in-line, centrifugal fans
 - 12. Type 12 – Fiberglass reinforced plastic centrifugal fans
 - 13. Type 13 – Industrial duty centrifugal fans
 - 14. Type 14 – Centrifugal sidewall exhaust fans
 - 15. Type 15 – Filtered side intake centrifugal roof supply fans
- B. Related Sections:
 - 1. Section 01 40 00 – Quality Requirements

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. AMCA (Air Movement and Control Association International, Inc.):
 - 1. 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
 - 2. 211 – Certified Rating Program- Product Rating Manual for Fan Air Performance.
 - 3. 300 – Reverberant Room Method for Sound Testing of Fan.
 - 4. 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- C. ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers):
 - 1. 52.1 – Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particle Matter.
 - 2. 68 – Laboratory Methods of Testing to Determine Sound-Power in a Duct.
- D. ASTM International:
 - 1. A108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - 2. D4167 – Standard Specification for Fiber Reinforced Plastic Fans and Blowers.
 - 3. E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. NEC (National Electrical Code).
- F. NEMA (National Electrical Manufacturers Association):
 - 1. 250 – Enclosures for Electrical Equipment (1000 V Maximum).

- G. NFPA (National Fire Protection Association):
 - 1. 90A – Standard for Installation of Air Conditioning and Ventilating Systems.
 - 2. 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
- H. NRCA (National Roofing Contractors Association).
- I. OSHA (Occupational Safety and Health Administration).
- J. UL (Underwriters' Laboratories, Inc.).

1.3 SYSTEM DESCRIPTION

- A. Design requirements:
 - 1. Provide fans that have sharply rising pressure characteristics which extend throughout the operating range and continue to rise beyond the efficiency peak.
 - 2. Provide fans that peak as close as possible to the maximum efficiency and whose operating range is within the normal fan selection range.
 - 3. When scheduled, provide guided vibration isolator for fans, so that NOT more than 10% of the vibration amplitude of the fan and motor is transmitted to the supporting structure.
 - 4. Design fan inner scroll and air stream surfaces to maintain smoothness for entire fan service life.
 - 5. Seismic supports: as specified in Section 01 10 00 – Summary.
 - 6. Wind supports for exterior units: as specified in Section 01 10 00 – Summary.
 - 7. Electrical components: UL listed and meeting the design and installation requirements of the NEC.
 - 8. Motors supplied with fans: Manufacturer's standard when type NOT scheduled; provide motor voltage phases and speed as scheduled; motor NOT to be overloaded at any point on the fan curve including belt losses.
 - a. 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.
 - 9. Roof curbs: Designed as specified in NRCA standards.
 - 10. Insulation and adhesives: Meet NFPA 90A requirements for flame spread and smoke generation.
 - 11. Belt drive systems: Adjustable for minimum within 5% speed change, rated for 1.5 times maximum horsepower motor available for the scheduled fan size or model.
 - 12. Screens: Provide bird or insect screen as specified with the fan type or as listed on the Fan Schedule:
 - a. Bird screen: Stainless steel; 0.5-inch mesh 18 gauge.
 - b. Insect screen: Stainless steel mesh and frame.
 - 13. Finishes: When NOT specified with fan type, coat ferrous metals as specified in Section 09 96 00 – High-Performance Coatings.
 - 14. Accessories: Provide accessories specified and those scheduled.
 - 15. Provide fans with fire/smoke control system as specified under paragraph Fire/Smoke Control System Design Requirements.
- B. Performance Requirements:
 - 1. Performance requirements are included in the Fan Schedule.
 - 2. Fan performance: Rated and licensed to bear the AMCA label as specified in AMCA 210 and AMCA 211.
 - 3. Total sound-power levels in the 8-octave band range as measured as specified in ASHRAE 68, AMCA 301, or AMCA 300 as appropriate for each fan: NOT to exceed the lesser of the following or the Sones levels on the Fan Schedule.

Sound-Power Level, decibel levels referenced to 10-12 watts								
Frequency, H	63	125	250	500	1,000	2,000	4,000	8,000
General	100	98	94	88	84	84	78	75

4. Air filters supplied with fans: 25–30% dust spot efficiency when rated per ASHRAE Testing Standard 52.1.
 5. Bearings: Rated per ABMA 9 or 11 for a L10 life rating of NOT less than 50,000 hours; provide greater life when specified with each fan type.
- C. Electrical and control system design:
1. Design and supply necessary electrical power and control systems, components, and wiring to make a complete functioning system. Design to perform the system ventilating functions with the control systems.
 2. See Division 26 – Electrical.
- D. Fire control system design requirements:
1. Provide all supply, exhaust, and odor control fans greater than or equal to 2,000 cubic feet per minute with smoke control system including the following minimum components.
 - a. Duct or fan mounted smoke detector.
 - b. Fan interlock to shut down fan upon smoke detection.
 - c. Signals for fans and smoke detectors to and from local fire alarm control panel if a fire alarm control panel is part of project design.
 - d. Provide all wire, conduit, end of line resistors, and other electrical equipment for complete functioning smoke control system. Provide in conformance with the electrical, mechanical, and instrumentation Drawings. When no electrical design for smoke control system is specified, Contractor shall provide design and installation of the smoke control system.

1.4 SUBMITTALS

- A. Product Data:
1. For each type of product specified. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 2. Include:
 - a. Certified fan performance curves with system operating conditions specified.
 - b. Certified fan sound-power ratings.
 - c. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - d. Material thickness and finishes, including color charts.
 - e. Dampers, including housings, linkages, and operators.
 - f. Roof curbs.

1.5 QUALITY ASSURANCE

- A. 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.
- B. AMCA Compliance:
1. Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards:
1. Power ventilators shall be as specified in UL 705.
 2. Power ventilators used for restaurant kitchen exhaust shall also as specified in UL 762.

1.6 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- C. Coordinate sizes and locations of wall openings and equipment supports with actual equipment provided.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.
 - 2. Provide two (2) extra sets (3 total) of filters per installed fan for fans specified with filters.

PART 2 - PRODUCTS

2.1 TYPE 1, DOWN BLAST CENTRIFUGAL ROOF EXHAUSTERS

- A. Manufacturers (ONE of the following):
 - 1. Greenheck, Model GB
 - 2. Penn Ventilator, Model Domex
 - 3. Loren Cook, Type ACE
 - 4. Other Approved Equal.
- B. Characteristics:
 - 1. Roof-mounted, centrifugal, down-blast type, spun-aluminum mushroom-style weather hoods, and aluminum centrifugal fan wheels.
 - 2. Statically and dynamically balanced.
 - 3. Aluminum: Suitable for outdoor installation in a marine environment.
 - 4. Fan blades or wheel material: Non-sparking type.
 - 5. Wheel diameters: As scheduled and as specified in standard sizes adopted by AMCA for non-overloading centrifugal fans.
 - 6. Centrifugal backwardly inclined type with airfoil blades, maximum efficiency, and quiet regular operation.
- C. Accessories:
 - 1. Mounting brackets:
 - a. Necessary for installation.
 - 2. Roof curb:
 - a. Factory fabricated of 16-gauge aluminum with wood nailer strip and gaskets.
 - b. Capable of supporting entire unit weight.
 - c. Suitable for installing and connecting ductwork to curb.
 - d. As specified in NRCA Standards.
 - e. Extend a minimum of 8 in. above top of built-up roofing, but no less than 14 in. high.
 - f. Flashing: as specified in NRCA Standards.
 - 3. Bird screen:
 - a. Provide bird screen if no screen is listed on the Fan Schedule.

2.2 TYPE 2, UP-BLAST CENTRIFUGAL ROOF EXHAUSTERS

- A. Manufacturers (One of the following):
 - 1. Greenheck, Model CUBE.
 - 2. Loren Cook, Model ACRU.
 - 3. Penn Ventilator, Model Fumex.
 - 4. Other Approved Equal.
- B. Characteristics:
 - 1. Roof-mounted, upblast circular exhaust fan unit.
 - 2. Backward inclined centrifugal fan wheel with Venturi inlet; performance as scheduled.
 - 3. Materials: Aluminum fan, housing, roof curb, and accessories.
 - 4. Fan bearings: Permanently lubricated ball bearing type.
 - 5. Belt drive rated for 150% of motor horsepower.
 - 6. Motor characteristics: As scheduled.
 - 7. Finishes: Provide Kynar paint coating over compatible primer on all steel surfaces.
 - 8. Provide roof curb and duct adapter.
 - 9. Provide other accessories as scheduled.
- C. Accessories:
 - 1. Mounting brackets: Necessary for installation.
 - 2. Roof curb:
 - a. Factory fabricated of 16-gauge aluminum with wood nailer strip and gaskets.
 - b. Capable of supporting entire unit weight.
 - c. Suitable for installing and connecting ductwork to curb.
 - d. As specified in NRCA Standards.
 - e. Extend a minimum of 8 in. above top of built-up roofing, but no less than 14 in. high.
 - f. Flashing: as specified in NRCA Standards.
 - 3. Bird screen: Provide bird screen if no screen is listed on the Fan Schedule.

2.3 TYPE 3, FILTERED CENTRIFUGAL ROOF SUPPLY FANS

- A. Manufacturers (Choose ONE):
 - 1. Greenheck, Model RSFP
 - 2. Loren Cook, Model ASP/ASP-T
 - 3. ACME, Model PL
 - 4. Other Approved Equal.
- B. Characteristics:
 - 1. Roof-mounted, louvered penthouse hooded supply fan with hinged cover.
 - 2. Forward-curved centrifugal fan wheel.
 - 3. Materials: Galvanized steel or aluminum as scheduled.
 - 4. Fan bearings: Permanently lubricated ball bearing type.
 - 5. Belt drive rated for 150% of motor horsepower.
- C. Accessories
 - 1. Filter section:
 - a. Low velocity 2-in. thick pleated, washable filters of commercially available sizes.
 - b. Filter face velocity: NOT to exceed 350 feet per minute nominal flow.
 - c. Provide filters of identical size for any 1 unit.
 - d. Filters: American Air Filter or equal.
 - 2. Insulated cover to prevent condensation.
 - 3. Finishes: Provide Kynar paint coating over compatible primer on all steel surfaces.
 - 4. Provide roof curb and duct adapter; same material as fan and housing.

2.4 TYPE 4, SIDEWALL PROPELLER FANS

- A. Manufacturers (ONE of the following):
 - 1. Greenheck, Model SC, or SBC
 - 2. Loren Cook, Model AWD or AWB
 - 3. Penn Ventilator, similar model
 - 4. Other Approved Equal.
- B. Characteristics:
- C. Type:
 - 1. Wall-mounted, low noise propeller type, packaged unit.
 - 2. Fan: Statically and dynamically balanced propeller with aluminum blades, unless noted otherwise.
 - 3. Motor: Permanently lubricated; selected to avoid running in the service factor.
- D. Accessories:
 - 1. Motor and fan side OSHA guards.
 - 2. Wall mount collar when necessary for installation as specified in Drawings.
 - 3. Dampers with damper guards when damper scheduled.
 - 4. Weather hood when scheduled.
 - 5. Bird screen: Provide bird screen if no screen is listed on the Fan Schedule.
 - 6. Finish: Coat fan, housing, and accessories with polyester finish.
 - 7. Diffusers and louvers when scheduled.
 - 8. Mounting hardware.

2.5 TYPE 5, CENTRIFUGAL CEILING EXHAUST FANS

- A. Manufacturers (One of the following):
 - 1. Greenheck, Model SP, CSP
 - 2. Cook, Gemini series
 - 3. Penn, Zephyr
 - 4. Other Approved Equal.
- B. Characteristics:
 - 1. Type: Cabinet type centrifugal fan.
 - 2. Fan: Steel, forward-curved, squirrel-cage type wheel.
 - 3. Housing: Heavy gauge carbon steel housing.
 - 4. Access: Removable access panel.
- C. Accessories:
 - 1. Exhaust grille, eggcrate pattern, aluminum, or PVC construction.
 - 2. Factory installed backdraft damper on discharge of fan.
 - 3. Finish: Galvanized fan, housing, and damper.

2.6 TYPE 6, CENTRIFUGAL IN-LINE CABINET FANS

- A. Manufacturers (One of the following):
 - 1. Greenheck, Model BCF
 - 2. Loren Cook, DB
 - 3. Other Approved Equal.
- B. Characteristics:
 - 1. Type: In-line cabinet type.
 - 2. Fan: Steel forward-curved, squirrel-cage type wheel.

3. Housing: Heavy gauge steel housing.
4. Access: Removable access panel.

C. Accessories:

1. Finish: Galvanized steel fan and housing.

2.7 TYPE 7, SQUARE IN-LINE CENTRIFUGAL FANS

A. Manufacturers (One of the following):

1. Greenheck, Model BSQ
2. Loren Cook, Model SQI
3. Penn Ventilator, Centrex Inliner
4. Other Approved Equal.

B. Characteristics:

1. Type: Square, in-line centrifugal type.
2. Fan: Backward-inclined, non-overloading, aluminum wheel; statically and dynamically balanced.
3. Housing: Square type with duct transitions to match fan supplied; galvanized steel or aluminum as scheduled, minimum 20 gauge panels with 10 gauge stiffeners and frame as required.
4. Motor: Mounted on exterior of housing for belt drive units.

C. Accessories:

1. External NEMA Type 3R disconnect and junction box for field connection of electrical wires, unless otherwise scheduled.
2. Counterbalanced backdraft damper on exhaust side of fan when backdraft damper scheduled.
3. Mounting base: Galvanized steel or aluminum; match scheduled casing material.
4. Fasteners: Stainless steel.
5. Finish: Baked epoxy on steel units, Kynar on aluminum units.

2.8 TYPE 8, LABORATORY FUME HOOD EXHAUST FANS

A. Manufacturers (One of the following):

1. Strobic Air Corporation, Tri-Stack models
2. Other Approved Equal.

B. Characteristics:

1. Type: Laboratory fume hood exhaust fan and discharge stack assembly.
2. Fan: Mixed flow, axial/backward centrifugal fan blades with stationary discharge guide vane section providing non-stall, non-overloading performance.
3. Motor: Direct drive TEFC, mill and chemical duty motor with 1.15 service factor and 200,000 hour L-50 bearing life.
4. Housing: Weatherproof design provided with internal drain to prevent rainwater from entering ducting.
5. Exhaust stack: Vertical exhaust stack features:
 - a. Twin fiberglass discharge nozzle to produce high velocity with minimal pressure drop and create Venturi effect to aspirate additional air.
 - b. Steel entrainment to provide induction of secondary air up to 270 percent of the primary airflow to achieve exhaust plume velocities up to 6,000 feet per minute.
 - c. Rigidly supported needing no guy wires for support.
6. Spark resistant construction.

- C. Accessories:
 - 1. Disconnect switch with NEMA Type 3R enclosure and cover, unless otherwise scheduled.
 - 2. Gravity backdraft damper of aluminum construction.
 - 3. Provide NRCA approved roof curb and flashing.
 - 4. PTFE gaskets between modular sections; Type 316 stainless steel or Monel fasteners.
 - 5. Finishes: 8-mil epoxy phenolic coating.

2.9 TYPE 9, HOODED AXIAL ROOF VENTILATORS

- A. Manufacturers (One of the following):
 - 1. Greenheck, Model RBE or RBS
 - 2. Loren Cook, "H" Series
 - 3. Penn Ventilator, similar model
 - 4. Other Approved Equal.
- B. Characteristics:
 - 1. Type: Belt driven propeller fan unit suitable for roof mounting.
 - 2. Fan: Aluminum fan.
 - 3. Housing: Aluminum with hood panels arched and rolled for strength and weather tightness; mounted on support angles.
 - 4. Bearings: Rated for L10 life of 100,000 hours.
- C. Accessories:
 - 1. Provide roof curbs suitable for roof type as specified in Drawings.
 - 2. Provide safety screens in roof openings.
 - 3. Provide motorized dampers interlocked with fan motor when backdraft dampers scheduled.

2.10 TYPE 10, CIRCULAR HOOD AXIAL SUPPLY FANS

- A. Manufacturers (One of the following):
 - 1. Greenheck, Model AIS
 - 2. Loren Cook, Type SEP
 - 3. Penn Ventilator, similar model
 - 4. Other Approved Equal.
- B. Characteristics:
 - 1. Type: Roof-mounted, propeller fan in mushroom shaped housing.
 - 2. Fan: Direct drive, low pressure, aluminum propeller fan.
 - 3. Housing: Mushroom circular aluminum hood with integral roof curb cap.
 - 4. Motor: Permanently lubricated bearings rated for L10 life of 200,000 hours; mounted on vibration isolators.
- C. Accessories:
 - 1. Provide NEMA Type 1 disconnect inside housing, unless otherwise scheduled.
 - 2. Provide roof curbs suitable for roof type as specified in Drawings.
 - 3. Provide safety screens in roof openings.
 - 4. Provide motorized backdraft damper interlocked with fan motor when backdraft dampers scheduled.

2.11 TYPE 11, TUBULAR CENTRIFUGAL FANS

- A. Manufacturers (One of the following):
 - 1. Greenheck, Model TCF

2. Loren Cook, Centri-Vane type CVD or CVB
3. Penn Ventilator, Centrex, Model REX
4. Other Approved Equal.

B. Characteristics:

1. Type: In-line tubular centrifugal fan with straightening vanes in a unit housing.
2. Fan: Airfoil, non-overloading centrifugal aluminum fan on aluminum hub.
3. Housing: Tubular aluminum construction with airflow straightening vanes; provide flanged inlet and outlet to match adjacent ducting.
4. Motor: Permanently lubricated bearings rated for L10 life of 200,000 hours; mounted on vibration isolators; type as scheduled.

C. Accessories:

1. Provide NEMA Type 3R disconnect outside housing, unless otherwise scheduled.
2. Provide belt guard and adjustable belt sheaves when belt drive scheduled.
3. Provide lifting lugs.
4. Finish: Kynar protective coating.

2.12 TYPE 12, FRP BASE MOUNT CENTRIFUGAL FANS

A. Manufacturers (One of the following):

1. New York Blower Company
2. Hartzell Fan
3. HEE Environmental Engineering, LLC
4. Other Approved Equal.

B. Characteristics:

1. Fan design/construction: As specified in ASTM D4167.
2. Fan housing: Solid FRP (Fiberglass Reinforced Plastic).
3. Fan wheel: Backward curved or backward inclined airfoil blades, non-overloading throughout entire curve at rated speed; solid FRP, totally encapsulated aluminum core insert for secure attachment to shaft.
4. Shaft: Ground and polished ASTM A108 grade 1040/1045 steel with Hastelloy sleeve in air stream or Type 316 stainless steel. Shaft to have maximum 1 mil run-out.
5. Bearings: Minimum ABMA L-10 life rating of 50,000 hours, grease-lubricated with lube tubes extended to outside of housing.
6. Shaft seal: Provide Teflon elements in FRP casing, Type 316 stainless steel double lip rings and springs. Extend shaft seal 1/2 inch beyond seal.
7. Duct connections: Provide flanged connections.
8. Drain: Provide 1-inch diameter FRP pipe bonded to a low point in the housing; provide PVC ball valve and threaded plug.
9. Fan inspection port: Provide 8-inch diameter fan housing port to allow examination of interior.
10. Motor and belt cover/guard: Provide FRP, aluminum or Type 316 stainless steel cover over motor and belt drive with louvered side panels to allow motor ventilation sufficient to prevent overheating at 100% of full load.
11. Electrical grounding: Coat air stream surfaces with graphite impregnated resin with grounding straps to motor frames or fan base to control static electricity.
12. Abrasive moisture coating: Coat fan wheel with 50 to 60 mil abrasive/erosive resistant coating.
13. Base and bearing support structures: Rigid Structural FRP, aluminum, or Type 316 stainless steel.
14. Duct connection orientation: As specified in Drawings.
15. Drive: Belt or direct as scheduled.

16. FRP requirements:
 - a. Suitable for continuous operation when exposed to vapors and gases expected to include methane, hydrogen sulfide, chlorine gas, sulfur dioxide, gasoline vapors, ammonia, and water saturated air. Air stream may contain droplets of dilute sulfuric acid, greases, and particulate matter and may vary from 30–130°F.
 - b. Housing resin:
 - 1) Type: Premium polyester resin
 - 2) Resin shall achieve Class I flame spread rating below 25 when tested as specified in ASTM E84 without the use of additives.
 - 3) Manufacturer (ONE of the following):
 - a) Ashland Chemical Company.
 - b) Derakane.
 - c) Hetron 92FR; Dow Chemical Company.
 - d) Other Approved Equal.
 - c. Wheel resin:
 - 1) Type: Premium Vinyl ester resin;
 - 2) Resin shall achieve Class II flame spread rating below 30 when tested as specified in ASTM E84.
 - 3) Manufacturer (Choose ONE):
 - a) Dow Chemical Company.
 - b) Derakane 510A40 or 570A40; Ashland Chemical Company,
 - c) Hetron.
 - d) Other Approved Equal.
 - d. Protect fiberglass surfaces with minimum 10-mil thickness of ultraviolet resistant resin after initial visual inspections of housing exterior is complete.
 - e. Provide Veil-Nexus corrosion resistant surfacing veil and additional coat of FRP resin on surfaces exposed to the air stream for corrosion resistance and chopped strand fiberglass for structural core strength.
17. Balancing: Dynamically balance fan assembly after fabrication and assembly to a maximum of 0.15 inches per second of unbalance at the operating speed.
18. Other accessories:
 - a. Vibration isolators: Provide rubber-in-shear type or spring type.
 - b. Cover access doors: FRP, neoprene gasket, non-hinged, stainless steel bolts.
 - c. Fasteners: Type 316 stainless steel and shall be encapsulated in FRP when exposed to air stream.
 - d. Inlet box:
 - 1) Provide FRP inlet box specifically designed by the fan manufacturer to optimize fan inlet conditions.
 - 2) Maximum pressure loss through inlet box shall be 1.0 inches water column at specified design flow rate.
 - 3) Inlet box shall be mounted and supported from integral fan/motor/inlet box base with rigid structural FRP, aluminum, or Type 316 stainless steel supports.
 - 4) Inlet box shall have a 1-inch drain connection at the lowest point in the orientation specified in Drawings; provide PVC ball valve and threaded plug.

2.13 TYPE 13, BASE MOUNT CENTRIFUGAL FANS

- A. Manufacturers (ONE of the following):
 1. Greenheck Fan Corporation, Series 41
 2. Loren Cook Series CA
 3. Other Approved Equal.
- B. Characteristics:
 1. Fan wheels: [Backwardly inclined,] [air foil] type; statically and dynamically balanced.
 2. Fan type: [Single width] [Double width], [single inlet, double inlet].

3. Fan Class: [Type I] [Type II] [Type III].
4. Fan construction materials: [Aluminum] [Spark resistant] [Steel] [Stainless steel].
5. Discharge: Flanged connection size as specified in Drawings.
6. Shaft: Precision-ground and polished solid [steel] [stainless steel].
7. Shaft size: Sized so that first critical speed is 25% over maximum operating speed.
8. Bearings: Anti-friction, grease-lubricated, split pillow block roller or ball type; supported on fabricated steel supports; 2 per fan; ABMA L10 life rating of minimum 200,000 hours.
9. Housing and bearing supports: Welded structural members.
10. Belt drive: Rated at 150% of driver nameplate horsepower.
11. Discharge orientation: As specified in Drawings.
12. Housing construction: [Single piece] [Split] [Swing out].

C. Accessories:

1. Provide inlet screen; stainless steel, 0.25 in. mesh.
2. V-belt drive and belt guards.
3. Support bases: Provide structural steel frame; mounted on vibration isolators; coat with epoxy and polyurethane system as specified in Section 09 96 00 – High-Performance Coatings.
4. Vibration Isolators: Provide guided spring type with 1/4-inch neoprene isolation pad; capable of transmitting maximum 10% of fan and motor vibration to support structure.
5. Provide belt drive guards.
6. Provide NEMA Type 3R disconnect switch, unless otherwise scheduled.
7. Provide weather hood with access door to protect motor and drive.
8. Extend lubrication lines to fittings mounted on fan frame.
9. Provide 1-inch drain connection.

2.14 TYPE 14, CENTRIFUGAL SIDEWALL EXHAUST FANS

A. Manufacturers (ONE of the following):

1. Greenheck, Model CWB
2. Loren Cook, Model ACWB
3. Penn Ventilator
4. Other Approved Equal.

B. Characteristics:

1. Wall-mounted, upblast circular exhaust fan unit.
2. Backward inclined centrifugal fan wheel with Venturi inlet; performance as scheduled.
3. Materials: Aluminum fan, housing, and accessories.
4. Fan bearings: Permanently lubricated ball bearing type.
5. Adjustable belt drive rated for 150% of motor horsepower.
6. Motor characteristics: As scheduled.
7. Finishes: Provide Kynar paint coating over compatible primer on all steel surfaces.
8. Provide duct adapter.
9. Provide other accessories as scheduled.

C. Accessories:

1. Mounting brackets: Necessary for installation.
2. Bird screen: Provide bird screen if no screen is listed on the Fan Schedule.

2.15 SILICON CONTROLLED RECTIFIER (SCR):

A. Manufacturers (ONE of the following):

1. Greenheck, Solid State Speed Controller
2. Penn Ventilator Lek-Trol Series
3. Other Approved Equal.

- B. Characteristics:
 - 1. Solid-state controller for use with 115-volt single phase shaded pole and open permanent split capacitor motors.
 - 2. Minimum 10-amp rating.
 - 3. Provide all necessary mounting boxes and hardware.
 - 4. Provide with manual speed adjustment knob and on/off control.

2.16 MOTORS

- A. See NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 26 – Electrical.
 - 1. Motor Sizes: Minimum size as specified. If NOT specified, large enough so driven load will NOT require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: See requirements for electrical devices and connections specified in Division 26 – Electrical.
- B. Enclosure Type:
 - 1. Totally enclosed, fan cooled.
- C. 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.

2.17 SOURCE QUALITY REQUIREMENTS

- A. Certify sound-power level ratings as specified in AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans as specified in AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests as specified in AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine and verify that Work is in condition to receive installation specified in this Section.
- B. Take measurements and verify dimensions to ascertain fit of installation.
- C. Ascertain support and openings are correctly located.

3.2 PREPARATION

- A. Before installation, remove dust and debris from equipment and ducts.
- B. During installation and until equipment is operated, protect equipment and ducts from dust and debris by covering openings with tape or plastic.

3.3 INSTALLATION

- A. Observe applicable installation requirements as specified.

- B. Anchoring and support:
 - 1. Provide anchoring and support for fans and appurtenances.
 - 2. Provide anchoring to sustain seismic and wind forces as specified in Section 01 10 00 – Summary.
- C. Adjust alignment of ducts where necessary to resolve conflicts with architectural features or to resolve conflicts with the work of other trades.
- D. Install flexible connections to fans.
- E. Install roof curb and fan as recommended by fan manufacturer.
- F. For fan housings with threaded water trap drain, provide drain piped from fan housing to the nearest drain channel, floor drain, or sump.
- G. Install fans level and plumb.
- H. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.
- I. Install units with clearances for service and maintenance.
- J. Label units with permanent labels.

3.4 CONNECTIONS

- A. Ground equipment as specified in Division 26 – Electrical.
- B. Connect wiring as specified in Division 26 – Electrical.

3.5 FIELD QUALITY REQUIREMENTS

- A. Perform Tests and Inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to specified rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.

- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Replace fan and motor pulleys as required to achieve design airflow.
- D. Lubricate bearings.

END OF SECTION

SECTION 23 74 13 – PACKAGED ROOFTOP AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work necessary for a complete installation of packaged rooftop air conditioning units.
- B. Related Sections:
 - 1. Section 23 05 00 – Common Work Results for Mechanical

1.2 REFERENCES

- A. Outside Air Damper Leakage:
 - 1. AMCA 500
- B. Perform Work in as specified in City of Moore standard.
- C. ARI:
 - 1. 210/240
 - 2. 270
 - 3. 340/360
- D. ASHRAE:
 - 1. 15
 - 2. 33
 - 3. 62.1
 - a. Section 5 – "Systems and Equipment"
 - b. Section 7 – "Construction and Startup"
- E. ASHRAE/IESNA:
 - 1. 90.1, Section 6 – "Heating, Ventilating, and Air-Conditioning."
- F. NFPA Compliance:
 - 1. 70, Article 100
 - 2. 820
 - 3. 90A
 - 4. 90B
- G. UL (Underwriters' Laboratories, Inc.)

1.3 SUBMITTALS:

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Action Submittals:
 - 1. Product Data:
 - a. Include Manufacturer's technical data including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings:
 - a. Include complete data on compressors, electric heating components electric motors, V-belt drives, coils, casing construction, vibration isolation, economizer cycle, and air filters.

- C. Informational Submittals:
 - 1. Qualification Data:
 - a. Fan Data:
 - 1) Capacity
 - 2) fan curve
 - 3) RPM brake horsepower
 - 4) fly wheel effect (WK2)
 - 5) class
 - 6) arrangement
 - 7) sound power levels for each octave band
 - b. Unit Data:
 - 1) total and sensible cooling capacities
 - 2) heating inputs and outputs
 - c. Curb Data:
 - 1) Unit configuration
 - 2. Warranty:
 - a. Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged rooftop air-conditioning units that fail in materials or workmanship within specified warranty period.
 - b. Warranty Period:
 - 1) For Compressor: Five year(s) from date of Substantial Completion.
 - 2) For Heat Exchanger: Five year(s) from date of Substantial Completion.
 - 3) For Parts and labor: One year(s) from date of Substantial Completion.

1.4 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- B. Coordinate electrical requirements with electrical contractor with actual equipment provided.

1.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Spare parts identified within this specification shall not be used to address warranty repairs.

1.6 WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers:
 - 1. Trane; American Standard Companies, Inc.
 - 2. Carrier Corporation
 - 3. YORK International Corporation
 - 4. Daikin Industries, Ltd.
 - 5. Or Approved Equal.

2.2 GENERAL:

- A. Packaged rooftop air conditioning units shall be completely factory assembled including compressors coils, electric heating section, refrigerant circuits, condensate drain pan, fans, motor(s), starters, filters, and controls in an insulated weather resistant casing.
 - 1. Units shall be rated and tested as specified in ARI standard 360.
 - 2. Units shall be UL listed and labeled and classified as specified in ANSI Z21.47 and UL 465.
 - 3. Units shall be dedicated downflow or horizontal airflow.
 - 4. Operating range shall be between 0°–115°.
 - 5. Minimum unit efficiency as specified in ICC IECC 2021.

2.3 CASING:

- A. Unit casing shall be constructed of zinc coated, minimum 22 GA, ASTM A527 G90 galvanized steel.
- B. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish.
- C. Seams shall be gasket sealed to be watertight.
- D. The air handling portions of the casing shall be completely insulated with coated, fire retardant glass fiber insulation, minimum 1 1/2 in. thick.
- E. Service panels with lifting handles and airtight seal shall provide access to all sections of the unit for maintenance.
- F. The base of the unit shall be suitable for mounting on a roof curb and shall have provisions for lifting by crane.

2.4 COMPRESSORS:

- A. Compressors shall be [standard efficiency with dual stage compressor]/ [high efficiency with modulating compressor] and on spring vibration isolators within the unit.
- B. Compressors shall be equipped with internal overcurrent and temperature protection as well as high-pressure and low-pressure protection.
- C. Each refrigerant circuit shall have independent capillary expansion devices, service pressure ports and refrigerant line filter driers.
- D. Units shall have dual compressors if available or otherwise noted.

2.5 COILS:

- A. Evaporator and condenser coils shall be seamless copper tube type with mechanically bonded aluminum fins.
- B. Coils shall be factory leak tested to 200 psig and pressure tested to 450 psig.
- C. Coils to be coated with Bygold XT or equal and shall be applied by a licensed professional.

2.6 FANS AND BLOWERS:

- A. Evaporator fan shall be forward curved blade centrifugal type statically and dynamically balanced with adjustable belt drive or direct drive.
- B. High efficiency motors shall be thermally protected.
- C. Fan and motor assemblies shall be spring isolated from the rest of the unit.
- D. Condenser fans shall be direct drive, vertical discharge propeller type, statically and dynamically balanced.
- E. Fan motors shall be permanently lubricated with built-in thermal overload protection.

2.7 OPERATION AND SAFETY CONTROLS

- A. Manual reset, high pressure cutout switches.
- B. Automatic reset, low pressure cutout switches.
- C. Low oil pressure cutout switch.
- D. Compressor winding cutout switch.
- E. Excessive cycling protection.

2.8 FILTERS

- A. Minimum arrestance per ASHRAE 52.1, and a minimum efficiency reporting value (MERV) per ASHRAE 52.2.
 - 1. Glass Fiber: Minimum 80% arrestance, and MERV 5.
 - 2. Pleated: Minimum 90% arrestance, and MERV 7.

2.9 CONDENSATE DRAIN PAN

- A. Condensate drain pan shall be stainless steel or double wall galvanized steel with bituminous corrosion resistant coating.
- B. Pans shall be insulated on bottom side to prevent condensation.

2.10 OPTIONS AND FEATURES

- A. Units shall include the following options and features:
 - 1. Hail guards.
 - 2. Hinged access doors.
 - 3. Duct mounted smoke detector.
 - 4. Low ambient cooling to 0°F.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, as specified in installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of piping and electrical connections before equipment installation.
- C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install unit as specified in manufacturers' instructions. Unit to be installed level and plumb, and firmly anchored to structure.
- B. Install trapped condensate drain piping from unit to discharge into roof drain or gutter (refer to detail on the drawings).
- C. Install economizer and powered exhaust modules.
- D. Install control wiring.
- E. Turn units over to Owner with a clean set of filters.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.
- B. Test all units in both 100% recirculation and 100% economizing modes. Test units for staged cooling. Test units with lead/lag control. Assure proper operation in all modes.
- C. For systems above 25 tons, engage in manufacturer's startup.

END OF SECTION

SECTION 23 83 01 – HEATING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Electric makeup air unit.
- B. Related Sections:
 - 1. Section 23 05 96 – Testing, Adjusting, and Balancing
 - 2. Section 23 09 00 – Instrumentation and Control for HVAC
 - 3. Section 26 05 93 – Electric Motors

1.2 REFERENCES

- A. AMCA (Air Movement and Control Association International, Inc):
 - 1. 302 – Application of Sone Ratings for Non-Ducted Air Moving Devices.
- B. AGA (American Gas Association).
- C. NEC (National Electric Code).
- D. NFPA (National Fire Protection Association):
 - 1. 54 – National Fuel Gas Code.
- E. NEMA (National Electrical Manufacturers Association):
 - 1. 250 – Enclosures for Electrical Equipment (100 V Maximum).
 - a. NEMA Type 3R enclosure as specified in NEMA 250.
- F. UL (Underwriters' Laboratories, Inc.).
- G. IFGC (International Fuel and Gas Code).
- H. IMC (International Mechanical Code).

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. System layout, mechanical, electrical power, and control diagrams.
 - 2. Materials.
 - 3. Supports and seismic bracing calculations and details.
 - 4. Cut sheets on primary and ancillary equipment.
 - 5. Sound ratings of fans in Sones as specified in AMCA Publication 302.
- C. Certificates:
 - 1. Successful testing of burners used in gas unit heaters.
- D. Operation and Maintenance Data.
- E. Warranties.

1.4 SYSTEM DESCRIPTION

- A. Design requirements:
 - 1. Provide seismic and wind supports as specified in Section 01 10 00 – Summary.
 - 2. Electrical components: UL listed and meeting the design and installation requirements of the NEC.
 - 3. Hot water piping, gas piping, drains, venting, and other appurtenances of unit heaters:
 - a. Install as specified in building code, mechanical code, and plumbing code as specified in the NFPA.
 - 4. Noise levels for unit heaters installed in offices, hallways, or entry areas: NOT to exceed 10 Sones as measured as specified in AMCA Publication 302.
 - 5. Motors supplied with heating units: As specified in Section 26 05 93 – Electric Motors.
- B. Performance requirements are included in the Heating Unit Schedules in the drawings.
- C. Design and supply necessary electrical power and control systems, components, and wiring to make a complete functioning system.
 - 1. See referenced electrical Sections and design to perform system heating functions.

1.5 QUALITY ASSURANCE

- A. 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.
- B. ASHRAE Compliance:
 - 1. ASHRAE 62.1:
 - a. Section 5 – "Systems and Equipment."
 - b. Section 7 – "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance:
 - 1. ASHRAE/IESNA 90.1, Section 6 – "Heating, Ventilating, and Air-Conditioning."
- D. Provide heating units and controls that are listed by UL.

1.6 WARRANTY

- A. Extend warranty from the date of Project Acceptance or the date of first beneficial use of the equipment.
- B. Two-year manufacturer's warranty on all components, except heating elements and coils.
- C. Heating elements and coils: 10 yr. warranty.
- D. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 ELECTRIC MAKEUP AIR UNIT

- A. Manufacturers (One of the following).
 - 1. Greenheck, Model MSX.
 - 2. Trane, T Series (for outdoor units), M Series (for indoor units).
 - 3. Other Approved Equal.

- B. Features:
1. General: Provide makeup air fan and electric heating unit in a packaged unit suitable for mounting as scheduled with air inlet and outlet oriented as scheduled.
 2. Power supply:
 - a. Design unit for power voltage and phases as scheduled.
 - b. Provide disconnect switch at unit; mount in NEMA 3R enclosure; when explosion proof construction is scheduled, provide disconnect suitable for Group D, Class I, Division 1 location.
 - c. Provide built-in magnetic contactors.
 3. Fan type: Aluminum axial flow or centrifugal as required to meet scheduled cfm and external static pressure (ESP):
 - a. Provide fan guards for fan intake if exposed; provide fan power disconnect switch on unit access door, fan automatically disconnected when door opened.
 - b. Dynamically balance.
 - c. Fan designed for quiet operation.
 - d. Permanently lubricated ball bearings.
 - e. Automatic reset thermal overload protection.
 - f. When explosion proof scheduled, provide antistatic, non-sparking materials.
 - g. Fan shaft designed so that first critical speed is 25% above manufacturer's maximum cataloged fan revolutions per minute.
 - h. Provide fan vibration isolators between fan and casing.
 4. Heating element characteristics:
 - a. Rated capacity at entering air temperature of 65°F.
 - b. Fin type, steel-plated heater elements, with elements brazed to common fins, designed for maximum strength and maximum heat transfer.
 - c. 3-phase designed for balanced phases.
 - d. Over temperature cutout with automatic reset.
 5. Cabinet:
 - a. Formed of minimum thickness 18 GA galvanized steel with steel stiffeners.
 - b. Provide roof curb and weatherproof flashing around duct penetrations as specified in building code and mechanical code.
 - c. Provide galvanized steel mounting rails or base for roof top mounting.
 - d. Filter section:
 - 1) Provide filter housing for 2 in. deep filter on fan inlet; provide filter with minimum 80% dust removal efficiency; provide 2 spare filters.
 - e. Provide hinged access doors for fan servicing and electric heater servicing; provide gasketing around doors.
 - f. Finish interior and exterior components with backed enamel in manufacturer's standard color.
 - g. Provide minimum of 1 in. thermal insulation.
 - h. Provide inlet weather hood with same material as casing.
 6. Controls:
 - a. Provide discharge duct mounted temperature-sensing element and thermostat with proportional output to maintain a constant furnace outlet temperature at varying ambient temperature; provide setpoint adjustment from 40°F – 90°F.
 - b. Provide proportioning power controllers SCR or other type controller to operate electric heating units at varying loads to maintain thermostat setpoint.
 - c. Provide control transformer suitable for 24 V or 120 V control and the input power supply as scheduled in the Electric Furnace Schedule.
 - d. Provide power and control wiring for a complete and functional unit.
 - e. Provide control interlocks as specified in Drawings.
 - f. When explosion proof construction is scheduled, provide enclosures suitable for NEC Group D, Class I, Division 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine and verify that Work is in condition to receive installation specified in this Section.
 - 1. Take measurements and verify dimensions to ascertain fit of installation.
 - 2. Verify structural sufficiency to support installation.
 - 3. Verify that chassis, shafts, and openings are correctly located.
 - a. Otherwise cut new openings where required.
 - 4. Confirm specified thermostat and other controls are compatible with specified equipment.
- B. Examine and verify structural details and sections specified in Drawings, ascertain adequacy, and determine possible conflicts in dimensions and clearances.

3.2 PREPARATION

- A. Before installation, remove dust and debris from equipment and ducts.
- B. During installation and until equipment is operated, protect equipment and ducts from dust and debris by covering openings with tape or plastic.

3.3 INSTALLATION

- A. Anchoring and support:
 - 1. Install anchoring for seismic and wind forces to meet the design criteria specified in Section 01 10 00 – Summary.
- B. Alignment:
 - 1. Adjust ductwork alignment when necessary to resolve conflicts with architectural and structural features or to resolve conflicts with work of other trades.
- C. Install and wire heating units and thermostats as specified in manufacturer's recommendations.
 - 1. Provide disconnect switches at the heating units wherever specified in Drawings, specified in this Section, scheduled, and wherever required by code.
- D. Adjust heater units with louvers for optimum air circulation.
- E. Provide gas unit heater venting as specified in mechanical code and plumbing code as specified in NFPA 54.

3.4 FIELD QUALITY REQUIREMENTS

- A. Test equipment and installation to verify operation is within manufacturer's standards and that noise levels DO NOT exceed levels specified.
- B. Test equipment performance and balance equipment as specified in Section 23 05 96 – Testing, Adjusting and Balancing.

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.

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 PVC-Coated steel or stainless steel.
 2. Clips, clamps, threaded rods, and fastening hardware shall be stainless steel.

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. Connection to Vibrating Equipment (Transformers, Motors, etc.): Liquid-tight Flexible Metal Conduit (LFMC).

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-Joint Fittings:

1. Install in each run of exterior aboveground conduit that has straight-run length that exceeds 25 ft.
2. Provide type and quantity of fittings for each run to accommodate a 125°F temperature change.
3. Install each expansion-joint fitting 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 43 – UNDERGROUND DUCTS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Conduit and accessories for below grade duct banks.
 - 2. Precast concrete boxes.
 - 3. Polymer concrete composite boxes.
- B. Related Sections:
 - 1. Section 26 05 33 – Raceway and Boxes for Electrical Systems
 - 2. Section 26 05 53 – Identification for Electrical Systems
 - 3. Section 31 23 16 – Excavation
 - 4. Section 31 23 16.13 – Trenching for Site Utilities
 - 5. Section 31 23 23.13 – Fill and Backfill

1.2 REFERENCES

- A. ASTM International:
 - 1. C857 – Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
 - 2. C858 – Standard Specification for Underground Precast Concrete Utility Structures.
 - 3. C891 – Standard Practice for Installation of Underground Precast Concrete Utility Structures.
 - 4. C1037 – Standard Practice for Inspection of Underground Precast Concrete Utility Structures.
- B. NEMA (National Electrical Manufacturers Association):
 - 1. FB 1 – Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing (EMT) and Cable.
 - 2. TC 2 – Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 3. TC 3 – Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - 4. TC 6 and 8 – Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations.
 - 5. TC 9 – Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
 - 6. TC 14 – Aboveground Reinforced Thermosetting Resin Conduit and Fittings.
- C. UL, Inc:
 - 1. 651A – Type EB and A Rigid PVC Conduit and HDPE Conduit.

1.3 DEFINITIONS

- A. Manhole:
 - 1. A pre-cast concrete underground box providing access to below grade cables and conductors.
- B. Handhole:
 - 1. A polymer-concrete composite underground box providing access to below grade cables and conductors.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.

- B. Action Submittals:
 - 1. Product Data:
 - a. Submit manufacturer information for metallic conduits, nonmetallic conduits, ducts, manhole accessories, handholes, and manholes.
 - b. Accessories for manholes, handholes, boxes.
 - 2. Shop Drawings:
 - a. Indicate dimensions, reinforcement, size and locations of duct entry provisions, grounding details, and accessory locations for each type and size of manhole or handhole provided.
 - 3. Duct-Bank Coordination Drawings:
 - a. Show duct profiles and coordination with other utilities and underground structures.
 - b. Include plans and sections, drawn to scale, and show bends and locations of fittings.
- C. Informational Submittals:
 - 1. Manufacturer's Certificate:
 - a. Certify that products meet or exceed specified requirements.
 - 2. Manufacturer Instructions:
 - a. Submit detailed instructions on installation requirements, including storage and handling procedures.
 - 3. Source Quality-Control Submittals:
 - a. Indicate results of factory tests and inspections.
 - 4. Qualifications Statement:
 - a. Submit qualifications for manufacturer.
 - 5. Product Certificates:
 - a. For concrete and steel used in precast concrete manholes, as required by ASTM C858.
 - 6. Closeout Submittals:
 - a. Project As-Built Documents:
 - 1) Record actual routing and elevations of underground conduit and duct.
 - 2) Record actual locations and sizes of manholes and handholes.

1.5 COORDINATION

- A. Coordinate Work of this Section with existing underground utilities and structures.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes and as approved by Engineer.

1.6 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this Section with a minimum of five years documented experience.

1.7 SOURCE QUALITY CONTROL

- A. Testing:
 - 1. Provide shop testing of completed assembly.
- B. Inspection:
 - 1. Inspect manholes according to ASTM C1037.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Inspection:
 - 1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store products according to manufacturer instructions.
- C. 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.
- D. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- E. Store manholes and handholes at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- F. Lift and support precast concrete units only at designated lifting or supporting points.

1.9 WARRANTY

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

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Interconnected system of conduits, ducts, manholes, and handholes to distribute power, control, and data communications wiring. Conduit and duct routing and manhole/handhole locations are shown in approximate locations on Drawings unless dimensions are indicated. Route and locate for completion of duct bank system.
- B. Design Requirements:
 - 1. Minimum below-grade conduit size shall be 1 in; raceways designated as 3/4 in. on drawings shall transition to 1 in. below grade.

2.2 RIGID STEEL CONDUIT

- A. Description:
 - 1. Rigid Steel Conduit:
 - a. See ANSI C80.1.
 - 2. Fittings:
 - a. See NEMA FB 1.
 - b. Material: Galvanized Steel.
- B. PVC COATED RIGID STEEL CONDUIT
 - 1. See 26 05 33.13 – PVC Coated Conduit for requirements.

2.3 PVC CONDUIT

- A. Description:
 - 1. Rigid Plastic Conduit:
 - a. See NEMA TC 2.
 - b. Material:
 - 1) PVC, Schedule 40.
 - c. Fittings and Conduit Bodies:
 - 1) See NEMA TC 3.

2.4 PRECAST CONCRETE MANHOLES AND BOXES

- A. Approved Manufacturers:
 - 1. Hanson Pipe & Precast
 - 2. Oldcastle Infrastructure Inc.
 - 3. Utility Structures Inc.
 - 4. WCP: Wichita Concrete Pipe
 - 5. Or Approved Equal.
- B. Description:
 - 1. Precast manhole designed according to ASTM C858, comprising modular, interlocking sections complete with accessories.
- C. Box to be provided with dampproof and waterproof coating designed for application on pre-cast concrete.
- D. Loading:
 - 1. ASTM C857, Class A-16, H-20 rated.
- E. Shape:
 - 1. Square or as indicated on drawings.
- F. Nominal Dimensions:
 - 1. 4 ft x 4 ft minimum, or as required to accommodate installed conductors and meet minimum dimension requirements per National Electric Code.
- G. Inside Depth:
 - 1. As required for application.
- H. Base Section:
 - 1. Sump:
 - a. Size: 4 in. deep by 12 in. in diameter.
 - b. Furnish cast sleeve and 1 in. ground rod opening.
- I. Top Section:
 - 1. Furnish 39 in. diameter, grooved opening for frame and cover.
- J. Riser Casting:
 - 1. Diameter: 12 in.
 - 2. Furnish manhole steps cast into frame.
- K. Frames and Covers:
 - 1. See ASTM A48.
 - 2. Material: Class 30B gray cast iron.
 - 3. Diameter: 30 in.

4. Surfacing: Machine finished with flat bearing surfaces.
 5. Furnish cover cast with ELECTRIC in large letters to indicate utility.
- L. Duct Entry Provisions:
1. Coordinate knockout locations and size with duct banks per drawings.
- M. Cable Pulling Irons:
1. Galvanized rod and hardware.
 2. Locate opposite each duct entry.
 3. Furnish watertight seal.
- N. Cable Rack Inserts:
1. Minimum Load Rating: 800 lbs.
- O. Cable Rack Mounting Channel:
1. Material: Steel channel.
 2. Furnish cable rack arm mounting slots as required.
- P. Cable Racks:
1. Material: Steel channel.
 2. Furnish fasteners to match mounting channel.
- Q. Cable Supports:
1. Porcelain clamps and saddles.
- R. Manhole Steps:
1. Description: Polypropylene plastic manhole step with 1/2 in. steel reinforcement.
 2. Cast steps at 12 in. O.C., vertically.
- S. Sump Covers:
1. Material: Class 30B gray cast iron.
 2. See ASTM A48.
- 2.5 HANDHOLES
- A. Manufacturers:
1. Quazite; brand of Hubbell
 2. Oldcastle Infrastructure Group
 3. Newbasis
 4. Or Approved Equal.
- B. Description:
1. Polymer concrete composite material, molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass. Open bottom unless otherwise indicated.
- C. Loading:
1. Tier 22 design loads for driveway, parking lot, and off-roadway applications subject to occasional nondeliberate heavy vehicular traffic.
- D. Shape:
1. Square or rectangular.

- E. Nominal Dimensions:
 - 1. 17 in. by 30 in. minimum, or as required to accommodate installed conductors and meet minimum dimension requirements per National Electric Code.
- F. Inside Depth:
 - 1. As required for application.
- G. Covers:
 - 1. Description:
 - a. Polymer concrete cover.
 - b. Stainless steel fasteners.
 - c. 0.5 coefficient of friction skid resistant surface.
 - d. Furnish cover embedded with ELECTRIC to indicate utility.
- H. Duct Entry Provisions:
 - 1. Coordinate knockout locations and size with duct banks per drawings.

2.6 ACCESSORIES

- A. Duct-Sealing Compound:
 - 1. Nonhardening, safe for contact with human skin, not deleterious to cable insulation and workable at temperatures as low as 35°F. Capable of withstanding temperature of 300°F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- B. Cover Hooks:
 - 1. Heavy duty, designed for lifts 60 lbs. and greater.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- B. Verify locations of manholes and handholes prior to excavating for installation.

3.2 UNDERGROUND DUCT APPLICATION

- A. Rigid nonmetallic conduit, NEMA Type EPC-40-PVC, arranged in concrete-encased duct bank, unless otherwise indicated.

3.3 UNDERGROUND BOX APPLICATION

- A. Circuits 600 V and Less:
 - 1. Box sizes up to 4 ft x 4 ft: Polymer concrete handholes or precast concrete manholes.
 - 2. Box sizes larger than 4 ft x 4 ft: Precast concrete manholes.
- B. Circuits Greater than 600 V:
 - 1. Precast concrete manholes.
- C. Do not install boxes within driveways without prior written approval from Engineer. When approved, boxes must be AASHTO H-20 rated for deliberate roadway traffic.

- D. Do not mix conductors of different voltage types within the same box without prior written approval from Engineer. In general, circuits shall be grouped into separate boxes:
 - 1. Circuits greater than 600 VAC.
 - 2. 480/277 VAC circuits.
 - 3. 120–240 VAC circuits.
 - 4. 24VDC analog signal and fiber-optic circuits.
- E. When different voltage types are approved within a common box, suitable barriers must be provided within the box to separate conductors of different voltages.
- F. Cables shall be looped or installed around perimeter of boxes to provide a minimum 3 ft of cable slack for future modifications – cables shall not be pulled tight or “straight through” the box.

3.4 INSTALLATION

- A. Duct Banks:
 - 1. Install duct to locate top of ducts at depths as indicated on Drawings. In no case shall ducts be installed less than 18 in. below grade without prior written approval from Engineer.
 - 2. Conduit and Duct Slope:
 - a. Minimum 4 in. per 100 ft.
 - b. Slope conduit and duct towards manholes/handholes and away from building entrances.
 - 3. PVC Conduit System:
 - a. Join nonmetallic conduit and duct using adhesive as recommended by manufacturer.
 - b. Wipe nonmetallic conduit and duct dry and clean before joining.
 - c. Apply full even coat of adhesive to entire area inserted in fitting.
 - d. Allow joint to cure for minimum 20 minutes.
 - 4. Conduit Bends:
 - a. Install no more than equivalent of three 90-degree bends between pull points.
 - b. For conduits containing cables operating at greater than 600 VAC, provide long-sweep elbows with a minimum radius of 36 in. for all bends.
 - c. For conduits containing fiber-optic cables, provide long-sweep elbows with a minimum radius of 36 in. for all bends.
 - 5. Install fittings to accommodate expansion and deflection. Stagger conduit and duct joints vertically at minimum 6 in. spacing.
 - 6. Terminate conduit and duct at manhole/handhole entries using end bells. Grout end bells into structure walls.
 - 7. Separators and Chairs:
 - a. Provide suitable separators and chairs, installed not greater than 5 ft on center.
 - 8. Concrete Encasement:
 - a. Band conduits and ducts together before backfilling or placing concrete.
 - b. Securely anchor conduit, separators, and chairs to prevent movement during concrete placement.
 - c. Place concrete as specified in Section 03 30 00 – Cast-in-Place Concrete.
 - d. Use mineral pigment to color concrete red. Pigment shall be thoroughly mixed into concrete for a uniform red color throughout.
 - e. Install ducts with a minimum of 3 in. of concrete cover at bottoms, tops, and sides of duct banks.
 - f. For duct bank runs under paved areas, install two No. 4 steel reinforcing bars in top of duct bank concrete.
 - g. Connect to existing concrete encasement and manhole walls using dowels.
 - 9. Backfill trenches as specified in Section 31 23 16.13 – Trenching for Site Utilities.

10. Duct Markers:
 - a. Install detectable underground warning tape above duct banks per requirements of Section 26 05 53 – Identification for Electrical Systems.
 11. Duct Cleaning:
 - a. Pull test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80% fill of duct. If obstructions are indicated, remove obstructions and retest.
 - b. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
 - c. Install suitable caps to protect duct against entrance of dirt and moisture.
 12. Pulling cord: Install 100 lbf-test nylon cord in ducts, including spares.
 13. Duct Bank Transition:
 - a. At building approaches, transition from concrete-encased duct bank to direct-buried PVC installed a minimum of 18 in. below building slab, without forming a trap in the line. Coordinate entrances to avoid building footings.
 - b. Transition to above ground, starting at the vertical 90-degree bend, shall be galvanized rigid conduit at dry indoor locations, PVC-coated steel conduit at exterior or interior wet locations, and PVC-coated steel conduit at chemical room locations.
- B. Precast Manholes:
1. Excavate for manhole installation as specified in Section 31 23 16 – Excavation.
 2. Install and seal to as specified in ASTM C891, unless otherwise indicated.
 3. Install manholes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 4. Seal around conduit penetrations after fittings are installed.
 5. Unless otherwise indicated, support manholes on a level 12 in. bed of crushed stone or gravel graded from 1 in. sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
 6. Use precast neck and shaft sections to bring manhole cover to finished elevation.
 7. Attach cable racks to inserts after manhole installation is complete.
 8. Install drains connected to manhole sumps and connect to Site drainage system.
 9. Backfill manhole excavation as specified in Section 31 23 23.13 – Fill and Backfill.
- C. Polymer Concrete Handholes:
1. Excavate for handhole installation as specified in Section 31 23 16 – Excavation.
 2. Install handholes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 3. Seal around conduit penetrations after fittings are installed.
 4. Unless otherwise indicated, support handholes on a level 12 in. bed of crushed stone or gravel graded from 1 in. sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
 5. Handhole covers: In hard-surface areas, set surface flush with finished grade. Set covers of other handholes 1-inch above finished grade.
 6. Backfill handhole excavation as specified in Section 31 23 23.13 – Fill and Backfill.
- D. Grounding:
1. Ground underground ducts and utility structures as specified in Section 26 05 26 – Grounding and Bonding for Electrical Systems.

END OF SECTION

SECTION 26 05 48 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Isolation pads
 - 2. Spring isolators
 - 3. Restrained spring isolators
 - 4. Channel support systems
 - 5. Restraint cables
 - 6. Hanger rod stiffeners
 - 7. Anchorage bushings and washers
- B. Related Sections:
 - 1. Section 26 05 29 – Hangers and Supports for Electrical Systems

1.2 DEFINITIONS

- A. The IBC:
 - 1. International Building Code.
- B. ICC-ES:
 - 1. ICC-Evaluation Service.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and specify style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
 - b. Annotate to specify application of each product submitted and as specified in requirements.
 - 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- C. Delegated-Design Submittal:
 - 1. For seismic-restraint details as specified in performance requirements and design criteria, including analysis data signed and sealed by the qualified professional Engineer responsible for their preparation.
 - 2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. See other Division 26 – Electrical requirements for equipment mounted outdoors.
 - 3. Specify materials and dimensions and identify hardware, including attachment and anchorage devices.
 - 4. Field-fabricated supports.

5. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Specify fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and specify directions and values of forces transmitted to the structure during seismic events.
- D. Coordination Drawings:
 1. Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- E. Welding certificates.
- F. Qualification Data:
 1. For testing agency.
- G. Field quality requirements test reports.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 1. Site Class as Defined in the IBC: D.
 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
 - a. Component Importance Factor: 1.5.
 - b. Component Response Modification Factor: 2.5, 6.
 - c. Component Amplification Factor: 1.0, 2.5.
 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 53.2%.
 4. Design Spectral Response Acceleration at 1.0 sec Period: 16.6%.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications:
 1. An independent agency, with the experience and capability to conduct the testing specified, that is a nationally recognized testing laboratory (NRTL) as specified in OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. See seismic-restraint requirements in the IBC unless requirements here are more stringent.
- C. Welding:
 1. Qualify procedures and personnel as specified in AWS D1.1 – "Structural Welding Code – Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are NOT available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs shall be signed and sealed by a qualified professional Engineer.
- E. As specified in NFPA 70.

1.6 WARRANTY

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

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Available Manufacturers (Subject to requirements):
1. Ace Mountings Co., Inc.
 2. Amber/Booth Company, Inc.
 3. California Dynamics Corporation
 4. Isolation Technology, Inc.
 5. Kinetics Noise Control
 6. Mason Industries
 7. Vibration Eliminator Co., Inc.
 8. Vibration Isolation
 9. Vibration Mountings & Controls, Inc.
 10. Or Approved Equal.
- B. Pads:
1. Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 2. Resilient Material: Oil-resistant and water-resistant neoprene.
- C. Spring Isolators:
1. Freestanding, laterally stable, open-spring isolators.
 2. Outside Spring Diameter: NOT less than 80% of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50% of the required deflection at rated load.
 4. Lateral Stiffness: More than 80% of rated vertical stiffness.
 5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
 6. Baseplates: Factory drilled for bolting to structure and bonded to 1/4 in. (6 mm) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
 7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators:
1. Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4 in. (6 mm) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment-mounting and leveling bolt that acts as blocking during installation.
 3. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 4. Outside Spring Diameter: NOT less than 80% of the compressed height of the spring at rated load.
 5. Minimum Additional Travel: 50% of the required deflection at rated load.
 6. Lateral Stiffness: More than 80% of rated vertical stiffness.
 7. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers (Subject with requirements):
 - 1. Amber/Booth Company, Inc.
 - 2. California Dynamics Corporation
 - 3. Cooper B-Line, Inc.; a division of Cooper Industries
 - 4. Hilti Inc.
 - 5. Loos & Co.; Seismic Earthquake Division
 - 6. Mason Industries
 - 7. TOLCO Incorporated; a brand of NIBCO INC.
 - 8. Unistrut; Tyco International, Ltd.
 - 9. Or Approved Equal.
- B. General Requirements for Restraint Components:
 - 1. Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES.
 - 2. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they shall be subjected.
- C. Channel Support System:
 - 1. MFMA-3, shop or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Restraint Cables:
 - 1. ASTM A492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener:
 - 1. Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. DO NOT weld stiffeners to rods.
- F. Bushings for Floor-Mounted Equipment Anchor:
 - 1. Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage:
 - 1. Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
- H. Resilient Isolation Washers and Bushings:
 - 1. One-piece, molded, oil and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor:
 - 1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested by ASTM E488. Minimum length of eight times diameter.
- J. Adhesive Anchor:
 - 1. Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide

anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and is tested as specified in ASTM E488.

2.3 FACTORY FINISHES

- A. Finish:
 - 1. Manufacturer's standard paint applied to factory-assembled and factory-tested equipment before shipping.
 - 2. Powder coating on springs and housings.
 - 3. All hardware shall be stainless.
 - 4. Powder coat for metal components on isolators for interior use.
 - 5. Color-code or otherwise mark vibration isolation and seismic-control devices to specify capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic-control devices as specified in requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables:
 - 1. Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.
- B. Hanger Rod Stiffeners:
 - 1. Install hanger rod stiffeners where specified or scheduled in Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies:
 - 1. Where NOT specified, select sizes of components so strength shall be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators on electrical equipment.
 - 2. Anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 in. (3.2 mm).
 - 3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

- C. Attachment to Structure:
 - 1. If specific attachment is NOT specified, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-In Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. DO NOT damage existing reinforcing or embedded items during coring or drilling. Notify the structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. DO NOT drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY REQUIREMENTS

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Engineer, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days of advance notice.
 - 3. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners.
 - 5. Test to 90% of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

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 73 – POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. A complete computer-based power system study including the following: short circuit analysis, equipment evaluation, protective device overcurrent coordination, and arc flash hazard analysis.
 - 2. Study shall cover all equipment, new or existing, installed downstream of utility service transformers at the Electrical Building 67 located at the North Pond.

1.2 DEFINITIONS

- A. One-Line Diagram:
 - 1. A diagram that specifies, by means of single lines and graphic symbols, the course of an electric circuit and the component devices or parts used therein.
- B. Protective Device:
 - 1. A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. Service:
 - 1. The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. For computer software program to be used for studies.
- C. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
 - 1. Power system analysis input data, including completed computer program input data sheets.
 - 2. Complete power system study report as required by this document; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Engineer for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.
 - b. Revised single-line diagram, reflecting field investigation results and results of power system analysis.
- D. Qualification Data:
 - 1. For power system analysis specialist.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Power System Analysis Specialist Qualifications:
 - 1. Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. Products (Subject to requirements, perform study using):
 - 1. SKM; PowerTools for Windows
 - 2. ESA International; EasyPower.
- B. As specified in:
 - 1. IEEE 399
 - 2. IEEE 551
 - 3. IEEE 242
 - 4. IEEE 1584
 - 5. NFPA 70E
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 DATA COLLECTION

- A. Obtain all data necessary to conduct the power system analysis.
 - 1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Engineer.
 - 2. For new equipment, use characteristics submitted under the provisions of submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.
- B. Gather and tabulate the following input data to support power system study. As specified in recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study and shall be by the engineer or its representative.
 - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance at the service, including 3-phase and 1-phase short circuit MVA and X/R ratio.
 - 3. Power sources and ties.
 - 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

5. For reactors, provide manufacturer and model designation, voltage rating and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
9. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
10. Motor horsepower and NEMA MG 1 code letter designation.
11. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
12. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

2.3 SYSTEM MODELING

- A. Provide a list of all assumptions made. The Engineer shall review and request any changes to assumptions before final approval of the model.
- B. Equipment names used in the modeling software shall be identical to the names used on the equipment nameplates installed in the field.
- C. For systems with more than one available power source (such as a generator or second utility source), separate scenarios shall be modeled for each possible operating condition. Each of the operating conditions shall be documented and modeled in the software to determine the worst-case arc flash hazard and short circuit values for the system components.
- D. All components in the model shall be based on nameplate data from the actual field device including manufacturer, type, style, ratings, actual settings, etc. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions or substitutions shall be documented in the report.
- E. The model shall include all electrical components of the system from the utility service (including primary relaying) down to all equipment more than 50 V. This includes all control panels, disconnects, or other panels where voltage greater than 50 V is present. Refer to requirements of arc flash analysis for evaluating hazards for equipment less than 240V.

2.4 SHORT CIRCUIT ANALYSIS

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents as specified in IEEE 551. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices.
- C. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- D. Actual transformer impedances shall be used if known. Design impedances shall only be used where actual impedance is unobtainable from field markings or from the manufacturer.

- E. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low and medium-voltage, 3-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the 3-phase bolted fault short-circuit study.
- F. Calculate short-circuit momentary and interrupting duties for a 3-phase bolted fault:
 - 1. Electric utility's supply termination point.
 - 2. Incoming switchgear.
 - 3. Low-voltage switchgear.
 - 4. Motor-control centers.
 - 5. Control panels.
 - 6. Standby generators and automatic transfer switches.
 - 7. Branch circuit panelboards.
 - 8. Disconnect switches.
 - 9. Other significant locations throughout the system.

2.5 EQUIPMENT EVALUATION

- A. Provide a short circuit evaluation of all electrical equipment and protective devices. Evaluation shall compare short circuit withstand and interrupting ratings of equipment with calculated short circuit values from the study.
- B. The software performing the equipment evaluation shall automatically adjust results for system X/R ratios that are higher than equipment test X/R ratios.
- C. Equipment in the evaluation shall be marked with:
 - 1. PASS – maximum short circuit current is less than 90% of equipment rating.
 - 2. MARGINAL – maximum short circuit current is 90–100% of equipment rating.
 - 3. FAIL – maximum short circuit current is greater than 100% of equipment rating.

2.6 PROTECTIVE DEVICE COORDINATION STUDY

- A. Provide settings for all overcurrent protective devices to achieve the following:
 - 1. Provide selective coordination for the electrical system.
 - 2. Protect equipment and cables from damage during overcurrent conditions.
 - 3. Minimize arc flash hazards.
- B. Graphically illustrate the settings of all overcurrent protective devices utilizing time current curves (TCCs):
 - 1. Display TCCs on log-log scale graphs printed in color on 8.5 in. by 11 in. sized paper. Each TCC shall have a unique title and associated one-line diagram with legend identifying the portion of the system depicted in the TCC.
 - 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 - 3. Each device specified on a TCC shall include a datablock identifying the name of the device, manufacturer make and model, and overcurrent settings.
 - 4. Develop TCCs for both phase and ground protective devices.
 - 5. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium voltage equipment overcurrent relays.
 - c. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.

- e. Transformer full load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground fault protective devices.
 - h. Motor starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. The largest feeder circuit breaker in each motor control center, switchboard, and panel board.
 - 6. Provide number of TCCs as required to adequately display the selective coordination of the system.
 - 7. Provide adequate time margins between device characteristics such that selective operation is achieved.
- C. For an existing system, provide the protective device settings as existing as well as recommendations for new settings if existing does not provide adequate selectivity. If settings changes are recommended, clearly identify the recommended changes in a table format.
- D. A table shall be developed to summarize the settings for all protective devices that contain adjustable settings. The table shall include the following:
- 1. Device identification.
 - 2. For circuit breakers: Manufacturer, type, style, sensor rating, long-time pickup, short-time pickup, instantaneous pickup, ground fault pickup, and associated time delay settings.
 - 3. For protective relays: Manufacturer, type, style, function pickup, current multiplier, time dial, and time delays. For multifunction units, list all devices being used. Include the CT and/or PT ratios for each function.
 - 4. Include both existing settings and recommended changes for all protective devices with recommended settings changes.
- E. Transformer Primary Overcurrent Protective Devices:
- 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads as specified in IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers as specified in IEEE C57.12.00, for fault currents.
- F. Motor Protection:
- 1. Select protection for low-voltage motors as specified in IEEE 242 and NFPA 70.
 - 2. Select protection for motors served at voltages more than 600 V as specified in IEEE 620.
- G. Conductor Protection:
- 1. Protect cables against damage from fault currents. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards specifying conductor size and short-circuit current.
- H. Generator Protection:
- 1. Select protection as specified in manufacturer's written recommendations and to IEEE 242.

2.7 ARC FLASH HAZARD ANALYSIS

- A. As specified in NFPA 70E and IEEE 1584 for hazard analysis study.
- B. Results from the short circuit current study and overcurrent coordination study shall be used as inputs to the arc flash hazard analysis.
- C. The flash protection boundary and incident energy shall be calculated at all significant locations in the electrical distribution system where work could be performed on energized parts. This includes but is not limited to switchboards, switchgear, motor control centers, panelboards, busways, and disconnect switches.
- D. For 3-phase or single-phase equipment rated 240 VAC or less fed from transformers less than 125 kVA, refer to NFPA 70E and IEEE 1584 for determining hazard category levels. Include in the report a description of methods used to determine hazard levels for equipment in this category.
- E. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary.
- F. The incident energy calculations for multiple scenarios must be compared and the greatest incident energy must be reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions. Note that maximum utility contribution is not defined as infinite bus, but rather the maximum value reported by the utility.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall account for the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond three to five cycles.
- H. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- I. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- J. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds.

PART 3 - EXECUTION

3.1 POWER SYSTEM STUDY REPORT CONTENTS

- A. Executive Summary:
 - 1. Brief description of the important findings and recommendations of the study. The executive summary should not include general study information or methodology.

- B. Introduction:
1. Describe the purpose and scope of the study and the methodology used for each analysis.
 2. Provide a description of the connection of the system and the different operating scenarios analyzed.
 3. List all engineering assumptions made for the study.
- C. Input Data:
1. Provide input data for all components of the system model in tabular format, including but not limited to the following:
 - a. Cable data including size, length, number per phase, conduit type, and conductor material.
 - b. Transformer data including winding connections, kVA rating, primary and secondary voltage ratings, %Z, and X/R ratios.
 - c. Reactor data including voltage rating and inductance.
 - d. Generator contribution data including kVA rating, power factor, voltage, and subtransient reactance.
 - e. Utility contribution data including rated voltage and 3-phase and single-line-ground contributions with X/R ratios.
- D. One-Line Diagram:
1. Provide one-line diagram(s) generated from the computer software package that specifies all electrical distribution for the system. Include as a minimum the following information on the diagram(s):
 - a. Protective device designations and ampere ratings.
 - b. Cable sizes and lengths.
 - c. Transformer kilovolt ampere (kVA), voltage, and impedance ratings.
 - d. Motor and generator designations and kVA ratings.
 - e. Utility contribution data
 - f. Switchgear, switchboard, motor-control center, and panelboard designations, voltage ratings, bus ampacities, and short circuit current ratings.
- E. Short Circuit Current Analysis:
1. Output data shall include but not be limited to the following reports:
 - a. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, specifying the following for each overcurrent device location:
 - 1) Voltage.
 - 2) Calculated fault-current magnitude and angle.
 - 3) Fault-point X/R ratio.
 - 4) Equivalent impedance.
 - b. Momentary Duty Report: Three-phase and unbalanced fault calculations, specifying the following for each overcurrent device location:
 - 1) Voltage.
 - 2) Calculated symmetrical fault-current magnitude and angle.
 - 3) Fault-point X/R ratio.
 - 4) Calculated asymmetrical fault currents:
 - a) Based on fault-point X/R ratio.
 - b) Based on calculated symmetrical value multiplied by 1.6.
 - c) Based on calculated symmetrical value multiplied by 2.7.
 - c. Interrupting Duty Report: Three-phase and unbalanced fault calculations, specifying the following for each overcurrent device location:
 - 1) Voltage.
 - 2) Calculated symmetrical fault-current magnitude and angle.
 - 3) Fault-point X/R ratio.
 - 4) No AC Decrement (NACD) ratio.
 - 5) Equivalent impedance.

- 6) Multiplying factors for 2, 3, 5, and 8-cycle circuit breakers rated on a symmetrical basis.
- d. Multiplying factors for 2, 3, 5, and 8-cycle circuit breakers rated on a total basis.

F. Equipment Evaluation:

1. The results of the short circuit equipment evaluation shall be reported in tabular format and provide the following information:
 - a. Equipment name, voltage rating, and short circuit rating
 - b. Calculated maximum available short circuit current at each device and bus
 - c. Percent over/under duty and PASS/FAIL/MARGINAL designation as defined in Part 2 of this specification.
 - d. Components that fail the equipment evaluation shall be highlighted for easy visual identification.

G. Protective Device Coordination Study:

1. Provide a summary of the findings of the study including any major selectivity problems or recommendations.
2. Provide all TCCs needed to illustrate the system including a table of contents and descriptions for all TCCs included.
3. Include a settings table to summarize the settings for all protective devices as required in Part 2 of this specification.

H. Arc Flash Hazard Analysis:

1. Provide a brief summary of the findings of the study including a list of any locations identified as Dangerous hazard category and recommendations for hazard category reductions.
2. Provide a table specifying the worst case scenario of all buses evaluated. Table shall include but is not limited to the following:
 - a. Arcing fault magnitude
 - b. Protective device clearing time
 - c. Duration of arc
 - d. Arc flash boundary
 - e. Working distance
 - f. Incident energy
 - g. Hazard risk category
3. Provide a separate table for each operating scenario. Provide the same information as required above for each table.

I. Recommendations:

1. Provide a section that summarizes and lists all recommendations for changes to the system as a result of the study. This includes protective device settings changes, equipment short circuit deficiency corrections, or other items as applicable.

3.2 ARC FLASH WARNING LABELS

- A. Provide a thermal transfer type label of high-adhesion polyester for each work location included in the analysis. Labels shall have a minimum size of 3.5 in. by 5 in.
- B. The labels shall include the following information taken directly from the arc flash hazard analysis:
 1. Equipment name (must match name on equipment nameplate)
 2. Nominal voltage
 3. Flash protection boundary
 4. Hazard risk category
 5. Incident energy
 6. Available short circuit current

7. Working distance
8. Glove class
9. Engineering report number, revision number, and issue date

- C. Labels shall be machine printed, with no field-applied markings.
- D. Labels to be applied on outdoor equipment shall have a weatherproof coating for protection from deterioration or fading due to rain and UV exposure.

3.3 LABELING

- A. Apply one arc flash label for each of the following locations:
 1. Panelboards
 2. Disconnects
 3. Motor control centers
 4. Switchboards
 5. Switchgear
 6. Control panels
 7. Any equipment likely to require servicing while energized.
- B. Installation of arc flash warning labels shall be done under the direct supervision and control of the power system study specialist.

3.4 ADJUSTING

- A. Contractor shall adjust both new and existing protective device trip settings as specified.
- B. Make minor modifications to equipment as specified.

3.5 DEMONSTRATION

- A. Train Owner's operating and maintenance personnel in the use of study results.

3.6 TRAINING

- A. Train Owner's operating and maintenance personnel in the potential arc flash hazards associated with working on energized equipment and the significance of arc flash warning labels.

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: ODP or 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. Vibration switches shall be Metrix 440 or equal, with independent adjustable alarm and shutdown mechanical relay outputs, unless specified otherwise. 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 hours (belted) or 100,000 hours (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 air conditioned, 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 1/2 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 detectable, 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 13 – SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboards rated 600 V and less.

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. For each type of switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component specified. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- C. Shop Drawings:
 - 1. For each switchboard and related equipment.
 - 2. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 3. Detail enclosure types.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 6. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - 7. Detail utility company's metering provisions with specified approval by utility company.
 - 8. Include evidence of NRTL listing for series rating of installed devices.
 - 9. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 10. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
 - 11. Include schematic and wiring diagrams for power, signal, and control wiring.
- D. Qualification Data:
 - 1. For qualified Installer.
- E. Seismic Qualification Certificates:
 - 1. Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces.
 - 2. Basis for Certification: Specify whether withstand certification is based on actual test of assembled components or on calculation.
 - 3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results as specified in requirements.

G. Operation and Maintenance Data:

1. For switchboards and components to include in emergency, operation, and maintenance manuals.
2. Routine maintenance requirements for switchboards and all installed components.
3. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
4. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.3 QUALITY ASSURANCE

A. Installer Qualifications:

1. An employer of workers qualified as specified in NEMA PB 2.1 and trained in electrical safety as specified in NFPA 70E.

B. Source Limitations:

1. Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space:

1. Drawings specify maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. As specified in 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. As specified in NEMA PB 2.

F. As specified in NFPA 70.

G. As specified in UL 891.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating, or connect factory-installed space heaters to temporary electrical service, to prevent condensation.

C. Handle and prepare switchboards for installation as specified in NEMA PB 2.1.

1.5 PROJECT CONDITIONS

A. Installation Pathway:

1. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards 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 specified conditions, unless otherwise specified:
 - a. Ambient Temperature: Not exceeding 122°F.

1.6 COORDINATION

- A. Coordinate layout and installation of switchboards 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.

1.7 WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Available Manufacturers (Subject to requirements):
 - 1. Eaton
 - 2. Square D; Schneider Electric
 - 3. ABB
 - 4. Siemens
 - 5. Other Approved Equal.
- B. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted
 - 2. Branch Devices: Panel (group) mounted
 - 3. Sections front and rear aligned
- C. Equipment Ratings:
 - 1. Nominal System Voltage: 480Y/277 V or as specified in Drawings.
 - 2. Main-Bus Continuous: Ampacity rating as specified in Drawings.
 - 3. Short Circuit Rating: As specified in Drawings. If no rating specified, provide 65kAIC minimum.
- D. Service Equipment Label:
 - 1. NRTL labeled for use as service equipment with one or more main service disconnecting and overcurrent protective devices.
- E. Seismic Requirements:
 - 1. Fabricate and test switchboards as specified in IEEE 344 to withstand seismic forces at the project location.

- F. Enclosures:
 - 1. Rated for the environmental conditions at the installed location:
 - a. Interior Locations: Type 1
 - b. Exterior Locations: Type 3R
 - 2. Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.
- G. Barriers:
 - 1. Between adjacent switchboard sections.
- H. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- I. Bus Transition and Incoming Pull Sections:
 - 1. Matched and aligned with basic switchboard.
- J. Hinged Front Panels:
 - 1. Allow access to circuit breaker, metering, accessory, and blank compartments.
- K. Pull Box on Top of Switchboard:
 - 1. Provide pull box if required for workable installation of conduit and conductors.
 - 2. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 3. Set back from front to clear circuit-breaker removal mechanism.
 - 4. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 - 5. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 - 6. Cable supports shall be arranged to facilitate cabling and adequate to support cables specified, including those for future installation.
- L. Buses and Connections:
 - 1. 3-phase, 4-wire unless otherwise specified.
 - 2. Phase- and Neutral-Bus Material: Tin or silver plated hard-drawn copper of 98% conductivity, with copper feeder circuit-breaker line connections.
 - 3. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 4. Ground Bus: 1/4 in. by 1 in. or the minimum-size required by UL 891, hard-drawn copper of 98% conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 5. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 6. Neutral Buses: 100% of the ampacity of phase buses unless otherwise specified, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- M. Surge Protection Devices:
 - 1. Include surge protective devices factory-installed integral to each switchboard, whether specified or not in Contract Drawings:
 - a. As specified in UL 1449, Type 2.
 - b. Connect through circuit breaker or fused switch for disconnection.

- c. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- d. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 3-phase, 4-wire circuits shall not exceed the following:
 - 1) Line to Neutral: 1,200 V
 - 2) Line to Ground: 1,200 V
 - 3) Line to Line: 2,000 V
- e. SCCR: Equal or exceed the short circuit current rating of the switchboard.
- f. Nominal Rating: 20 kA

N. Multifunction Digital-Metering Monitor:

- 1. Include microprocessor-based power meter factory-installed integral to each switchboard, whether specified or not in Contract Drawings.
 - a. Power meter shall be suitable for 3-wire or 4-wire systems and with:
 - 1)
- 2. Switch-selectable digital display of values with maximum accuracy tolerances as specified:
 - a. Phase Currents, Each Phase: Plus or minus 0.5%
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5%
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5%
 - d. Megawatts: Plus or minus 1%
 - e. Megavars: Plus or minus 1%
 - f. Power Factor: Plus or minus 1%
 - g. Frequency: Plus or minus 0.1%
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1%; accumulated values unaffected by power outages up to 72 hrs
 - i. Megawatt Demand: Plus or minus 1%; demand interval programmable from 5–60 min
- 3. Unit to have ethernet port for connection to external monitoring system.

O. Future Devices:

- 1. Provide a minimum of 12 unused circuit spaces for future use, in addition to any breakers specified in Contract Drawings as spares.
- 2. Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

P. Key Interlocking:

- 1. Where specified in Drawings, provide a key interlocking system for specified circuit breakers to prevent simultaneous energization of multiple sources.

2.2 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 switchboard 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 ampere 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).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards as specified in NEMA PB 2.1.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards as specified in 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 switchboards and accessories as specified in NEMA PB 2.1.
- B. Equipment Mounting:
 - 1. Install floor mounted switchboards on concrete base, 4 in. nominal thickness. Concrete base specified in Section 03 30 00 – Cast-in-Place Concrete.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise specified, install dowel rods on 18 in. centers around the full perimeter of concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions:
 - 1. Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

- D. Operating Instructions:
 - 1. Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, surge protection devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. As specified in NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs for identification as specified in Section 26 05 53 – Identification for Electrical Systems.
- B. Switchboard Nameplates:
 - 1. Label each switchboard compartment with a nameplate as specified in Section 26 05 53 – Identification for Electrical Systems.
- C. Device Nameplates:
 - 1. Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate as specified in Section 26 05 53 – Identification for Electrical Systems.

3.4 FIELD QUALITY CONTROL

- A. Inspect and test as specified in NETA ATS.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Perform infrared scan tests and inspections and prepare test reports:
 - 1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. 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. Switchboard will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Set field-adjustable circuit-breaker trip ranges as specified by Power System Study, or as recommended by manufacturer.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION

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: 0–122°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 Dedicated Locations (Electrical Rooms): Type 1
 - b. Interior Dry Locations (Nondedicated Spaces subject to Dust, Dirt only): Type 12
 - c. Interior Wet Locations (Wash-Down or Corrosive): Type 4X
 - d. Exterior Locations: 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, 3-phase, 4-wire circuits shall not exceed:
 - a. Line to Neutral: 1,200 V
 - b. Line to Ground: 1,200 V
 - c. Line to Line: 2,000 V
 - 5. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, 3-phase, 4-wire circuits shall not exceed:
 - a. Line to Neutral: 700 V
 - b. Line to Ground: 700 V
 - c. Line to Line: 1,200 V
 - 6. Protection modes and UL 1449 VPR for 240/120 V, 1-phase, 3-wire circuits shall not exceed:
 - a. Line to Neutral: 700 V
 - b. Line to Ground: 700 V
 - c. Line to Line: 1,200 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 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. Install stranded conductor for branch circuits 10 AWG and smaller. 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 28 16.13 – ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Molded-case circuit breakers in individual enclosures.
- B. Related Sections:
 - 1. Section 26 05 26 – Grounding and Bonding for Electrical Systems
 - 2. Section 26 05 29 – Hangers and Supports for Electrical Systems
 - 3. 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. UL (Underwriters Laboratories Inc.):
 - 1. 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. Submit catalog sheets showing ratings, trip units, time current curves, dimensions, and enclosure details.
- C. Product Data:
 - 1. For each type of enclosed switch, circuit breaker, accessory, and component specified. Include dimensioned elevations, sections, weights and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories and finishes.
 - 2. Enclosure types and details for all types specified, including NEMA 250, Type 1.
 - 3. Current and voltage ratings.
 - 4. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 5. Include evidence of Nationally Recognized Testing Laboratory listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- D. Shop Drawings:
 - 1. For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Wiring Diagrams: for power, signal, and control wiring.
- E. Qualification Data:
 - 1. For qualified testing agency.
- F. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

G. Operation and Maintenance Data:

1. For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 77 00 – Closeout Procedures include:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

H. Closeout Submittals:

1. Project Record Documents: Record actual locations and trip unit settings of enclosed circuit breakers.

1.4 QUALIFICATIONS

A. Manufacturer:

1. Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 QUALITY ASSURANCE

A. Source Limitations:

1. Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category from single manufacturer.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. See NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.8 WARRANTY

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

PART 2 - PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKER

A. Manufacturers:

1. Eaton
2. Siemens
3. Square D

- 4. ABB
- B. Product Description:
 - 1. Enclosed, molded-case circuit breaker conforming to UL 489, suitable for use as service entrance equipment where applied, with interrupting capacity to comply with available fault currents.
- C. Service Conditions:
 - 1. Temperature: 104°F
- D. 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 amps frame size shall have changeable trip units with adjustable magnetic trip settings.
- E. 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 amps 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.
- F. Arc Reduction Maintenance Mode:
 - 1. Provide arc reduction maintenance mode (ARMS) feature for all circuit breakers rated 1,200 amperes and larger, or where specified in Drawings.
- G. Current Limiting Circuit Breaker:
 - 1. Circuit breaker specified as current-limiting have automatically-resetting, current limiting elements in each pole. Let-through current and energy: less than permitted for same size Class RK-5 fuse.
- H. Current Limiter:
 - 1. Designed for application with molded case circuit breaker.
 - 2. Coordinate limiter size with trip rating of circuit breaker to prevent nuisance tripping and to achieve interrupting current rating specified for circuit breaker.
 - 3. Interlocks trip circuit breaker and prevent closing circuit breaker when limiter compartment cover is removed or when one or more limiter is not in place or has operated.
- I. Accessories:
 - 1. As specified in Drawings. As specified in UL 489.
 - 2. Shunt Trip Device: 120 VAC.
 - 3. Undervoltage Trip Device: 120 VAC.
 - 4. Auxiliary Switch: 120 VAC.
 - 5. Alarm Switch: 120 VAC.
 - 6. Electrical Operator: 120 VAC.
 - 7. Handle Lock: Provisions for padlocking.
 - 8. Grounding Lug: In each enclosure.
- J. Service Entrance:
 - 1. Enclosed circuit breakers identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

2.2 ENCLOSURES

- A. 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 4X
 - 4. Exterior Locations: Type 4X.
 - 5. Hazardous Locations: Type 7/8 Explosion Proof

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers as specified in installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install enclosed circuit breakers plumb. Provide supports as specified in Section 26 05 29 – Hangers and Supports for Electrical Systems.
- B. Install individual enclosed devices with tops at uniform height unless otherwise specified.
- C. Height:
 - 1. 5 ft to operating handle. Receive Engineer or Owner approval for other mounting heights. In no instance shall the operating handle be greater than 6 ft 7 in. above the floor or working platform.
- D. Install grounding and bonding as specified in Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- E. Locate and install engraved plastic nameplates as specified in Section 26 05 53 – Identification for Electrical Systems.

3.3 FIELD QUALITY CONTROL

- A. Perform inspections and tests listed in NETA ATS.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. 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. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed devices will be considered defective if they DO NOT pass tests and inspections.

- E. Prepare test and inspection reports, including a certified report that identifies enclosed devices. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.4 ADJUSTING

- A. Adjust trip settings to coordinate circuit breakers with other overcurrent protective devices in circuit.
- B. Adjust trip settings to provide adequate protection from overcurrent and fault currents.
- C. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION

SECTION 26 29 23 – VARIABLE–FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of 3-phase, squirrel-cage induction motors.

1.2 QUALIFICATIONS

- A. Manufacturer:
 - 1. The manufacturer shall have a minimum of 15 years of experience in the manufacturer of variable frequency motor controllers.
- B. Support:
 - 1. The manufacturer shall maintain factory trained and authorized service facilities within 100 miles of the project and shall have a demonstrated record of service for at least the previous ten years.
 - 2. Support personnel are to be direct employees of the manufacturer.
 - 3. The manufacturer shall provide all required startup and training services.

1.3 DEFINITIONS

- A. CE:
 - 1. Conformance Europeene (European Compliance).
- B. CPT:
 - 1. Control power transformer
- C. EMI:
 - 1. Electromagnetic interference
- D. IGBT:
 - 1. Insulated-gate bipolar transistor
- E. LED:
 - 1. Light-emitting diode
- F. MCP:
 - 1. Motor-circuit protector
- G. NC:
 - 1. Normally closed
- H. NO:
 - 1. Normally open
- I. OCPD:
 - 1. Overcurrent protective device
- J. PCC:
 - 1. Point of common coupling

- K. PID:
 - 1. Control action, proportional plus integral plus derivative
- L. PWM:
 - 1. Pulse-width modulated
- M. RFI:
 - 1. Radio-frequency interference
- N. TDD:
 - 1. Total demand (harmonic current) distortion
- O. THD(V):
 - 1. Total harmonic voltage demand
- P. VFC:
 - 1. Variable frequency motor controller
- Q. VFD:
 - 1. Variable frequency drive
- R. MPS:
 - 1. Motor Protection System

1.4 SUBMITTALS

- A. Product Data:
 - 1. For each type and rating of VFC specified. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. For each VFC specified. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
 - 2. Show tabulations of installed devices, equipment features, and ratings. Include:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Enclosure types and details.
 - d. Nameplate legends.
 - e. Short-circuit current (withstand) rating of enclosed unit.
 - f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
 - g. Specified modifications.
 - 3. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings:
 - 1. Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Specify field measurements.
- D. Seismic Qualification Certificates:
 - 1. For VFCs, accessories, and components, from manufacturer.

2. Basis for Certification: Specify whether withstand certification is based on actual test of assembled components or on calculation.
3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
4. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

E. Product Certificates:

1. For each VFC, from manufacturer.

F. Operation and Maintenance Data:

1. For VFCs to include emergency, operation, and maintenance manuals.
2. Include the following:
 - a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
 - b. Manufacturer's written instructions for setting field-adjustable overload relays.
 - c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

G. Load-Current and List of Settings of Adjustable Overload Relays:

1. Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic Performance:

1. VFCs shall withstand the effects of earthquake motions determined as specified in ASCE/SEI 7.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. See NFPA 70.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise specified:
 - a. Operating Ambient Temperature Range in Conditioned Spaces: 32–104°F.
 - b. Operating Ambient Temperature Range in Nonconditioned Spaces: 32–122°F.
 - c. Storage Ambient Temperature Range: (-40)–158°F.
 - d. Relative Humidity Range: 5–95% non-condensing.
 - e. Altitude: Up to 3,300 ft.

B. Enclosure Limitations:

1. VFD overall enclosure size shall not exceed specific length and width dimensions of 4'-8" and 3'-0" unless approved by engineer.

1.8 WARRANTY

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

1.9 COORDINATION

- A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
 1. Torque, speed, and horsepower requirements of the load.
 2. Ratings and characteristics of supply circuit and required control sequence.
 3. Ambient and environmental conditions of installation location.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

- A. Products in this section rated 75HP or greater shall be low harmonic type, as manufactured by:
 1. Schneider Electric – Square D Altivar 680.
 2. ABB ACQ580 - Low Harmonic.
 3. Rockwell Automation Powerflex 755T.
 4. Eaton CPX or PowerXL EGP.
 5. Or approved equivalent.
- B. Products in this section rated less than 75HP shall be manufactured by:
 1. Schneider Electric – Square D Altivar 660.
 2. ABB ACQ580.
 3. Rockwell Automation Powerflex 755.
 4. Eaton PowerXL DG1.
 5. Or approved equivalent.
- C. General Requirements for VFCs:
 1. See NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- D. VFC Description:
 1. Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more 3-phase induction motors by adjusting output voltage and frequency.
 2. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 3. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 4. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- E. Output Rating:

1. Three-phase; 10 Hz – 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
1. The VFC shall accept nominal plant power at 60 Hz.
 2. Input AC Voltage Tolerance: Plus 10% and minus 15% of VFC input voltage rating.
 3. Input AC Voltage Unbalance: Not exceeding 5%.
 4. Input Frequency Tolerance: Plus or minus 3% of VFC frequency rating.
 5. Minimum Efficiency: 97% at 60 Hz, full load.
 6. Minimum Displacement Primary-Side Power Factor: 95% under any load or speed condition.
 7. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
 8. Vibration Withstand: See IEC 60068-2-6.
 9. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.5 times the base load current for 3 seconds.
 10. Starting Torque: Minimum 100% of rated torque from 3 Hz–60 Hz.
 11. Speed Regulation: Plus or minus 5%.
 12. Stop Modes: Programmable; includes ramp, coast, fast, and dc injection braking.
- G. Isolated Control Interface:
1. Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
 2. Signal: Electrical, 4 mA DC – 20 mA DC.
- H. Internal Adjustability Capabilities:
1. Minimum Speed: 5–25% of maximum rpm.
 2. Maximum Speed: 80–100% of maximum rpm.
 3. Acceleration: 0.1% – 999.9 seconds.
 4. Deceleration: 0.1% – 999.9 seconds.
 5. Current Limit: 30 to minimum of 150% of maximum rating.
- I. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide 3-phase protection against damage from supply voltage surges 10% or more above nominal line voltage.
 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 3. Under- and overvoltage trips.
 4. Inverter overcurrent trips.
 5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
 6. Critical frequency rejection, with three selectable and adjustable deadbands.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 10. Short-circuit protection.
 11. Motor overtemperature fault.
- J. Automatic Reset/Restart:
1. Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- K. Power-Interruption Protection:

1. To prevent motor from reenergizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- L. Bidirectional Autospeed Search:
1. Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- M. Torque Boost:
1. Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- N. Motor Temperature Compensation at Slow Speeds:
1. Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- O. Integral Input Disconnecting Means and OCPD:
1. NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
 2. Disconnect Rating: Not less than 115% of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
 3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
 4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
 5. NC and NO alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION

- A. Panel-Mounted Operator Station:
1. Manufacturer's standard front-accessible, LCD display and keypad.
- B. Status Lights:
1. Refer to contract drawings for required status lights for each VFD.
 2. At a minimum provide the following:
 - a. VFD Running.
 - b. VFD Fault.
- C. Control Switches:
1. Refer to contract drawings for required control switches for each VFD.
 2. At a minimum provide the following:
 - a. Three position selector switch
 - b. Reset pushbutton
 - c. Speed potentiometer
- D. Control Signal Interfaces:
1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 4 mA DC – 20 mA DC.
 - b. A minimum of six multifunction programmable digital inputs.
 2. Output Signal Interface: A minimum of one programmable analog output signal(s) (4 mA DC – 20 mA DC), which can be configured for any of:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (VDC).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).

3. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120 VAC, 1 A) for remote indication of:
 - a. VFD Running.
 - b. VFD Fault.
4. Other control signal interfaces as specified in Contract Drawings.

2.3 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning:
 1. For VFDs 75HP and larger, provide one of the following to limit TDD and THD(V) at the defined PCC as specified in IEEE 519:
 - a. Active Front End components.
 - b. 18 pulse rectifier.
 2. For VFDs smaller than 75HP, provide 6 pulse rectifier with a minimum 5% input reactor or DC link choke impedance.
- B. Output Filtering:
 1. For motor lead lengths greater than 100 ft but less than 500 ft, provide a dv/dt output filter meeting VFC manufacturer's recommendations
 - a. Filter shall be TCI V1K or equal.
 - b. Filter shall be located inside the VFD enclosure.
 2. For motor lead lengths greater than 500 ft, provide a low-pass sine wave output filter meeting:
 - a. Filter shall be TCI MotorShield or equal.

2.4 ENCLOSURES

- A. VFC Enclosures:
 1. NEMA 250 to comply with environmental conditions at installed location.
 2. Interior Dedicated Locations (Electrical Rooms): Type 1
 3. Interior Dry Locations (Nondedicated Spaces subject to Dust, Dirt only): Type 12
 4. Interior Wet Locations (Wash-Down or Corrosive): Type 4X

2.5 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices:
 1. NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise specified.
 2. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oil tight type.
 - a. Push Buttons: Recessed types; maintained or momentary as required.
 - b. Pilot Lights: LED types; push to test.
 - c. Selector Switches: Rotary type.
 - d. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- B. Control Relays:
 1. Auxiliary and adjustable solid-state time-delay relays.
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays:
 1. Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 2. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. See IEEE C57.13.

- D. Cooling Fan and Exhaust System:
 - 1. Supply and/or exhaust fans, with composite stainless-steel intake and exhaust grills and filters; 120 VAC; obtained from integral CPT. Fan system shall not compromise the NEMA rating of the enclosure.
- E. Spare control-wiring terminal blocks; wired.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, as specified in requirements for installation tolerances, and other conditions affecting performance.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 MOTOR PROTECTION STUDY

- A. Where a motor protection relay is provided as specified in Contract Drawings, engage the relay manufacturer to provide a motor protection study to determine protective functions and settings to be utilized for both the motor protection relay and integral VFD protection settings. Prepare and submit a motor protection report for review. Configure all settings during startup as specified in motor protection study recommendations.

3.3 INSTALLATION

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Floor-Mounting Controllers:
 - 1. Install VFCs on 4 in. nominal thickness concrete base. See requirements for concrete base specified in Division 03 – Concrete.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise specified, install dowel rods on 18 in. centers around the full perimeter of concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Temporary Lifting Provisions:
 - 1. Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in each fusible-switch.

- E. Install fuses in control circuits if not factory installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. See NECA 1.

3.4 IDENTIFICATION

- A. Identify VFCs, components, and control wiring.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFC with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions:
 - 1. Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and facility's central-control system.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
 - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks as specified in manufacturer's written instructions.

3.7 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Set field-adjustable circuit-breaker trip ranges as recommended by the manufacturer.

3.8 PROTECTION

- A. Temporary Heating:
 - 1. Apply temporary heat to maintain temperature as specified in manufacturer's written instructions until controllers are ready to be energized and placed into service.

- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION

SECTION 26 43 13 – SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Field-mounted SPDs for low-voltage (120 V – 600 V) power distribution and control equipment.
- B. Related Section:
 - 1. Section 26 24 13 – Switchboards for factory-installed SPDs.
 - 2. Section 26 24 16 – Panelboards for factory-installed SPDs.

1.2 DEFINITIONS

- A. Inominal:
 - 1. Nominal discharge current.
- B. MCOV:
 - 1. Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection:
 - 1. The pair of electrical connections where the VPR applies.
- D. MOV:
 - 1. Metal-oxide varistor; an electronic component with a significant nonohmic current-voltage characteristic.
- E. OCPD:
 - 1. Overcurrent protective device.
- F. SCCR:
 - 1. Short-circuit current rating.
- G. SPD:
 - 1. Surge protective device.
- H. VPR:
 - 1. Voltage protection rating.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Action Submittals:
 - 1. Product Data:
 - a. For each type of product.
 - b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - c. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

- C. Informational Submittals:
 - 1. Field quality requirements reports.
 - 2. Sample Warranty: For manufacturer's special warranty.
 - 3. Closeout Submittals:
 - a. Maintenance Data: For SPDs to include in maintenance manuals.

1.4 WARRANTY

- A. Manufacturer's Warranty:
 - 1. Manufacturer agrees to replace SPDs that fail in materials or workmanship within specified warranty period.
 - 2. Warranty Period: Five years from date of Substantial Completion.
- B. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.
- D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR

- A. SPDs:
 - 1. Comply with UL 1449, Type 1.
 - 2. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1
 - 3. SPDs with the following features and accessories:
 - a. Integral disconnect switch.
 - b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - c. Indicator light display for protection status.
 - d. The 5 A and 250 VAC rating of the Form-C contacts is suitable for remote annunciators using Class 1 control circuits. Insert other ratings when monitoring is performed by Ethernet communications protocol used by building power monitoring and control system.
 - e. Form-C contacts rated at 5 A and 250VAC one normally open and one normally closed, for remote monitoring of protection status.
 - f. Surge counter.
- B. Comply with UL 1283.

- C. Peak Surge Current Rating:
 - 1. The minimum single-pulse surge current withstand rating per phase shall NOT be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 3-phase, 4-wire circuits shall NOT exceed:
 - 1. Line to Neutral: 1200 V.
 - 2. Line to Ground: 1200 V.
 - 3. Line to Line: 2000 V.
- E. Protection modes and UL 1449 VPR for 240/120 V, 1-phase, 3-wire circuits shall NOT exceed:
 - 1. Line to Neutral: 700 V.
 - 2. Line to Ground: 700 V.
 - 3. Line to Line: 1000 V.
- F. SCCR:
 - 1. Equal or exceed 65 kA.
- G. Inominal Rating:
 - 1. 20 kA.

2.3 ENCLOSURES

- A. Indoor Enclosures:
 - 1. NEMA 250, Type 1.
- B. Outdoor Enclosures:
 - 1. NEMA 250, Type 4X.

2.4 CONDUCTORS AND CABLES

- A. Power Wiring:
 - 1. Same size as SPD leads, as specified in Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
- B. Class 2 Control Cables:
 - 1. Multiconductor cable with copper conductors NOT smaller than NO. 22 AWG, as specified in Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
- C. Class 1 Control Cables:
 - 1. Multiconductor cable with copper conductors NOT smaller than No. 18 AWG, as specified in Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest

leads. DO NOT splice and extend SPD leads unless specifically permitted by manufacturer. DO NOT exceed manufacturer's recommended lead length. DO NOT bond neutral and ground.

- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Wiring:
 - 1. Power Wiring: Comply with wiring methods in Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
 - 2. Controls: Comply with wiring methods in Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

3.2 FIELD QUALITY REQUIREMENTS

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for as specified in Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD shall be considered defective if it does NOT pass tests and inspections.
- C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. DO NOT perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

SECTION 26 51 00 – INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior luminaires and accessories.
- B. Related Sections:
 - 1. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
 - 2. 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. Shop Drawings:
 - 1. Specify dimensions and components for each luminaire not standard product of manufacturer.
- C. Product Data:
 - 1. For each type of lighting fixture, arranged in order of fixture designation.
 - 2. Include data on features, accessories, finishes and the following:
 - a. Physical description of lighting fixture including dimensions.
 - b. Emergency lighting units including battery and charger.
 - c. Life, output (lumens, CCT, and CRI), Kelvin temperature, and energy-efficiency data for LED lights.
 - d. Photometric data and adjustment factors based on laboratory tests, as specified in IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those specified for the lighting fixture as applied in this Project.
 - e. Low voltage transformers
 - f. LED power supplies.
 - g. Types of LEDs, including manufacturer, wattage, and Color Rendering Index (CRI) and color temperature in degrees Kelvin (K).
- D. Installation instructions.
- E. Dimming Driver Compatibility Certificates certifying that drivers are compatible with dimming systems and equipment with which they are used, or each type of driver for dimmer controlled luminaires.
- F. Qualification Data:
 - 1. For qualified agencies providing photometric data for lighting fixtures.
- G. Field quality-control reports.
- H. Operation and Maintenance Data:
 - 1. For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
 - 2. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

- I. Review of luminaire submittals which specify voltage, mounting condition, or quantities shall not be considered to be approval of said voltage, mounting condition or quantities. Contractor shall field verify voltage and actual mounting condition and method.

1.3 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this section with minimum five years of documented experience.

1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 - 1. NRTL as defined by OSHA in 29 CFR 1910.7
- B. Designated manufacturers are listed to define the requirements for quality and function of the specified product.
- C. See NFPA 70.

1.5 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression systems, and partition assemblies.
- B. Provide all frames, supplementary support structures, hangers, spacers, stems, aligner canopies, auxiliary junction boxes and other hardware as required for a complete and proper installation.
- C. Recessed luminaires shall have frames that are compatible with the ceiling system specified in Drawings.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries:
 - 1. Manufacturer's standard form in which manufacturer of battery powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 2. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
- B. Special Warranty for LEDs' and Drivers:
 - 1. Manufacturers standard form in which manufacturer of LED's and drivers agrees to replace components that fail in materials or workmanship within specified warranty period.
 - 2. LED arrays: 10 years from date of Substantial Completion.
 - 3. Drivers: 10 years from date of Substantial Completion.
- C. See Section 01 78 36 – Warranties and Bonds for additional requirements.

1.8 MAINTENANCE MATERIALS

- A. Spare parts and maintenance products.
- B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 Insert quantity of each type and rating installed. Furnish at least one of each type.
 - 2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. LED-fixture-mounted, emergency battery pack: One for every 20 emergency lighting unit.
 - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 INTERIOR LUMINAIRES

- A. Product Description:
 - 1. Complete interior luminaire assemblies, with features, options, and accessories as listed in the Lighting Fixture Schedule on Drawings.
- B. Products:
 - 1. Subject to requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) specified in Drawings.
- C. See Section 01 60 00 – Product Requirements for product options. Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance. Substitutions shall be as specified in applicable building codes.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. All interior luminaires shall be LED type.
- B. Luminaires shall be as specified in UL 1598 and be listed and labeled for the installed location by an NRTL acceptable to authorities having jurisdiction.
- C. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
- D. Sheet Metal Components:
 - 1. Steel unless otherwise specified. Form and support to prevent warping and sagging. Finish ferrous mounting hardware and accessories to prevent corrosion and discoloration to adjacent materials.
- E. Doors, Frames, and Other Internal Access:
 - 1. Smooth operating, free of light leakage under operating conditions and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Safety devices shall be detachable if necessary and shall not interfere with luminaire performance, maintenance, or the seating of any luminaire element. Safety device shall not be visible during normal luminaire operation and from normal viewing angles.

- F. Luminaires provided shall have means for disconnection from power source during service, as required in NEC Article 410.
- G. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100% virgin acrylic plastic. UV stabilized High resistance to yellowing and other changes due to aging, exposure to heat and UV radiation.
 - a. Lenses shall have uniform brightness throughout the entire visible area without LED pixilation.
 - 2. Glass Globes: Annealed crystal glass unless otherwise specified.
- H. Adjustable luminaires shall have positive locking devices to fix aiming angle. Luminaires shall be capable of being re-lamped without adjusting aiming angle.
- I. All luminaires and drivers shall operate within the temperature limits of their design and as specified by UL in the applications and mounting conditions specified.
- J. Luminaires recessed in suspended ceilings where the space above the ceiling is either an air supply or return plenum shall conform to NEC requirements.
- K. Provide plaster frame for recessed luminaires mounted in other than T-bar ceilings. Verify mounting with architectural reflected ceiling plan before ordering luminaires.
- L. Fixtures installed in "hard" ceilings shall have all connections accessible through the luminaire.
- M. Provide wire guards on all open strip type luminaires in unfinished spaces.
- N. For weatherproof or vapor-tight installations, finishes of luminaires shall be completely corrosion resistant for the service intended. Where aluminum parts encounter bronze or steel parts, apply a coating material to both surfaces to prevent corrosion.
- O. Luminaires for use in areas designated as damp or wet locations shall be suitably gasketed to prevent the entrance of moisture. Provide approved wire mesh screens for ventilation openings. Dissimilar metals shall be separated by nonconductive material to prevent galvanic action.
- P. Factory-Applied Labels:
 - 1. See UL 1598. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when light bars are in place.
- Q. Luminaires shall be free of light leaks while providing sufficient ventilation of LEDs and drivers to provide the required photometric performance.
- R. Luminaires shall hold LED arrays securely against normal vibration and maintenance handling.

2.3 EMERGENCY BATTERY PACK FOR LUMINAIRES

- A. Internal Type:
 - 1. Self-contained, modular, battery-inverter unit, factory mounted within/top of luminaire body and compatible with driver. See UL 924.
 - 2. Indicator light:
 - a. Visible without opening luminaire or entering ceiling space.
 - b. Indicator Light: LED indicates normal power on.
 - 3. Battery: Sealed, maintenance-free, Lithium type, sized for ninety (90) minutes of operation.
 - 4. Charger: Fully automatic, solid-state.

5. Integral Self-Test: Factory-installed electronic device automatically initiates code required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
6. Universal Voltage input.

2.4 LED LUMINAIRES AND DRIVERS

- A. All Luminaires:
 1. See IES LM-79-08 Approved Method for measuring lumen maintenance of LED light sources.
 2. See IES LM-80-08 Approved Method for electrical and photometric measurement of SSL product.
 3. LED's shall be Restriction of Hazardous Substances Directive (RoHS) compliant.
 4. LED arrays shall be sealed, high performance, long life type; minimum 70% rated output at 50,000 hours. (L70)
 5. LED luminaires shall deliver a minimum of 80 lumens per watt.
 6. Drivers shall be solid state.
 7. The LED light source shall be fully dimmable with use of compatible dimmers switch designated for low voltage loads.
 8. LED color temperatures: 4,000°K unless otherwise noted, plus or minus 275°K.
 9. Luminaires shall have internal thermal protection.
 10. Indoor luminaires shall have a minimum CRI of 85.
 11. Luminaire manufacturers shall adhere to device manufacturer guidelines, certification programs, and test procedures for thermal management.
 12. LED package(s)/module(s)/array(s) used in qualified luminaires shall deliver a minimum 70% of initial lumens, when installed in-situ, for a minimum of 50,000 hours.
 13. Luminaires shall be fully accessible from below ceiling plane for changing drivers, power supplies and arrays.
- B. Power Supplies and Drivers
 1. Power Factor: 0.90 or higher.
 2. Maximum driver case temperature not to exceed driver manufacturer recommended.
 3. Output operating frequency: 60Hz.
 4. Interference: EMI and RFI compliant with FCC 47 CFR Part 15.
 5. Total Harmonic Distortion Rating: 20% Maximum.
 6. Meet electrical and thermal conditions as described in LM-80 Section 5.0.
 7. Fully dimmable, 0 VDC–10 VDC standard.
 8. Secondary Current: Confirm secondary current specified by individual luminaire manufacturers.
 9. Compatibility of dimming switches: Certified by manufacturer for use with individually specified luminaire and individually specified control components.

2.5 LED ARRAYS

- A. All LED's of the same type are to be provided by the same manufacturer.
- B. Equip each luminaire with the proper LED array of the type shown or specified in the Light Fixture Schedule.

2.6 WIRING

- A. No internal wiring shall be visible at normal viewing angles.

2.7 LUMINAIRE SUPPORT COMPONENTS

- A. Single-Stem Hangers:
 - 1. 1/2 in. steel tubing with swivel ball fitting and ceiling canopy.
 - 2. Finish shall be the same as the luminaire.
- B. Twin-Stem Hangers:
 - 1. Two, 1/2 in. steel tubes with single canopy arranged to mount a single fixture.
 - 2. Finish shall be the same as the luminaire.
- C. Rod Hangers:
 - 1. 3/16 in. minimum diameter, cadmium-plated threaded steel rod.
- D. Wires:
 - 1. ASTM A641, Class 3, soft temper, zinc coated steel, 12 GA.
- E. Wires for humid spaces shall be ASTM A580, composition 302 or 304, annealed stainless steel, 12 GA.
- F. Aircraft Cable Support shall use cable, anchorages, and intermediate supports recommended by luminaire manufacturer.
- G. Hangers for pendant industrial luminaires shall be heavy duty No. 8 jack chain with hangers, "S" hooks, mounting straps, and all required accessories for complete installation.

2.8 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units:
 - 1. Self-contained units as specified in UL 924.
 - 2. Housing: 20 ga. Steel.
 - 3. Flexible cord and plug connections shall not be permitted.
 - 4. Battery: Sealed, maintenance-free, Lithium type.
 - 5. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 6. Lamping: LED.
 - 7. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80% of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 8. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 9. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 10. Wire Guard: Heavy-chrome-plated wire guard to protect lamp heads or units in areas where subject to physical damage.
 - 11. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
 - 12. Integral Self-Test: Factory-installed electronic device automatically initiates code required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
 - 13. Factory supplied molded plug and cord where specified.

PART 3 - EXECUTION

3.1 EXISTING WORK

- A. Disconnect and remove abandoned luminaires, lamps, and accessories.

3.2 INSTALLATION

- A. Lighting fixtures:
 - 1. Set level, plumb, and square with ceilings and walls, and secure as specified in manufacturer's written instructions and approved submittal materials, unless otherwise specified.
- B. Temporary Lighting:
 - 1. If it is necessary, and approved by Engineer, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps and reinstall.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 in., brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- D. Connect wiring as specified in Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
- E. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at specified height.
- F. Support luminaires larger than 2 ft by 4 ft size independent of ceiling framing.
- G. Lay-in Ceiling Luminaire Supports:
 - 1. Use grid as a support element.
 - 2. Luminaires of Sizes Less Than Ceiling Grid: Install as specified in reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4 in. metal channels spanning and secured to ceiling tees. In addition, provide slack safety wire hangers secured diagonally from opposite luminaire corners to structural members above suspended ceiling.
- H. Locate recessed ceiling luminaires as specified in Drawings.
- I. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- J. Exposed Grid Ceilings:
 - 1. Support surface-mounted luminaires on grid ceiling directly from building structure. Install auxiliary members spanning ceiling grid members to support surface mounted luminaires. Fasten surface mounted luminaires to ceiling grid members using bolts, screws, rivets, or suitable clips.

- K. In accessible suspended ceilings, luminaire wiring connections, including equipment grounding conductor, is to be through use of 72 in. (maximum) flexible conduit from a rigidly supported junction box.
- L. Provide all necessary hanging or mounting devices and accessories for all luminaires. Verify the types needed for various ceiling conditions. Plaster rings shall be provided where required.
- M. Verify weight and mounting method of all luminaires prior to ordering and provide suitable support. Coordinate with General Contractor for luminaires that require additional blocking or support. Luminaire mounting assemblies shall be as specified in all local seismic codes and regulations.
- N. Install recessed luminaires to permit removal from below.
- O. Luminaires shall not be secured to ductwork or other Systems.
- P. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- Q. Metal decking shall not be pierced for luminaire support.
- R. Install clips to secure recessed grid-supported luminaires in place.
- S. Install wall-mounted luminaires at height as specified in Drawings.
- T. Brace suspended luminaires installed near ducts or other elements so that they do not swing into obstructions.
- U. Install accessories furnished with each luminaire.
- V. Luminaires located in recessed ceilings with a fire resistive rating of 1 hour or more shall be enclosed in an approved fire resistive rated box equal to that of the ceiling. Acoustical ceiling tiles are not acceptable.
- W. Contractor shall be responsible for adjusting aperture flanges or rings on all recessed luminaires to be flush with the finished ceiling. Trim shall completely conceal ceiling opening.
- X. Connect luminaires to branch circuit outlets provided under Section 26 05 33 – Raceway and Boxes for Electrical Systems using flexible conduit as specified in Drawings.
- Y. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- Z. Install specified lamps in each luminaire.
- AA. Refer to reflected ceiling plans for coordination of luminaire locations with mechanical, fire protection, technology, and fire safety equipment. Where conflicts occur, coordinate with Engineer prior to installing any of the Systems.
- BB. Ground and bond interior luminaires as specified in Section 26 05 26 – Grounding and Bonding for Electrical Systems.

3.3 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.
- B. Test for Emergency Lighting:
 - 1. Interrupt power supply to demonstrate proper operation.
 - 2. Verify transfer from normal power to battery/generator and retransfer to normal.
 - 3. Walk test and verify foot-candle levels meet Code with meter.
- C. Prepare a written report of tests, inspections, observations, and verifications specifying and interpreting results. If adjustments are made to the lighting system, retest to demonstrate compliance with standards.
- D. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- E. Advance Notice:
 - 1. Give dates and times for field tests.
- F. Malfunctioning Luminaires and Components:
 - 1. Replace or repair, then retest.
 - 2. Repeat procedure until units operate properly.

3.4 ADJUSTING

- A. Aim and adjust luminaires accordingly.

3.5 CLEANING

- A. Remove dirt and debris from enclosures.
- B. Clean photometric control surfaces as recommended by manufacturer.
- C. Clean finishes and touch up damage.

END OF SECTION

SECTION 26 56 00 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Exterior luminaires, poles, and accessories.

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Product Data:
 - 1. For each luminaire, pole, and support component, arranged in order of lighting unit designation.
 - 2. Include:
 - a. Data on features, accessories, finishes
 - b. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of specified parameters.
 - c. Details of attaching luminaires and accessories.
 - d. Details of installation and construction.
 - e. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those specified for the lighting fixture as applied in this Project.
 - f. Photoelectric relays.
 - g. Life, output (lumens, CCT, and CRI), Kelvin temperature, and energy-efficiency data for LED lights.
 - h. Low voltage transformers
 - i. LED power supplies.
 - j. Types of LED's, including manufacturer, wattage, and Color Rendering Index (CRI) and color temperature in degrees Kelvin (K).
 - k. Materials, dimensions and finishes of poles.
 - l. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 - m. Anchor bolts for poles.
- C. Shop Drawings:
 - 1. Include plans, elevations sections, details, and attachments to other work.
 - 2. Detail equipment assemblies and specify dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.
 - 3. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 - 4. Wiring Diagrams: for power, signal, and control wiring.
- D. Qualification Data:
 - 1. For qualified agencies providing photometric data for lighting fixtures.
- E. Field quality-control reports.
- F. Operation and Maintenance Data:
 - 1. For luminaires and poles to include in emergency, operation, and maintenance manuals.

- G. Review of luminaire submittals which specify voltage, mounting condition, or quantities shall not be considered to be approval of said voltage, mounting condition or quantities. Contractor shall field verify voltage and actual mounting condition and method.

1.3 QUALIFICATIONS

- A. Manufacturer:
 - 1. Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 - 1. NRTL as defined by OSHA in 29 CFR 1910.7
- B. Designated manufacturers are listed to define the requirements for quality and function of the specified product.
- C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle solid wood poles in accordance with ANSI O5.1.
- B. Package aluminum poles for shipping according to ASTM B660.
- C. Store poles on decay-resistant-treated skids at least 12 in. above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- D. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.6 COORDINATION

- A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.8 MAINTENANCE MATERIALS

- A. Provide spare parts and maintenance products.
 - 1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 2. Lamps: 1 for every 10 of each type and rating installed. Furnish at least one of each type.
 - 3. Glass and Plastic Lenses, Covers and Other Optical Parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Gloves and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
- B. Furnish two gallons of touchup paint for each different painted finish and color.

1.9 WARRANTY

- A. Special Warranty:
 - 1. Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode or chalk due to effects of weather or solar radiation within specified warranty period.
 - 2. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - 3. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.
- B. Special Warranty for LEDs and Drivers:
 - 1. Manufacturers standard form in which manufacturer of LED's and drivers agrees to replace components that fails in materials or workmanship within specified warranty period.
 - 2. LED arrays: 10 years from date of Substantial Completion.
 - 3. Drivers: 10 years from date of Substantial Completion.
- C. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 LUMINAIRES

- A. Product Description:
 - 1. Complete exterior luminaire assemblies, with features, options, and accessories as listed in the Lighting Fixture Schedule on Drawings.
- B. Products:
 - 1. Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, product(s) specified in Drawings.
- C. See Section 01 60 00 – Product Requirements for product options. Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance. Substitutions shall be as specified in applicable building codes.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. All exterior luminaires shall be LED type.
- B. All exterior luminaires shall be full cutoff and dark sky compliant.
- C. Luminaires:
 - 1. As specified in UL 1598
 - 2. List and label for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- D. Lateral Light Distribution Patterns:
 - 1. See IESNA RP-8 for parameters of lateral light distribution patterns specified for luminaires.
- E. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.

- F. Sheet Metal Components:
 - 1. corrosion-resistant aluminum unless otherwise specified. Form and support to prevent warping and sagging.
- G. Housings:
 - 1. Rigidly formed, weathertight and lighttight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- H. Doors, Frames, and Other Internal Access:
 - 1. Smooth operating, free of light leakage under operating conditions and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Safety devices shall be detachable if necessary and shall not interfere with luminaire performance, maintenance, or the seating of any luminaire element. Safety device shall not be visible during normal luminaire operation and from normal viewing angles.
- I. Exposed Hardware Material:
 - 1. Stainless steel.
- J. Plastic Parts:
 - 1. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- K. Lenses and Refractors Gaskets:
 - 1. Use heat-resistant and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish:
 - 1. Manufacturer's standard paint applied to factory-assembled and test luminaire before shipping. Where specified, match finish process and color of pole or support materials.
- M. Factory-Applied Labels:
 - 1. Comply with UL 1598. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
- N. Luminaires shall be free of light leaks while providing sufficient ventilation of LEDs and drivers to provide the required photometric performance.
- O. Luminaires shall hold LED arrays securely against normal vibration and maintenance handling.

2.3 LED LUMINAIRES AND DRIVERS

- A. All Luminaires
 - 1. Comply with IES LM-79-08 Approved Method for measuring lumen maintenance of LED light sources.
 - 2. Comply with IES LM-80-08 Approved Method for electrical and photometric measurement of SSL product.
 - 3. LED's shall be Restriction of Hazardous Substances Directive (RoHS) compliant.
 - 4. LED arrays shall be sealed, high performance, long life type; minimum 70% rated output at 50,000 hours. (L70)
 - 5. LED luminaires shall deliver a minimum of 80 lumens per watt.
 - 6. Drivers shall be solid state.
 - 7. The LED light source shall be fully dimmable with use of compatible dimmers switch designated for low voltage loads.

8. LED color temperatures: 4000K unless otherwise noted, $\pm$ 275K.
9. Luminaires shall have internal thermal protection.
10. Indoor luminaires shall have a minimum CRI of 85.
11. Luminaire manufacturers shall adhere to device manufacturer guidelines, certification programs, and test procedures for thermal management.
12. LED package(s)/module(s)/array(s) used in qualified luminaires shall deliver a minimum 70% of initial lumens, when installed in-situ, for a minimum of 50,000 hrs.
13. Luminaires shall be fully accessible from below ceiling plane for changing drivers, power supplies and arrays

B. Power Supplies and Drivers:

1. Power Factor: 0.90 or higher.
2. Maximum driver case temperature not to exceed driver manufacturer recommended.
3. Output operating frequency: 60Hz.
4. Interference: EMI and RFI compliant with FCC 47 CFR Part 15.
5. Total Harmonic Distortion Rating: 20% Maximum.
6. Meet electrical and thermal conditions as described in LM-80 Section 5.0.
7. Fully dimmable, 0 VDC – 10 VDC standard.
8. Secondary Current: Confirm secondary current specified by individual luminaire manufacturers.
9. Compatibility of dimming switches: Certified by manufacturer for use with individually specified luminaire and individually specified control components.

2.4 LED ARRAYS

- A. All LEDs of the same type are to be provided by the same manufacturer.
- B. Equip each luminaire with the proper LED array of the type shown or specified in the Light Fixture Schedule.

2.5 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Provide all exterior luminaires with photoelectric relay control. Where central photoelectric control is not provided, provide individual photoelectric device at each luminaire.
- C. Contact Relays:
 1. Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 fc–3 fc and off at 4.5 fc–10 fc with 15 sec minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
 2. Relay with locking-type receptacle shall comply with ANSI C136.10.
- D. Adjustable window slide for adjusting on-off set points.

2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics:
 1. Comply with AASHTO LTS-4-M.
 2. Wind-Load Strength of Poles: Adequate at specified heights above grade without failure, permanent deflection, or whipping in steady winds of speed.
 3. Strength Analysis: for each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

- B. Luminaire Attachment Provisions:
 - 1. Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise specified.
- C. Mountings, Fasteners and Appurtenances:
 - 1. Corrosion-resistant items compatible with support components.
 - 2. Materials: shall not cause galvanic action at contact points.
 - 3. Anchor Bolts, Leveling Nuts, Bolt Caps, and washers: Stainless steel unless otherwise specified.
 - 4. Anchor-bolt Template: Plywood or steel.
- D. Handhole:
 - 1. Oval-shaped, with minimum clear opening of 2 1/2 in. by 5 in, with cover secured by stainless-steel captive screws. Provide on all poles.
- E. Concrete Pole Foundations:
 - 1. Cast in place, with anchor bolts to match pole-base flange.
- F. Hinged Pole Base:
 - 1. Where specified in Plans, provide hinged pole bases for lowering light poles.

2.7 ALUMINUM POLES

- A. Poles:
 - 1. Seamless, extruded aluminum alloy structural tube with access handhole in pole wall.
- B. Finish:
 - 1. Powder coating finish.
- C. Height:
 - 1. As specified in Drawings.
- D. Shaft Size:
 - 1. As required to meet structural characteristic requirements and pole height.
- E. Pole-Top Tenons:
 - 1. Fabricated to support luminaire or luminaires and brackets specified, and securely fastened to pole top.
- F. Grounding and Bonding Lugs:
 - 1. Welded 1/2 in. threaded lug, as specified in Section 26 05 26 – Grounding and Bonding for Electrical Systems, listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- G. Brackets for Luminaires:
 - 1. Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 - 2. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 - 3. Finish: Same as pole and luminaire.
 - a. Color: As selected by Engineer from manufacturer's full range.

2.8 POLE ACCESSORIES

- A. Base Covers:
 - 1. Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify foundations are ready to receive fixtures.

3.2 INSTALLATION

- A. Install concrete bases for lighting poles at locations as specified in Drawings and in Section 03 30 00 – Cast-In-Place Concrete.
- B. Install poles plumb. Install double nuts to adjust plumb. Grout around each base.
- C. Install lamps in each luminaire.
- D. Bond and ground luminaires, metal accessories and metal poles in accordance with Section 26 05 26 – Grounding and Bonding for Electrical Systems. Install supplementary grounding electrode at each pole.
- E. Fasten luminaire to specified structural supports.
- F. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
- G. Alignment:
 - 1. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- H. Clearances:
 - 1. Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise specified in Drawings:
 - a. Fire Hydrants and Storm Drainage Piping: 60 in.
 - b. Water, Gas, Electric, Communication, and Sewer Lines: 10 ft
 - c. Trees: 15 ft from tree trunk
- I. Concrete Pole Foundations:
 - 1. Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.
- J. Foundation-Mounted Poles:
 - 1. Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.
 - 2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers unless otherwise specified.
 - 4. Use a short piece of 1/2 in. diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

- K. Raise and set poles using web fabric slings (not chain or cable).
- L. Where hinged poles are installed, arrange pole base oriented to allow for lowering of pole without obstruction.

3.3 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection. Inspect for improper connections and operation.
- B. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- C. Measure illumination levels and provide written report of results.
- D. Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

3.4 ADJUSTING

- A. Aim and adjust luminaries accordingly.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- C. Prepare a written report of tests, inspections, observations, and verifications specifying and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.5 CLEANING

- A. Clean photometric control surfaces as recommended by manufacturer.
- B. Clean finishes and touch up damage.

END OF SECTION

**DIVISION 31
EARTHWORK**

SECTION 31 11 00 – SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The Work required for site preparation.

1.2 DEFINITIONS

- A. Interfering or Objectionable Material:
 - 1. Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- B. Clearing:
 - 1. Removal of interfering or objectionable material lying on or protruding above ground surface.
- C. Grubbing:
 - 1. Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2 in. caliper to a depth of 12 in. below subgrade.
- D. Scalping:
 - 1. Removal of sod without removing more than upper 3 in. of topsoil.
- E. Stripping:
 - 1. Removal of topsoil remaining after applicable scalping is completed.
- F. Project Limits:
 - 1. Areas, as shown or specified, within which Work is to be performed.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Drawings clearly showing clearing, grubbing, and stripping limits.

1.4 QUALITY ASSURANCE

- A. Obtain Engineer's approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.5 SCHEDULING AND SEQUENCING

- A. Prepare site only after adequate erosion and sediment controls are in place. Limit areas exposed to uncontrolled erosion during installation of temporary erosion and sediment controls to maximum of 5 acres.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Clear, grub, and strip areas needed for waste disposal, borrow, or site improvements within limits shown or specified.
- B. DO NOT injure or deface vegetation that is NOT designated for removal.

3.2 LIMITS

- A. DO NOT extend beyond Project limits:
 - 1. Excavation, including trenches, 5 ft beyond top of cut slopes or shored walls.
 - 2. Fill:
 - a. Clearing and Grubbing: 5 ft beyond toe of permanent fill.
 - b. Stripping and Scalping: 2 ft beyond toe of permanent fill.
 - 3. Structures: 15 ft outside of new structures.
 - 4. Roadways: Clearing, grubbing, scalping, and stripping 15 ft from centerline.
 - 5. Other Areas: As shown.
- B. Remove rubbish, trash, and junk from entire area within Project limits.

3.3 CLEARING

- A. Clear areas within limits shown or specified.
- B. Fell trees so that they fall away from facilities and vegetation NOT designated for removal.
- C. Cut stumps NOT designated for grubbing to within 6 in. of ground surface.
- D. Cut off shrubs, brush, weeds, and grasses to within 2 in. of ground surface.

3.4 GRUBBING

- A. Grub areas within limits shown or specified.

3.5 SCALPING

- A. DO NOT remove sod until after clearing and grubbing is completed and resulting debris is removed.
- B. Scalp areas within limits shown or specified.

3.6 STRIPPING

- A. DO NOT remove topsoil until after scalping is completed.
- B. Strip areas within limits to minimum depths shown or specified. DO NOT remove subsoil with topsoil.
- C. Stockpile strippings, meeting requirements for topsoil, separately from other excavated material.

3.7 TOPSOIL

- A. Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1 1/2 in. maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

3.8 DISPOSAL

- A. Clearing and Grubbing Debris:
 - 1. Dispose of debris
 - 2. Burning of debris shall NOT be allowed.
 - 3. Woody debris may be chipped. Chips may be sold to Contractor's benefit or used for landscaping as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and NOT support combustion. Maximum dimensions of chipped material used shall be 1/4 in. by 2 in. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
 - 4. Limit disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will NOT be visible from Project.
- B. Scalpings:
 - 1. As specified for clearing and grubbing debris.
- C. Strippings:
 - 1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil.
 - 2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 31 22 19 – GRADING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Removal and storage of topsoil.
 - 2. Rough grading the site for site structures, building pads, and drive and parking aisles.
 - 3. Finished grading for planting.
- B. Related Sections:
 - 1. Section 31 23 16 – Excavation
 - 2. Section 31 23 23.13 – Fill and Backfill
 - 3. Section 31 23 16.13 – Trenching for Site Utilities

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Project Record Documents:
 - 1. Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.3 QUALITY ASSURANCE

- A. Perform Work as specified in State of Oklahoma Highway Department standards.
 - 1. Maintain one copy onsite.

1.4 PROJECT CONDITIONS

- A. Protect above – and below – grade utilities that remain.
- B. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.
- C. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving and curbs from grading equipment and vehicular traffic.

1.5 WARRANTY

- A. See Section 01 33 00 – Warranties and Bonds for requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil:
 - 1. Shall be soil suitable for sustaining grass and vegetation and shall NOT have any particles larger than 3/4 in. in diameter and shall be free of any trash, debris, or deleterious material.
- B. Other Fill Materials:
 - 1. See Section 31 23 23.13 – Fill and Backfill.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that survey benchmark and intended elevations for the Work are as specified.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Locate, identify, and protect utilities that remain from damage.
- D. Notify utility company to remove and relocate utilities.

3.3 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, relandscaped, or regraded without mixing with foreign materials.
- B. DO NOT remove topsoil when wet.
- C. Remove subsoil from areas to be further excavated, relandscaped, or regraded.
- D. DO NOT remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
- E. When excavating through roots, perform work by hand and cut roots with a sharp axe.
- F. Stability:
 - 1. Replace damaged or displaced subsoil to same requirements as for specified fill.

3.4 SOIL REMOVAL

- A. Stockpile excavated topsoil onsite.
- B. Stockpile excavated subsoil onsite.
- C. Stockpiles:
 - 1. Use areas designated onsite; pile depth NOT to exceed 8 ft; protect from erosion.

3.5 FINISHED GRADING

- A. Before Finished Grading:
 - 1. Verify building and trench backfilling have been inspected.
 - 2. Verify subgrade has been contoured and compacted.
- B. Remove debris, roots, branches, stones, more than 1/2 in. in size. Remove soil contaminated with petroleum products.
- C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 in.
- D. Place topsoil in areas where seeding is specified.

- E. Place topsoil in compacted thicknesses:
 - 1. Areas to be Seeded with Grass:
 - a. 6 in.
 - 2. Areas to be Sodded:
 - a. 4 in.
 - 3. Shrub Beds:
 - a. 18 in.
 - 4. Flower Beds:
 - a. 12 in.
 - 5. Planter Boxes:
 - a. To within 3 in. of box rim
- F. Place topsoil during dry weather.
- G. Remove roots, weeds, rocks, and foreign material while spreading.
- H. Near plants spread topsoil manually to prevent damage.
- I. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.
- J. Lightly compact placed topsoil.

3.6 TOLERANCES

- A. Top Surface of Subgrade:
 - 1. Plus or minus 1/10 ft from required elevation.
- B. Top Surface of Finished Grade:
 - 1. Plus or minus 1/2 in.

3.7 FIELD QUALITY REQUIREMENTS

- A. See Section 31 23 23.13 – Fill and Backfill for compaction density testing.

3.8 CLEANING AND PROTECTION

- A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 31 23 16 – EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work and materials associated with excavation.
- B. Related Sections:
 - 1. Section 02 41 00 – Demolition
 - 2. Section 31 11 00 – Site Preparation
 - 3. Section 31 23 19 – Dewatering
 - 4. Section 31 50 00 – Excavation Support Systems

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Excavation Plan, Detailing:
 - a. Methods and sequencing of excavation.
 - b. Proposed locations of stockpiled excavated material.
 - c. Proposed locations of spoil disposal sites.
 - d. Numbers, types, and sizes of equipment proposed to perform excavations.

1.3 QUALITY ASSURANCE

- A. Provide adequate survey control to avoid unauthorized over-excavation.

1.4 WEATHER LIMITATIONS

- A. Material excavated when frozen or when air temperature is less than 32°F shall NOT be used as fill or backfill until material completely thaws.
- B. Material excavated during inclement weather shall NOT be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.5 SEQUENCING AND SCHEDULING

- A. Demolition:
 - 1. Complete applicable Work specified in Section 02 41 00 – Demolition, prior to excavating.
- B. Clearing, Grubbing, and Stripping:
 - 1. Complete applicable Work as specified in Section 31 11 00 – Site Preparation, prior to excavating.
- C. Dewatering:
 - 1. See Section 31 23 19 – Dewatering, prior to initiating excavation.
- D. Excavation Support:
 - 1. Install and maintain, as specified in Section 31 50 00 – Excavation Support Systems, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Excavate to lines, grades, and dimensions specified and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 ft except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.
- B. DO NOT over excavate without written authorization of Engineer.
- C. Remove or protect obstructions as shown and as specified in Section 01 50 00 – Temporary Facilities and Controls.

3.2 UNCLASSIFIED EXCAVATION

- A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.3 TRENCH WIDTH

- A. Minimum Width of Trenches:
 - 1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
 - a. Less than 4 in. Outside Diameter or Width: 18 in.
 - b. Greater than 4 in. and up to 18 in. Outside Diameter or Width: 12 in. greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
 - c. Greater than 18 in. Diameter or Width: 24 in. greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
 - 2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 in. greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
 - 3. Increase trench widths by thicknesses of sheeting.
- B. Maximum Trench Width:
 - 1. Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.4 PIPE BEDDING GROOVES FOR NONPERFORATED DRAIN LINES

- A. Semicircular, trapezoidal, or 90-degree-V.
- B. Excavated or plowed into trench bottom. Forming groove by compaction shall NOT be acceptable.

3.5 STOCKPILING EXCAVATED MATERIAL

- A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.
- B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

- C. Confine stockpiles to within easements, rights-of-way, and approved work areas. DO NOT obstruct roads or streets.
- D. DO NOT stockpile excavated material adjacent to trenches and other excavations unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
- E. DO NOT stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.6 DISPOSAL OF SPOIL

- A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill,
- B. Dispose of debris resulting from removal of underground facilities as specified in Section 02 41 00 – Demolition, for demolition debris.
- C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 11 00 – Site Preparation, for clearing and grubbing debris.

3.7 EXCAVATION SAFETY

- A. See applicable federal, state, and local regulations for requirements.

3.8 SUBGRADE PREPARATION

- A. The excavation for all structures and facilities shall be in dewatered, firm, undisturbed earth. If, in the Engineer's opinion, the subgrade has been disturbed, corrective measures may include:
 - 1. Scarification and recompaction to 95% relative compaction
 - Or,
 - 2. Over-excavation and replacement with compacted granular fill.
- B. If the source of disturbance is determined to be the result of the actions, or inactions of the Contractor, (for example, inadequate dewatering, disturbance by excavating or hauling equipment) the cost of additional subgrade preparation shall be at the Contractor's expense.

END OF SECTION

SECTION 31 23 16.13 – TRENCHING FOR SITE UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Backfilling and compacting for utilities outside the building to utility main connections.
- B. Related Sections:
 - 1. Section 31 22 19 – Grading
 - 2. Section 31 23 16 – Excavation
 - 3. Section 31 23 23.13 – Fill and Backfill
 - 4. Section 31 23 23.16 – Trench Backfill

1.2 REFERENCES

- A. ASTM International:
 - 1. D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
 - 2. D2167 – Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
 - 3. D6938 – Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
 - 4. D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
 - 5. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cf)
 - 6. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cf)
- B. AASHTO
 - 1. T180 – Standard Method of Test for Moisture–Density Relations of Soils Using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop

1.3 DEFINITIONS

- A. Subgrade Elevations:
 - 1. 4 in. below finished grade elevations specified in Drawings, unless otherwise specified.
- B. Finished Grade Elevations:
 - 1. 4 in. above subgrade elevations specified in Drawings, unless otherwise specified.

1.4 SUBMITTALS

- A. Subject to requirements as specified in Section 01 33 00 – Submittal Procedures.
- B. Compaction Density Test Reports.

1.5 PROJECT CONDITIONS

- A. Provide enough fill to meet project schedule and requirements. When necessary, store materials on site in advance of need.
- B. Verify that survey benchmarks and intended elevations for the work are as specified.

1.6 WARRANTY

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

PART 2 - PRODUCTS

2.1 UTILITIES

- A. Contractor shall call the Oklahoma One-Call System “CALL OKIE” two working days before starting excavation. The ONE CALL phone number is 1-800-522-6543 or 811.
- B. The location and/or elevation of existing utilities as shown on these plans is based on records of the various utility companies and, where possible, measurements taken in the field. The information is not to be relied upon as being exact or complete. The Contractor must call each utility owner at least two working days before any excavation to request exact field location of utilities.
- C. Protect utilities encountered during excavation.
- D. DO NOT interrupt service in utilities encountered during excavation without approval of the utility owner.
- E. If utilities are damaged or utility service is interrupted by work under this section, the utility owner has the first right to repair. If public health or safety is at risk, Contractor shall take appropriate prudent action to repair damage and service interruption. Costs of utility protection and repair shall be at no additional cost to the Owner.
- F. If existing utilities are found to interfere with the permanent facility being constructed, notify the Engineer for instructions. Do not proceed with permanent relocation of utilities without written instructions from the Engineer.

2.2 FILL MATERIALS

- A. As specified in Section 31 23 23.16 – Trench Backfill.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.
- C. Notify utility company to remove and relocate utilities.
- D. See Section 31 22 19 – Grading, for additional requirements.

3.2 TRENCHING

- A. Requirements:
 - 1. Provide and install trench bracing and shoring that conforms to the requirements of 29 CFR Part 1926 Subpart P of the OSHA Standards. Bracing shall be so arranged as not to place any strain on portions of completed work until the construction has proceeded far enough to provide ample strength.

2. Over-excavation, whether by Contractor's negligence or at direction of the Engineer, shall be repaired to required lines and grades.
 3. Trenches shall be dug to the alignment and depth required and shall not advance more than 100 ft ahead of the completed pipe, unless otherwise permitted by the Engineer.
- B. Notify Owner's Representative of unexpected subsurface conditions and discontinue affected Work in areas until notified to resume work.
 - C. Slope banks of excavations deeper than 4 ft to angle of repose or less until shored.
 - D. DO NOT interfere with 45-degree bearing splay of foundations.
 - E. Cut trenches wide enough to allow inspection of installed utilities.
 - F. Hand trim excavations. Remove loose matter.
 - G. Remove excavated material that is unsuitable for reuse from site.
 - H. Remove excess excavated material from site.
- 3.3 PREPARATION FOR UTILITY PLACEMENT
- A. Cut out soft areas of subgrade NOT capable of compaction in place. Backfill with general fill.
 - B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
 - C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.
- 3.4 BACKFILLING
- A. Backfill to contours and elevations specified using unfrozen materials.
 - B. Employ a placement method that does NOT disturb or damage other work.
 - C. Systematically fill to allow maximum time for natural settlement. DO NOT fill over porous, wet, frozen, or spongy subgrade surfaces.
 - D. Maintain optimum moisture content of fill materials to attain required compaction density.
 - E. Slope grade away from building minimum 2 in. in 10 ft. unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
 - F. Correct areas that are over-excavated:
 1. Thrust bearing surfaces: Fill with concrete.
 2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97% of maximum dry density.
 - G. Compaction Density Unless Otherwise Specified.
 1. Under paving, slabs-on-grade, and similar construction: 97% of maximum dry density.
 2. All other locations: 95% of maximum dry density.
 - H. Reshape and recompact fills subjected to vehicular traffic.

3.5 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Utility Piping, Conduits, and Duct Bank:
 - 1. Bedding: Use general fill.
 - 2. Cover with general fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 in. lifts to 95% of maximum dry density.
- B. At Pipe Culverts:
 - 1. Bedding: use general fill.
 - 2. Cover with general fill.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 in. lifts to 95% of maximum dry density.

3.6 TOLERANCES

- A. Top Surface of General Backfilling:
 - 1. Plus or minus 1 in. from required elevations.

3.7 FIELD QUALITY REQUIREMENTS

- A. Perform compaction density testing on compacted fill as specified in ASTM D1556, ASTM D2167, ASTM D6938, or ASTM D3017.
- B. Evaluate results in relation to compaction curve determined by testing uncompacted material as specified in ASTM D698 ("Standard Proctor"), ASTM D1557 ("Modified Proctor"), or AASHTO T180.
- C. If tests specify work does NOT meet specified requirements, remove work, replace, and retest.
- D. Frequency of Tests; each lift.

3.8 CLEANUP

- A. Leave unused materials in a neat compact stockpile.
- B. Remove unused stockpiled material, leave area in a clean and neat condition. Grade stockpile areas to prevent standing surface water.
- C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 31 23 19 – DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work required to dewater excavations.

1.2 WATER CONTROL PLAN

- A. As a Minimum, Include:
 - 1. Descriptions of proposed groundwater and surface water control facilities including, but NOT limited to, equipment; methods; standby equipment and power supply, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
 - 2. Drawings showing locations, dimensions, and relationships of elements of dewatering system.
- B. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Remove and control surface and subsurface water during periods when necessary to properly accomplish Work.

3.2 SURFACE WATER CONTROL

- A. See Section 01 50 00 – Temporary Facilities and Controls.
- B. Remove surface runoff controls when no longer needed.

3.3 DEWATERING SYSTEMS

- A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 ft below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.
- B. Design and Operate Dewatering Systems:
 - 1. To prevent loss of ground as water is removed.
 - 2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
 - 3. To relieve artesian pressures and resultant uplift of excavation bottom.
 - 4. Prevent softening, loosening or otherwise disturbing the excavation subgrade.
- C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.
- D. Provide supplemental ditches and sumps only as necessary to collect water from local seeps.

3.4 DISPOSAL OF WATER

- A. Obtain discharge permit for water disposal from authorities having jurisdiction.
- B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.
- C. Discharge water as required by discharge permit and in manner that will NOT cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.
- D. The discharge of groundwater into treatment facilities shall NOT be permitted unless specifically authorized by the Owner. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency, if Owner allows groundwater discharge into facilities.

3.5 PROTECTION OF PROPERTY

- A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but NOT limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.
- B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but NOT be limited to, sheeting bracing, underpinning, or compaction grouting.

3.6 REMEDIATION OF GROUNDWATER AFTER DEPLETION

- A. If dewatering reduces quantity or quality of water produced by existing wells, temporarily supply water to affected well Owners from other sources. Furnish water of a quality and quantity equal to or exceeding the quality and quantity available to the well Owner prior to beginning Work or as satisfactory to each well Owner.

END OF SECTION

SECTION 31 23 23.13 – FILL AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work and materials required for fill and backfill for all excavations other than trench type excavations.
- B. Related Sections:
 - 1. Section 02 41 00 – Demolition
 - 2. Section 03 30 00 – Cast-In-Place Concrete
 - 3. Section 31 11 00 – Site Preparation
 - 4. Section 31 23 16 – Excavation
 - 5. Section 31 23 23.16 – Trench Backfill

1.2 REFERENCES

- A. ASTM International:
 - 1. C117 – Standard Test Method for Materials Finer Than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing.
 - 2. C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 3. D75 – Standard Practice for Sampling Aggregates.
 - 4. D698 – Standard Test Methods for Laboratory Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cf).
 - 5. D1556 – Standard Test Method for Density of Soil in Place by the Sand Cone Method.
 - 6. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cf).
 - 7. D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 - 8. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - 9. D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.3 DEFINITIONS

- A. Relative Compaction:
 - 1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined as specified in ASTM D698.
 - 2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.
- B. Optimum Moisture Content:
 - 1. Determined as specified in ASTM D698 specified to maximum dry density for relative compaction.
 - 2. Determine field moisture content on basis of fraction passing 3/4 in. sieve.
- C. Relative Density:
 - 1. Calculated as specified in ASTM D4254 based on maximum index density determined as specified in ASTM D4253 and minimum index density determined as specified in ASTM D4254.
- D. Prepared Ground Surface:

1. Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and preparation.
- E. Completed Course:
1. A course or layer that is ready for next layer or next phase of Work.
- F. Lift:
1. Loose (uncompacted) layer of material.
- G. Geosynthetics:
1. Geotextiles, geogrids, or geomembranes.
- H. Well-Graded:
1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
 2. Does NOT define numerical value that shall be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
 3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.
- I. Influence Area:
1. Area within planes sloped downward and outward at 60 degrees from horizontal measured from:
 - a. 1 ft outside outermost edge at base of foundations or slabs.
 - b. 1 ft outside outermost edge at surface of roadways or shoulder.
 - c. 0.5 ft outside exterior at spring line of pipes or culverts.
- J. Borrow Material:
1. Material from required excavations or from designated borrow areas on or near site.
- K. Selected Backfill Material/Select Fill:
1. Materials available onsite that Engineer determines to be suitable for specific use.
- L. Imported Material:
1. Materials obtained from sources suitable for specified use.
- M. Structural Fill:
1. Fill materials as required under structures, pavements, and other facilities.
- N. Embankment Material:
1. Fill materials required to raise existing grade in areas other than under structures.
- O. Standard Specification:
1. The latest edition, including supplements of the Oklahoma Department of Transportation (ODOT) Standard Specifications for Highway Construction.

1.4 SUBMITTALS

- A. Subject to requirements as specified in Section 01 33 00 – Submittal Procedures.
- B. Quality requirements Submittals:
1. Catalog and manufacturer's data sheets for compaction equipment.
 2. Certified test results from independent testing agency.

1.5 QUALITY ASSURANCE

- A. Notify Engineer when:
 - 1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
 - 2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
 - 3. Fill material appears to be deviating from sections.

1.6 SEQUENCING AND SCHEDULING

- A. Prior to placing fill or backfill, complete applicable Work specified in:
 - 1. Section 02 41 00 – Demolition
 - 2. Section 31 11 00 – Site Preparation
 - 3. Section 31 23 16 – Excavation
- B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00 – Cast-In-Place Concrete. Obtain acceptance of concrete work and attained strength prior to placing backfill.
- C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00 – Cast-In-Place Concrete.
- D. DO NOT place granular base, subbase, or surfacing until after subgrade has been prepared.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY REQUIREMENTS

- A. Gradation Tests:
 - 1. It shall be the Contractor's responsibility to conduct testing as necessary to locate acceptable sources of imported material.

2.2 EARTH FILL

- A. Excavated material from required excavations, free from rocks larger than 3 in, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

2.3 SELECT FILL

- A. Onsite or imported Earth Fill, free of organic matter or rock larger than 2 in. Plasticity Index (PI) to be between 8 and 15, liquid limit less than 35, and a maximum of 70% passing the No. 200 sieve with organics < 2%.

2.4 GRANULAR FILL

- A. Type D aggregate meeting all the requirements of Section _____ **[Fill In]** of the Standard Specifications. **or** [Type A, Grade 3 or better crushed limestone base material meeting all the requirements of Item 247 of the Oklahoma Department of Transportation Standard Specifications].
 - 1. Exception: [List any exceptions. Example: The fraction passing the #200 sieve shall be limited to 2% max].

2.5 WATER FOR MOISTURE CONDITIONING

- A. Free of hazardous or toxic contaminants, or contaminants deleterious to proper compaction.

2.6 FOUNDATION STABILIZATION ROCK

- A. Crushed rock or pit run rock.
- B. Uniformly graded from coarse to fine.
- C. Free from excessive dirt and other organic material.
- D. Maximum 2 1/2 in. particle size.

PART 3 - EXECUTION

3.1 GENERAL

- A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.
- C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.
- D. DO NOT place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.
- E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
 - 1. Fill or backfill to an elevation 2 ft above top of item to be laid.
 - 2. Excavate trench for installation of item.
 - 3. Install bedding, if applicable, as specified in Section 31 23 23.16 – Trench Backfill.
 - 4. Install item.
 - 5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.16 – Trench Backfill, before resuming filling or backfilling specified in this section.
- F. Tolerances:
 - 1. Final Lines and Grades: Within a tolerance of 0.1 ft, unless dimensions or grades are specified otherwise.
 - 2. Grade to establish and maintain slopes and drainage as specified. Reverse slopes are NOT permitted.
- G. Settlement:
 - 1. Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.
- H. Fill and backfill materials shall be conditioned to a water content that is within plus or minus 2% of the optimum required for compaction as determined by ASTM D698.

3.2 BACKFILL UNDER AND AROUND STRUCTURES

- A. Under Facilities:
 - 1. Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise specified. Place granular fill in lifts of 6 in. maximum thickness and compact each lift to minimum of 95% relative compaction as determined as specified in ASTM D698, Method C.
- B. Subsurface Drainage:
 - 1. Backfill with granular drain material where specified. Place granular drain material in lifts of 6 in. maximum thickness and compact each lift to minimum of 90% relative density.
- C. Other Areas:
 - 1. Backfill with select fill to lines and grades specified, with proper allowance for topsoil thickness where specified. Place in lifts of 6 in. maximum thickness and compact each lift to minimum 95% relative compaction as determined as specified in ASTM D698, Method C.

3.3 FILL

- A. Outside Influence Areas Beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities:
 - 1. Unless otherwise specified, place select fill.
 - 2. Allow for 6 in. thickness of topsoil where required.
 - 3. Maximum 9 in. thick lifts.
 - 4. Place and compact fill across full width of embankment.
 - 5. Compact to minimum 95% relative compaction as determined as specified in ASTM D698, Method C.
 - 6. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.4 SITE TESTING

- A. Gradation:
 - 1. One sample from each 400 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
 - 2. If test results specify material does NOT meet section requirements, terminate material placement until corrective measures are taken.
 - 3. Remove material placed in Work that does NOT meet Specification requirements.
- B. In-Place Density Tests:
 - 1. As specified in ASTM.
 - 2. During placement of materials, test:
 - a. One test per every other lift per 200 LF of roadway or trench.
 - b. A minimum of two tests on granular fill beneath structures.
 - c. A minimum of two tests per 300 yds³ during backfilling of walls.
- C. Testing shall be the Contractor's responsibility and conducted by persons experienced in such work.

3.5 REPLACING OVEREXCAVATED MATERIAL

- A. Replace excavation carried below grade lines specified or established by Engineer:
 - 1. Beneath Footings: Concrete of strength equal to that of respective footing.

2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular fill.
4. Trenches:
 - a. Unauthorized Over-excavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.16 – Trench Backfill.
 - b. Authorized Over-excavation: Trench stabilization material, as specified in Section 31 23 23.16 – Trench Backfill.
5. Permanent Cut Slopes (Where Overlying Area is NOT to Receive Fill or Backfill):
 - a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Select Fill.
 - b. Steep Slopes (Steeper than 3:1):
 - 1) Correct over-excavation by transitioning between areas and designed slope adjoining areas, provided such cutting does NOT extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
 - 2) Backfilling over-excavated areas is prohibited unless, in opinion, backfill will remain stable, and over-excavated material is replaced as compacted select fill.

END OF SECTION

SECTION 31 23 23.16 – TRENCH BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Installation materials and methods for open trench installation of utility lines.
 - 2. Trench Excavation Safety Systems.
- B. Related Sections:
 - 1. Section 03 30 00 – Cast-in-Place Concrete
 - 2. Section 31 23 23.13 – Fill and Backfill
 - 3. Section 31 23 19 – Dewatering
 - 4. Section 31 50 00 – Excavation Support Systems

1.2 REFERENCES

- A. ANSI:
 - 1. 253.1, Safety Color Code.
- B. APWA:
 - 1. Uniform Color Code for Temporary Marking of Underground Utility Locations.
- C. ASTM International:
 - 1. D448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
 - 2. C33 – Standard Specification for Concrete Aggregates
 - 3. C94 – Specification for Ready-Mixed Concrete.
 - 4. C117 – Standard Test Method for Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
 - 5. C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 6. C150 – Standard Specification for Portland Cement.
 - 7. C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - 8. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/cf).
 - 9. D1140 – Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve in Soils by Washing.
 - 10. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf).
 - 11. D3776 – Standard Test Methods for Mass per Unit Area (Weight) of Fabric.
 - 12. D3786 – Standard Test Method for Bursting Strength of Textile Fabrics: Diaphragm Bursting Strength Tester Method.
 - 13. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - 14. D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - 15. D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - 16. D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - 17. D4832 – Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
 - 18. D4991 – Standard Test Method for Leakage Testing of Empty Rigid Containers by Vacuum Method.
 - 19. D5034 – Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

1.3 DEFINITIONS

- A. Base Rock:
 - 1. Granular material upon which manhole bases and other structures are placed.
- B. Bedding Material:
 - 1. Granular material upon which pipes, conduits, cables, or duct banks are placed.
- C. Imported Material:
 - 1. Material obtained by the Contractor from source(s) offsite.
- D. Lift:
 - 1. Loose (uncompacted) layer of material.
- E. Pipe Zone:
 - 1. Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable, or duct bank.
- F. Prepared Trench Bottom:
 - 1. Graded trench bottom after stabilization and installation of bedding material.
- G. Relative Compaction:
 - 1. The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.
- H. Relative Density:
 - 1. As specified by ASTM D4253 and ASTM D4254.
- I. Selected Backfill Material:
 - 1. Material available that the Engineer determines to be suitable for a specific use.
- J. Well-Graded:
 - 1. A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does NOT define any numerical value that shall be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.4 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Manufacturer's descriptive literature for marking tapes.
- C. Samples:
 - 1. Trench stabilization material
 - 2. Bedding and pipe zone material
 - 3. Granular drain
 - 4. Granular backfill
 - 5. Select backfill
 - 6. Sand(s)
 - 7. Geotextile

- D. Quality requirements Submittals:
 - 1. Catalog and manufacturer's data sheets for compaction equipment.
- E. Certified Gradation Analysis:
 - 1. Submit NOT less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to site.
- F. Controlled Low Strength Material:
 - 1. Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

1.5 WARRANTY

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

PART 2 - PRODUCTS

2.1 MARKING TAPE

- A. Plastic:
 - 1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
 - 2. Thickness: Minimum 4 mils.
 - 3. Width: 12 in.
 - 4. Identifying Lettering: Minimum 1 in. high, permanent black lettering imprinted continuously over entire length.
 - 5. Manufacturers and Products:
 - a. Reef Industries; Terra Tape
 - b. Allen Precision Equipment; Markline
- B. Metallic:
 - 1. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
 - 2. Thickness: Minimum 5 mils.
 - 3. Width: 12 in.
 - 4. Identifying Lettering: Minimum 1 in. high, permanent black lettering imprinted continuously over entire length.
 - 5. Joining Clips: Tin or nickel-coated, furnished by tape manufacturer.
 - 6. Manufacturers and Products:
 - a. Reef Industries; Terra Tape Sentry Line
 - b. Allen Precision Equipment; Detectatape
- C. Color:
 - 1. As specified in APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color ¹	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Water, irrigation, and slurry lines
Notes:	

1. As specified in ANSI Z53.1, Safety Color Code.

2.2 TRENCH STABILIZATION MATERIAL

- A. Clean, hard, durable 3 in. minus crushed rock gravel, or pit run, free from clay balls, other organic materials, or debris.
- B. Uniformly graded from coarse to fine, less than 8% by weight passing the 1/4 in. sieve.

2.3 BEDDING MATERIAL AND PIPE ZONE MATERIAL

- A. Unfrozen, friable, and no clay balls, roots, or other organic material.
- B. Clean or gravelly sand with less than 5% passing No. 200 sieve, as determined as specified in ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.
 - 1. Duct Banks: 3/4 in. maximum particle size.
 - 2. PVC Irrigation System Piping, and Ductile Iron Pipe with Polyethylene Wrap: 3/8 in. maximum particle size.
 - 3. Pipe Under 18 in. Diameter: 3/4 in. maximum particle size, except 1/4 in. for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3 in. diameter.
 - 4. Pipe Greater than 18 in. Diameter: 1 1/2 in. maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe. 3/4 in maximum particle size for PVC, FRP, or HDPE Pipe.
 - 5. Perforated Pipe: Granular drain material.
 - 6. Conduit and Direct-Buried Cable:
 - a. Sand, clean or clean to silty, less than 12% passing the No. 200 sieve.
 - b. Individual Particles: Free of sharp edges.
 - c. Maximum Size Particle: Pass a No. 4 sieve.
 - d. If more than 5% passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined as specified in ASTM D4318.

2.4 SELECT FILL

- A. As specified in Section 31 23 23.13 – Fill and Backfill.

2.5 CONTROLLED LOW STRENGTH FILL

- A. Select and proportion ingredients to obtain compressive strength between 50 psi–150 psi at 28 days as specified in ASTM D4832.
- B. Materials:
 - 1. Cement: ASTM C150, Type I or II.
 - 2. Aggregate: ASTM C33, Size 7.
 - 3. Fly Ash (if used): ASTM C618, Class C.
 - 4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.6 CONCRETE BACKFILL

- A. Provide as specified in Section 03 30 00 – Cast-In-Place Concrete.

2.7 TOPSOIL

- A. Topsoil removed and stockpiled from onsite excavation.

2.8 SOURCE QUALITY REQUIREMENTS

- A. Perform gradation analysis as specified in ASTM C136 for:
 - 1. Select backfill, including specified class(es).
 - 2. Trench stabilization material.
 - 3. Bedding and pipe zone material.
- B. Certify Laboratory Performance of Mix Designs:
 - 1. Controlled low strength fill.
 - 2. Concrete.

PART 3 - EXECUTION

3.1 TRENCH PREPARATION

- A. Water Control:
 - 1. As specified in Section 31 23 19 – Dewatering.
 - 2. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. DO NOT place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
 - 3. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
 - 4. Provide continuous water control until trench backfill is complete.
- B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.2 TRENCH BOTTOM

- A. Firm Subgrade:
 - 1. Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if specified.
- B. Soft Subgrade:
 - 1. If it is encountered that it may require removal to prevent pipe settlement, notify Engineer. Engineer shall determine the depth of over-excavation, if any, required.

3.3 TRENCH STABILIZATION MATERIAL INSTALLATION

- A. Rebuild trench bottom with trench stabilization material.
- B. Place material over full width of trench in 6 in. lifts to required grade, providing allowance for bedding thickness.
- C. Compact each lift to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.4 BEDDING

- A. Furnish imported bedding material where, in the opinion of the Engineer, excavated material unsuitable for bedding or insufficient in quantity.
- B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 in.
- C. Hand grade and compact each lift to provide a firm, unyielding surface.

- D. Minimum Thickness:
 - 1. Pipe, 15 in. and Smaller:
 - a. 4 in.
 - 2. Pipe, 18 in. – 36 in:
 - a. 6 in.
 - 3. Pipe, 42 in. and Larger:
 - a. 12 in.
 - 4. Conduit:
 - a. 3 in.
 - 5. Direct-Buried Cable:
 - a. 3 in.
 - 6. Duct Banks:
 - a. 3 in.
- E. Check grade and correct irregularities in bedding material. Loosen top 1 in.–2 in. of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.
- F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.
- G. Bell or Coupling Holes:
 - 1. Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.5 BACKFILL PIPE ZONE

- A. Upper limit of pipe zone shall NOT be less than:
 - 1. Pipe: 12 in. above top of pipe, unless specified otherwise.
 - 2. Conduit: 3 in. above top of conduit, unless specified otherwise.
 - 3. Direct-Buried Cable: 3 in. above top of cable, unless specified otherwise.
 - 4. Duct Bank: 3 in. above top of duct bank, unless specified otherwise.
- B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.
- C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
 - 1. Pipes 10 in. and Smaller Diameter: First lift less than or equal to pipe-diameter.
 - 2. Pipes Over 10 in. Diameter: Maximum 6 in. lifts.
- D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are filled before placing each succeeding lift.
- E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.
- F. DO NOT use power-driven impact compactors to compact pipe zone material.

3.6 MARKING TAPE INSTALLATION

- A. Continuously install marking tape along centerline of all buried piping, at depth of 2 ft. Coordinate with Piping Installation Drawings.

1. Metallic Marking Tape: Install with nonmetallic piping.
2. Plastic Marking Tape: Install with metallic piping.

3.7 BACKFILL ABOVE PIPE ZONE

- A. General:
 1. Process excavated material to meet specified gradation requirements.
 2. Adjust moisture content as necessary to obtain specified compaction.
 3. DO NOT allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 ft of backfill has been provided over the top of pipe.
 4. DO NOT use power driven impact type compactors for compaction until at least 4 ft of backfill is placed over top of pipe.
 5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
 6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise specified.
- B. Select Excavated Backfill:
 1. Place in lifts NOT exceeding 9 in. thickness.
 2. Mechanically compact each lift to a minimum of 95% relative compaction prior to placing succeeding lifts.
- C. Excavated Backfill:
 1. Backfill trench above the pipe zone with granular backfill in lifts NOT exceeding 8 in. Compact each lift to a minimum of 95% relative compaction prior to placing succeeding lifts.
- D. Concrete Backfill:
 1. Place above bedding.
 2. Minimum Concrete Thickness: 6 in. on top and sides of pipe.
 3. DO NOT allow dirt or foreign material to become mixed with concrete during placement.
 4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
 5. Prevent flotation of pipe.
 6. Begin and end concrete backfill within 4 in. of a pipe joint on each end.
 7. DO NOT encase pipe joints except within the limits of the concrete backfill.
- E. Controlled Low Strength Fill:
 1. Discharge from truck mounted drum type mixer into trench.
 2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.

3.8 REPLACEMENT OF TOPSOIL

- A. Replace topsoil in top 6 in. of backfilled trench.
- B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.9 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock:

1. Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil:

1. Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.

D. Asphaltic Pavement:

1. Replace settled areas or fill with asphalt.

E. Other Areas:

1. Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

- A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill, shall be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 50 00 – EXCAVATION SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Work required to install and remove excavation support systems.
- B. Related Sections:
 - 1. Section 31 23 23.13 – Fill and Backfill

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Excavation support plan.
 - 2. Movement monitoring plan.
- C. Quality requirements Submittals:
 - 1. Movement measurement data and reduced results specifying movement trends.

1.3 QUALITY ASSURANCE

- A. Provide surveys to monitor movements of critical facilities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Design, provide, and maintain shoring, sheeting, and bracing as necessary and where shown to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.
- B. Minimum areas for shoring, sheeting, and bracing are shown on the Drawings. It shall be the Contractor's responsibility to determine if areas require excavation slope retention to protect existing structures and facilities from damage resulting from the Contractor's excavation or excavation methods.
- C. The Contractor shall also be responsible for providing shoring, sheeting, and bracing of excavations as needed for worker safety and as may be required by federal, state, and local regulations.

3.2 EXCAVATION SUPPORT PLAN

- A. Prepare Excavation Support Plan Addressing Following Topics:
 - 1. Details of shoring, bracing, sloping, or other provisions for worker protection of existing structures or facilities.
 - 2. Design assumptions and calculations.
 - 3. Methods and sequencing of installing excavation support.
 - 4. Proposed locations of stockpiled excavated material.

5. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.

3.3 MOVEMENT MONITORING PLAN

- A. Prepare Movement Monitoring Plan Addressing Following Topics:
 1. Survey control.
 2. Locations of monitoring points (at least one every 50 ft).
 3. Plots of data trends.
 4. Interval between surveys (not to exceed five working days).
- B. Movement monitoring shall be done on every existing structure that is adjacent to the Contractor's excavations.
- C. Results of movement monitoring shall be delivered for the Engineer at least once a week.

3.4 REMOVAL OF EXCAVATION SUPPORT

- A. DO NOT begin to remove excavation support until it can be removed without damage to existing facilities, completed Work, or adjacent property.
- B. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities. Maintain soil wall support as excavation is backfilled.
- C. Fill voids immediately with approved backfill compacted to density specified in Section 31 23 23.13 – Fill and Backfill.

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, ASME 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 hrs. for visible leaks test and minimum of 2 hrs. 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 hrs.
 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 hrs. 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 hrs. 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 to 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

- 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. Equipment connection fittings
 - 11. Service saddles
 - 12. Annular pressure seals
 - 13. Insulating flanges, couplings, and unions
 - 14. Strainers
 - 15. Spray nozzles
 - 16. Quick couplings
 - 17. Quick disconnect cam operating couplings for chemical service
 - 18. 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 Oklahoma.

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 96 00 – High Performance Coatings.
- 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 in.–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 in.–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 EQUIPMENT CONNECTION FITTINGS

- A. Manufacturers and Products:
 1. Steel or Ductile Iron Pipe:
 - a. Romac – ECF400 (3 in.–72 in.)
 - b. Ford Meter Box Company – FECF (3 in.–24 in.)
- B. Tie-Rods – 316 SST.
- C. Pressure Rating:
 1. Capable of withstanding a maximum working pressure of 275 psi.

2.11 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.)

2.12 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.

2.13 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

2.14 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 Approved Equal.

2.15 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.

2.16 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

2.17 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

2.18 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.

2.19 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 96 00 – High Performance Coatings.
- G. Manufacturer and Products:
 - 1. Gizmo (1/16 in.–8 in.)
 - 2. Or Approved Equal.

2.20 INSULATION

- A. As indicated on Drawings or pipe schedule.

2.21 FINISHES

- A. Prepare piping appurtenances for field finishes as specified in Section 09 96 00 – High Performance Coatings.

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 96 00 – High Performance Coatings.
- 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. Cathodically 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's 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 03 10 00 – Concrete Forming
 - 2. Section 03 20 00 – Concrete Reinforcing
 - 3. Section 03 30 00 – Cast-in-Place Concrete
 - 4. Section 09 96 00 – High-Performance Coatings
 - 5. Section 40 05 51 – Common Requirements for Process Valves
 - 6. Section 40 23 39 – Process Piping – General
 - 7. Section 40 23 39.43 – Polyvinyl Chloride 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
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: Stainless steel.
 2. Atmospheric Exposed:
 - a. Galvanized or painted steel as specified in Section 09 96 00 – Painting and Coating.
 3. Corrosive Areas: FRP
 4. Stainless Steel (Type 304 or 316):
 - a. Use in all submerged locations, 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.
 5. Hot-Dip Galvanized Steel:
 - a. Use in areas other than above and where specified in Drawings. Hot-dip galvanize pipe supports after fabrication.
 6. Plastic, aluminum, FRP, and other miscellaneous materials:
 - a. Use where specifically indicated on the Drawings.
 7. Nonmetallic pipe support systems shall be used in areas where exposed to reactive chemicals such as chemical pumping area and chemical storage area.
 8. Fiberglass Resin:
 - a. Corrosion resistant premium grade vinylester.
 9. Injection Molded Components:
 - a. Polyurethane thermoplastics.
 10. Flame Spread of Fiberglass:
 - a. Vinylester Fiberglass (Series VF): Class 1, ASTM E84.
 - b. Polyurethane: V-O UL 94V.

11. 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

12. Surface Veil:

- a. Fiberglass channel shall have polyester surface veil over 100% of the surface to provide protection against degradation from ultraviolet light.

13. 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 in.–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° 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. ASTM A576, steel
 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
 - 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.
- E. Touchup Paint Galvanized Surfaces:
 - 1. Manufacturers (Choose ONE):
 - a. Galvinox, Galvo-Weld
 - b. Or Approved Equal.
 - 2. Touchup Paint for Painted Surfaces:
 - a. Same formulation as factory paint.
 - 3. Hot-dip galvanize support system components after fabrication to required length and shape.
 - 4. DO NOT galvanize or paint stainless steel components.

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° 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 lbs.
 - 2) Medium (MSS Type 32): 1,500 lbs.
 - 3) Heavy (MSS Type 33): 3,000 lbs.
 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°.
 - 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.

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 36.13 – FRP PIPE AND ACCESSORIES FOR ODOR CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Filament wound and hand lay-up circular fiberglass reinforced plastic (FRP) pipe (duct) and fittings for transporting foul air in the odor control system.
 - 2. Hand layup and contact molded rectangular fiberglass reinforced plastic (FRP) duct and fittings for transporting foul air in the odor control system.
 - 3. Fiberglass dampers for odor control duct, including balancing, isolation, and back draft dampers.
 - 4. EPDM expansion joints for odor control duct.
 - 5. Accessories.
- B. Definitions
 - 1. The terms “pipe” and “duct” in this section are used interchangeably.

1.2 REFERENCES

- A. American Water Works Association (AWWA):
 - 1. M-45 American Water Works Manual of Water Supply Practices “Fiberglass Pipe Design”
- B. ASTM International, Inc. (ASTM):
 - 1. C582 Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment
 - 2. D2310 Classification for Machine-Made “Fiberglass” Pipe
 - 3. D2996 – Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe.
 - 4. D3982 Specification for Contact Molded “Fiberglass” Duct and Hoods
- C. Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA)
 - 1. Thermoset FRP Duct Construction Manual
 - a. Use only for rectangular duct.
- D. Voluntary Product Standard, U.S. Department of Commerce (VPS):
 - 1. PS 15-69 Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 – SUBMITTALS
- B. Product Data: For the following products:
 - 1. FRP Duct
 - 2. Expansion Joints
 - 3. Dampers
 - 4. Accessories
- C. Shop Drawings:
 - 1. Scaled layout drawings of fiberglass ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between

- ductwork and proximate equipment, required clearances, method of field assembly, components, and location and size of each field connection.
- 2. Provide a detailed layout of the duct support system showing locations and type of hangers and supports to be provided.
- 3. Provide field butt and wrap joint connection details on shop drawings.
- 4. Expansion joint dimensions, connections and retainer rings.
- 5. Damper cutsheets, dimensions, and connections.
- 6. A statement on letterhead sealed by a Professional Engineer licensed in the state of the project, stating that the duct wall thickness has been calculated to meet the requirements of this specification and is suitable for the installation. Complete calculations, if submitted, will be received as record data and will not be reviewed.

D. Operation and Maintenance Data: Provide in accordance with Section 01 77 00 – CLOSEOUT PROCEDURES

1.4 QUALITY ASSURANCE

A. Manufacturers: The following Manufacturers are acceptable:

- 1. FRP Duct:
 - a. Daniel Company
 - b. Engineered Composite Systems
 - c. Belco Manufacturing
 - d. Ameron
 - e. Smith Fibercast
- 2. FRP Balancing and Isolation Dampers
 - a. Daniel Company
 - b. Engineered Composite Systems
 - c. Belco Manufacturing
 - d. Swartwout
- 3. FRP Backdraft Dampers
 - a. Daniel Company
 - b. Engineered Composite Systems
 - c. Belco Manufacturing
 - d. Approved Equal
- 4. Expansion Joints
 - a. Red Valve
 - b. Mercer Rubber Company
 - c. Approved equal

B. All materials and equipment supplied under this section shall be suitable for use in a wastewater treatment plant environment exposed to sunlight, variable weather conditions, temperatures ranging from 0°F to 120°F, internal hydrogen sulfide concentrations exceeding 700 ppm, external ambient hydrogen sulfide, and incidental exposure to chemicals in common use at such facilities.

C. Warranty

- 1. Provide a one-year warranty beginning from the time the equipment is placed into continuous service. In the event the pipe or accessories fail to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.

1.5 COORDINATION

- A. Coordinate sizes, dimensions, and locations with connecting equipment and structures.

PART 2 - PRODUCTS

2.1 FRP DUCT AND FITTINGS

A. Design conditions for FRP Duct and Fittings

1. Minimum structural wall thickness: Designed by Manufacturer to meet the following:
 - a. Minimum Internal Pressure: 25 psig
 - b. Minimum Internal Vacuum: 30 in. w.c.
 - c. Design safety factors: FS=10 for pressure and FS=5 for vacuum.
 - d. Buried Duct: HS-20 loading per AWWA M45.
 - e. Temperature range, °F: 0 to 120
 - f. Duct shall be designed for the support spacing shown on the drawings and spacing shown on the typical details (the most stringent of what is shown on the design drawings and the typical details shall govern). Duct shall not sag more than 0.25-inches long term for the support spacing shown on the drawings. Duct shall withstand loads imposed, including condensate buildup within the duct, without excessive sagging.
 - g. Total wall thickness shall be the greater of the design by the Manufacturer to meet the above requirements or:

Duct Inside Diameter, Inches	Above Grade Minimum Wall Thickness, mils	Buried Minimum Wall Thickness, mils
20" and less	340	340
24" to 36" inclusive	400	420
42" and larger	460	600

- h. Structural wall thickness calculations shall not include the thickness of the interior corrosion barrier, inner surface, and interior layer.
 - i. Buried duct shall not deflect more than 5 percent in the installed condition and under HS-20 loads.
 2. Coefficient of linear thermal expansion: Shall not exceed 10.5×10^{-6} in/in/oF.

B. Materials

1. Resin:
 - a. Resin Type: Premium corrosion resistant and fire-retardant brominated bisphenol-A vinyl ester. Resin shall not contain pigments, dyes, colorants or fillers.
 - b. Flame Spread Rating: Class 1 flame spread rating (25 or less).
 - c. Thixotropic agents may be added to control resin viscosity per resin manufacturer's instructions. Corrosion liner shall be clear with no fillers or additives.
 - d. Resins shall be as recommended by AOC-Resins or Ashland. Submit resin manufacturer's certification that resin used is suitable for the intended application
2. Reinforcement:
 - a. Surfacing Veil: Class C with a silane finish and a styrene soluble binder.
 - b. Chopped Strand Mat: Type E glass, minimum 1-1/2 ounces per square foot with a silane finish and a styrene soluble binder.
 - c. Continuous Roving, Chopper Gun Spray-up: Type E glass.
 - d. Woven Roving: Type E glass, minimum 24 ounces per square yard with a five by four weave.
 - e. Continuous Roving, Filament Wound: Type E glass with a silane finish.

C. Fabrication:

1. Duct sizes 10-inch diameter and smaller shall be fabricated using hand layup or filament wound construction.
2. Duct sizes 12-inch diameter and larger shall be fabricated using filament wound construction.
3. Rectangular duct shall be fabricated using hand layup or contact molded construction.
4. Duct fabricated using centrifugally cast construction is not acceptable.
5. Laminates:
 - a. Interior corrosion barrier shall be 100 mil total thickness.
 - 1) Inner surface shall consist of a 10 mil thickness composed of a single ply of type C glass surfacing veil embedded in resin rich surface. Resin content shall be 90%
 - 2) Interior layer shall consist of a 90 mil thickness composed of at least two layers of chopped strand mat. Resin content shall be 75%.
 - b. Structural Layer shall be Type E glass to meet wall thickness requirements.
 - 1) Hand lay construction shall include alternate layers of chopped strand mat and woven roving.
 - 2) Filament wound construction shall be preceded by a layer of chopped strand mat or spray chop. The structural layer shall consist of a minimum of two complete cross hatched layers of continuous filaments applied in a helix angle of 55 degrees for above ground duct and 75 degrees for buried duct.
 - c. Exterior corrosion layer shall be 10 mil thickness composed of a single A or C veil.
 - d. UV Coating shall be a gel coat with UV inhibitors.
6. Fittings:
 - a. Elbows 12-inch diameter and smaller shall be smooth radius with a laying length of 1-1/2 times the pipe diameter.
 - b. 90° Elbows 14-inch diameter and larger shall be 5 piece mitered duct construction with a laying length of 1-1/2 times the pipe diameter.
 - c. 45° Elbows 14-inch diameter and larger shall be 3 piece mitered duct construction with a laying length of 1-1/2 times the pipe diameter.
 - d. Tees and crosses shall be the manufacturer's standard product constructed to attach to the connecting duct.
 - e. Wyres and specials shall be constructed of duct, mitered and FRP wrapped. Special fittings called out on the drawings may have a laying length other than 1.5D.
7. Flanges shall be hand layup construction, with a minimum thickness of 3/4 inches, drilled to match connecting equipment and accessories.

D. Curing:

1. Post curing with indirect heaters or steam. Temperatures and length of curing shall be per resin manufacturer recommendations.

2.2 FRP DAMPERS

A. Isolation Dampers: All dampers shall be isolation dampers unless noted otherwise on the drawings.

1. Materials of construction:
 - a. Body: Vinyl Ester FRP
 - b. Blade: Vinyl Ester FRP
 - c. Blade Seal: PTFE encapsulated O-ring, EPDM O-ring
 - d. Blade Stop: FRP integral to the damper body
 - e. Shaft: 316 stainless steel or vinyl ester FRP
 - f. Shaft Seal: Viton O-ring
 - g. Bearings and bushings: Graphite impregnated PTFE
 - h. Hardware: 316 stainless steel
 - i. Maximum Operating Temperature: 175°F

- j. Minimum Pressure: 30 in. w.c.
- k. Resin System: Fire retardant vinyl ester with MEKP cure system
- l. Internal Corrosion Barrier: Minimum 100 mils thickness
- m. Connections: Flanged per NBS PS15-69 Table 2
- n. External Coating: Gel coat with UV inhibitors
- o. Gaskets: EPDM
- p. Maximum leakage: 4.4 cfm/sq. ft. at 30 in. w.c.

B. Balancing Dampers: Use where shown on the drawings.

- 1. Materials of construction:
 - a. Body: Vinyl Ester FRP
 - b. Blade: Vinyl Ester FRP
 - c. Shaft: 316 stainless steel or Vinyl Ester FRP
 - d. Shaft Seal: EPDM, Viton, or PTFE
 - e. Bearings and bushings: Graphite impregnated PTFE
 - f. Hardware: 316 stainless steel
 - g. Maximum Operating Temperature: 175°F
 - h. Minimum Pressure: 30 in. w.c.
 - i. Resin System: Fire retardant vinyl ester with MEKP cure system
 - j. Internal Corrosion Barrier: Minimum 100 mils thickness
 - k. Connections: Flanged per NBS PS15-69 Table 2
 - l. External Coating: Gel coat with UV inhibitors
 - m. Gaskets: EPDM

C. Backdraft Dampers: Use in line with duct and where shown on the drawings.

- 1. Backdraft dampers shall allow the flow of air though the damper in one direction only and shall close when air reverses direction.
- 2. Materials of construction: As specified for balancing dampers.
- 3. Horizontal backdraft dampers: Dual parallel blades mounted on independent shafts which are linked together externally with an adjustable gravity counter weight to adjust opening pressure.
- 4. Vertical backdraft dampers: Wafer style dual blades mounted to independent axles along the centerline axis of the duct with independent adjustable gravity counter weight to adjust opening pressure.
- 5. Backdraft dampers shall open when a differential pressure of 1 in. w.c. is present when the adjustable counter weight is located at the middle of the adjustment range.
- 6. When used on tank covers, backdraft dampers shall open to relieve vacuum under the cover when the vacuum exceeds 1 in. w.c.

D. Actuators:

- 1. Dampers 20-inches and smaller: Hand quadrant actuator fabricated from 316 stainless steel with a fully adjustable slot with extra hole drilled in handle to permit locking pin once system has been balanced. Provide drilled hole in the actuator handle support plate to permit locking in the full open and full closed positions.
- 2. Dampers larger than 20-inches: Epoxy coated gear operator with locking handwheel.
- 3. Dampers below grade or located in areas not normally accessible (all sizes) such as in wetwells or junction boxes:
 - a. Operator: Geared ¼ turn, Dynatorque stainless steel series DT12 (no chain wheel) or DT21 (with chain wheel) or equal.
 - b. Shaft: 316 stainless steel
 - c. Enclosure: 316 stainless steel
 - d. Hardware: 316 stainless steel
 - e. Gears: 316 stainless steel or 6061 aluminum
 - f. Extension: 316 stainless steel with 2" operating nut, minimum 1-inch diameter or equal to the shaft diameter, whichever is larger. Provide an indicator at the top of the extension stem to indicate full open and full closed positions.

4. Dampers located 6 feet or more above finished floor or grade elevation shall use geared operators as specified above with chain wheel operator and chain extending to within 3 feet of finished floor or grade elevation. Chain wheels shall be aluminum or 316SS by Babbitt, Rotohammer or equal and shall come equipped with 316SS chain. Wheels shall be 316SS. For installations where operator and chain weight exceed 40 lbs the damper shall be reinforced to accommodate the added weight.

2.3 EXPANSION JOINTS

- A. One piece reinforced EPDM arched expansion joints with integral flanges and backer rings. Slip on expansion joints are not acceptable unless specifically noted on the drawings.
- B. Materials of construction:
 1. Body: EPDM
 2. Reinforcing: Nylon, polyester or steel fully encapsulated within the EPDM body.
 3. Flange Rings: 316 Stainless Steel
 4. Hardware: 316 stainless steel
 5. Minimum Operating Temperature: 175°F
 6. Minimum Pressure: 30 in. w.c.
 7. Connections: Flanged per NBS PS15-69 Table 2
- C. Performance Requirements:
 1. Minimum Compression:
 - a. Duct size up to 6 inches: 1-3/16 inches
 - b. Duct size 8 to 36 inches: 2-1/16 inches
 - c. Duct size over 36 inches: 3 inches
 2. Minimum Extension:
 - a. Duct size up to 6 inches: 3/4 inches
 - b. Duct size 8 to 36 inches: 1-1/8 inches
 - c. Duct size over 36 inches: 1-11/16 inches
 3. Minimum Lateral deflection:
 - a. All Duct Sizes: 1-1/2 inches
 4. Rectangular duct: As needed to accommodate the thermal movement of the duct for the installation condition.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which fiberglass ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Coat duct, dampers and fittings after installation as specified in Section 09 96 00 HIGH-PERFORMANCE COATINGS. After painting, in 2-inch black lettering stencil "FOUL AIR" and a flow direction arrow on the duct at each vertical riser duct, at each horizontal duct at maximum 40-ft spacing, and at each duct junction. Coordinate stencil locations with Owner.

3.2 INSTALLATION OF DUCTWORK

- A. General:
 1. Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight and noiseless (no objectionable noise) systems, capable of performing each indicated service.
 2. Shop fabricate duct to the maximum extent possible.
 3. Install each run with minimum number of joints.

4. Align ductwork accurately at connections, within 1/8-inch tolerance and with internal surfaces smooth.
5. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor or as recommended by manufacturer.
6. Duct connections shall be by butt connections with FRP wrap per ASTM D3982. Connections to equipment, structures, dampers, and expansion joints shall be flanged.
 - a. Duct manufacturer shall supply all field weld kits. Field weld kits shall include all necessary fiberglass reinforcing material precut and individually packaged for each joint.
 - b. Hardware shall be type 316 stainless steel. Duct manufacturer shall provide a materials list of all hardware required for procurement by the contractor.
7. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.
8. Routing: Locate ductwork runs as indicated in the plans.
9. Coordination: Coordinate duct installations with installation of accessories, dampers, equipment, controls, odor control covers, and other associated work of ductwork system.

3.3 INSTALLATION OF DAMPERS

- A. The dampers shall be positioned to fit in the connecting piping. Unless otherwise necessary for proper operation of the damper, the axles shall be installed in the horizontal position. The inside of the dampers shall be smooth, clean, and free from blisters and dirt when installed. Dampers in isolation service shall be installed with the shaft side of the damper on the pressure side (toward the equipment isolated).

3.4 FIELD QUALITY CONTROL

- A. Any ductwork found to be improperly installed shall be removed and replaced with ductwork, liner or fittings meeting these specifications. Improper installation shall include, but not be limited to, the following:
 1. Fiberglass duct smaller than specified.
 2. Construction joints not properly sealed.

3.5 EQUIPMENT CONNECTIONS

- A. General: Connect ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.6 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of fiberglass or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.
- C. Balancing: Refer to Section 43 31 83 ADJUSTING AND BALANCING ODOR CONTROL SYSTEMS for air distribution balancing of odor control duct. Seal any leaks in ductwork that become apparent in balancing process.

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 (1,000 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 job site 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
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

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.
 - 3. Pneumatic rotary vane 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.
- 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. Auma.
 - 2. Limitorque Company.
 - 3. EIM Company.
 - 4. Rotork.
- C. Design:
 - 1. Sized to move gates or 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.

2.4 PNEUMATIC ROTARY VANE ACTUATORS

- A. Pneumatic operators for gates and valves shall be the product of a single supplier for each type of gate or valve.
- B. Approved Manufacturers:
 - 1. Kinetrol.
 - 2. Rotork.

- C. Description:
 - 1. Comply with AWWA C541.
- D. Materials of Construction
 - 1. Housing:
 - a. Zinc or aluminum alloy.
 - b. Corrosion resistant epoxy coating internal and external.
 - 2. Output Shaft: Stainless steel or ductile iron.
 - 3. Vane Seals: Wear resistant polyurethane or Buna-N.
- E. Actuator Position Control Capability:
 - 1. Open/Close Valves:
 - a. Actuators shall be solenoid valve operated. Coordinate operating voltage with control systems.
 - b. Provide speed control devices to allow independent adjustment of open and close cycling speed.
 - c. Provide manual override to hold valve in either the open or closed position.
 - d. Exhaust air mufflers shall be standard.
 - e. Provide SPDT position feedback limit switches for open and closed indication.
 - f. Provide visual indication of open and closed position.
 - 2. Modulating Valves:
 - a. Provide positioner designed to control the valve in any intermediate position from fully open to fully closed.
 - b. Positioners shall accept a 4 mA – 20 mA control signal.
 - c. Provide 4 mA – 20 mA position output signal.
 - d. Provide position feedback limit switches for fully open and closed indication.
 - 3. Mechanical Manual Override:
 - a. Actuators shall include a handwheel operated override mounted between the actuator and the valve.
 - b. Manual override shall be able to move and hold the valve in any position.
- F. Torque Capability
 - 1. The rated torque capability shall be sufficient to seat, unseat, and rigidly hold the valve disc it controls under the operating conditions specified.
 - 2. Torque safety factors shall conform to AWWA standards and in no case shall be less than 1.25 times the valve manufacturer torque requirements for open/close applications, and 1.5 times for modulating applications.
- G. Stop-Limiting Devices
 - 1. Actuators shall be equipped with adjustable mechanical stop devices to prevent overtravel of the valve disc.
- H. Pneumatic actuators shall have a working pressure of 150 psig with an overload pressure of 220 psig.

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
FV-5011-3	08-I112	ROS	V513	MOD	16	FLP	2.5	MGD	500	FT
FV-5011-4	08-I112	ROS	V513	OC	16	N/A	2.5	MGD	500	FT

NOTES:

- MOD – Modulating
OC – Open/Close Operation
- 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

B. Pneumatic Operated Valve Schedule:

- Note that this list may not be inclusive of all pneumatic operated valves on the project. Comply with all requirements of contract drawings and specifications.

PNEUMATIC 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
FV-2021-8	08-102	RW	V513	12 in.	OC	FLP	3	MGD	100	psi
FV-2021-8	08-102	RW	V513	12 in.	MOD	FO	3	MGD	100	psi
NOTES: 1. MOD – Modulating OC – Open/Close Operation 2. Fail-Action codes below for loss of motive air pressure or 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 64 – BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Type V500: 3 in. and Larger AWWA C504 Rubber-Seated Butterfly Valves – Exposed
 - 2. Type V504: 3 in. and Larger AWWA C504 Rubber-Seated Butterfly Valves – Buried
 - 3. Type V510: 2 in. and Larger Lug-Style Butterfly Valves
 - 4. Type V511: 2 in. and Larger Wafer-Style Butterfly Valves
 - 5. Type V512: 12 in. and Smaller Plastic Butterfly Valves
 - 6. Type V513: 2 in. and Larger High-Performance Butterfly 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

1.2 REFERENCES

- A. AWAA (American Water Works Association):
 - 1. C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
 - 2. C207 – Steel Pipe Flanges for Waterworks Service, Sizes 4 in.–144 in.
 - 3. C504 – Rubber-Seated Butterfly Valves
 - 4. C516 – Large-Diameter Rubber-Seated Butterfly Valves, Sizes 78 in. and Larger
 - 5. C519 – High-Performance Waterworks Butterfly Valves
- 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
- C. ASTM International:
 - 1. A48 – Standard Specification for Gray Iron Castings
 - 2. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - 3. A276 – Standard Specification for Stainless Steel Bars and Shapes
 - 4. A351 – Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
 - 5. A479 – Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
 - 6. A536 – Standard Specification for Ductile Iron Castings
 - 7. A564 – Standard Specification for Hot-Rolled and Cold-Finished Age Hardening Stainless Steel Bars and Shapes
 - 8. A582 – Standard Specification for Free-Machining Stainless Steel Bars
 - 9. D429 – Standard Test Methods for Rubber Property – Adhesion to Rigid Substrates
 - 10. D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- D. NSF (National Science Foundation):
 - 1. 61 – Health Effects for Drinking Water System Components
 - 2. 372 – Lead Content for Drinking Water System Components

1.3 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.
- 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. Manufacturer Instructions:
 - 1. Submit detailed instructions on installation requirements, including storage and handling procedures.
- F. Source Quality-Control Submittals:
 - 1. Specify results of factory tests and inspections.
- G. Field Quality-Control Submittals:
 - 1. Specify results of Contractor-furnished tests and inspections.
- H. Manufacturer Reports:
 - 1. Certify that equipment has been installed as specified in manufacturer instructions.
 - 2. Specify activities on site, adverse findings, and recommendations.
- I. 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 C504.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements:
 - 1. 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 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.

1.8 WARRANTY

- A. Furnish a 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 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 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 Section 40 05 57 – Actuators for Process Valves and Gates and valve schedules.

2.2 TYPE V500: 3 IN. AND LARGER AWWA C504 RUBBER-SEATED BUTTERFLY VALVES – EXPOSED

- A. Manufacturers:
 - 1. Henry Pratt Co.
 - a. Class 150B: 2FII Bonded Seat (3 in.–20 in.) or Triton XR-70 Rubber-Seated (24 in.–144 in.)
 - b. Class 250B: HP250II (3 in.–48 in.)
 - 2. Mueller Co.
 - a. Class 150B: Lineseal III (3 in.–48 in.)
 - b. Class 250B: Lineseal XP (3 in.–48 in.)
 - 3. DeZURIK
 - a. Class 150B and 250B: AWWA Butterfly Valves BAW (3 in.–168 in.)
 - 4. Val-Matic
 - a. Class 150B: American-BFV Butterfly Valves (3 in.–144 in.)

- b. Class 250B: American-BFV Butterfly Valves (3 in.–96 in.)
- B. General:
 - 1. Minimum Rated Working Pressure:
 - a. 150 psig for AWWA C504 Class 150B or 250 psig AWWA C504 Class 250B.
 - 2. Maximum Process Fluid Temperature:
 - a. 125°F
 - 3. Valve and Operator designed and manufactured as specified in AWWA C504, Class 150B or Class 250B, AWWA C516.
- C. Construction and Materials:
 - 1. Body:
 - a. Type: Flanged, narrow body design.
 - b. Material:
 - 1) Class 150B: ASTM A126 Class B gray iron or ASTM A536 Grade 65-45-12 ductile iron
 - 2) Class 250B: ASTM A536 Grade 65-45-12 ductile iron
 - 2. Disc:
 - a. Material:
 - 1) 3 in.–6 in. (Choose ONE):
 - a) ASTM A536 Grade 65-45-12 ductile iron with a stainless-steel seating edge
 - b) ASTM A351 Grade CF8N stainless steel
 - 2) 8 in. and Larger (Choose ONE):
 - a) ASTM A126 Class B gray iron with a stainless-steel seating edge
 - b) ASTM A536 Grade 65-45-12 ductile iron with a stainless-steel seating edge.
 - b. No disc stops shall be installed on the interior of the valve body.
 - 3. Seat:
 - a. Type: Resilient and replaceable. Shall have a full 360 degrees circumference around the valve body or disc without interruption.
 - b. Mounting:
 - 1) On the valve body or on the valve disc. Where the seat is mounted to the valve disc, an ASTM A276 Type 316 stainless steel seating ring shall be provided on the valve body.
 - 2) Seats shall have adhesive integrity of bond between seat and body or seat and disc assured by testing with minimum 75 lbs. pull as specified in ASTM D429 Method B.
 - c. Construction:
 - 1) 3 in.–20 in.: Molded and bonded directly into the valve body or retained by mechanical means without use of fasteners or retaining rings.
 - 2) 24 in. and Larger: Retained by mechanical means without use of fasteners or retaining rings.
 - d. Material: Buna-N.
 - 4. Shafts:
 - a. ASTM A276 Type 304 stainless steel
 - b. ASTM A276 Type 316 stainless steel
 - c. ASTM A564 Type 630 stainless steel
 - 5. Packing:
 - a. V-type and replaceable without dismantling valve.
 - 6. Bearings:
 - a. Shall be sleeve type that is PTFE lined and self-lubricating. Metal-to-metal thrust bearings shall not be installed on the interior of the valve body.
 - 7. Hardware:
 - a. ASTM A276 Type 304 or 316 stainless steel

- D. End Connections:
 - 1. Flanged. Comply with ASME B16.1 Class 125 or Class 250, or AWWA C207 Class D.
 - E. Finishes:
 - 1. Factory primer. Field finish to match connecting pipe.
- 2.3 TYPE V504: 3 IN. AND LARGER AWWA C504 RUBBER-SEATED BUTTERFLY VALVES – BURIED
- A. Manufacturers:
 - 1. Henry Pratt Co.
 - a. Class 150B: 2FII Bonded Seat (3 in.–20 in.) or Triton XR-70 Rubber-Seated (24 in.–144 in.)
 - b. Class 250B: HP250II (3 in.–48 in.)
 - 2. Mueller Co.
 - a. Class 150B: Lineseal III (3 in.–48 in.)
 - b. Class 250B: Lineseal XP (3 in.–48 in.)
 - 3. DeZURIK
 - a. Class 150B and 250B: AWWA Butterfly Valves BAW (3 in.–168 in.)
 - 4. Val-Matic
 - a. Class 150B: American-BFV Butterfly Valves (3 in.–144 in.)
 - b. Class 250B: American-BFV Butterfly Valves (3 in.–96 in.)
 - B. General:
 - 1. Minimum Rated Working Pressure:
 - a. 150 psig for AWWA C504 Class 150B or 250 psig AWWA C504 Class 250B.
 - 2. Maximum Process Fluid Temperature:
 - a. 125°F
 - 3. Valve and Operator designed and manufactured as specified in AWWA C504, Class 150B or Class 250B, AWWA C516.
 - C. Construction and Materials:
 - 1. Body:
 - a. Type:
 - 1) Buried, mechanical joint
 - b. Material:
 - 1) Class 150B (Choose ONE):
 - a) ASTM A126 Class B gray iron
 - b) ASTM A536 Grade 65-45-12 ductile iron
 - 2) Class 250B:
 - a) ASTM A536 Grade 65-45-12 ductile iron
 - 2. Disc:
 - a. Material:
 - 1) 3 in. – 6 in. (Choose ONE):
 - a) ASTM A536 Grade 65-45-12 ductile iron with a stainless-steel seating edge
 - b) ASTM A351 Grade CF8N stainless steel
 - 2) 8 in. and Larger (Choose ONE):
 - a) ASTM A126 Class B gray iron with a stainless-steel seating edge
 - b) ASTM A536 Grade 65-45-12 ductile iron with a stainless-steel seating edge
 - b. No disc stops shall be installed on the interior of the valve body.
 - 3. Seat:
 - a. Type: Resilient and replaceable. Shall have a full 360° circumference around the valve body or disc without interruption.

- b. Mounting:
 - 1) On the valve body or on the valve disc. Where the seat is mounted to the valve disc, an ASTM A276 Type 316 stainless steel seating ring shall be provided on the valve body.
 - 2) Seats shall have adhesive integrity of bond between seat and body, or seat and disc assured by testing with minimum 75 lbs. pull as specified in ASTM D429 Method B.
- c. Construction:
 - 1) 3 in. – 20 in.:
 - a) Molded and bonded directly into the valve body or retained by mechanical means without use of fasteners or retaining rings.
 - 2) 24 in. and Larger:
 - a) Retained by mechanical means without use of fasteners or retaining rings.
- d. Material:
 - 1) Buna-N.
- 4. Shafts (Choose ONE):
 - a. ASTM A276 Type 304 stainless steel
 - b. ASTM A276 Type 316 stainless steel
 - c. ASTM A564 Type 630 stainless steel.
- 5. Packing:
 - a. V-type and replaceable without dismantling valve.
- 6. Bearings:
 - a. Shall be sleeve type that is PTFE lined and self-lubricating. Metal-to-metal thrust bearings shall not be installed on the interior of the valve body.
- 7. Hardware:
 - a. ASTM A276 Type 304 or 316 stainless steel.

- D. End Connections:
 - 1. Mechanical joint. Comply with AWWA C111.

- E. Finishes:
 - 1. Fusion bonded epoxy

2.4 TYPE V510: 2 IN. AND LARGER LUG–STYLE BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Henry Pratt Co. – BF Series (2 in.–48 in.)
 - 2. DeZURIK – On-Center Resilient Seated Butterfly Valves BOS-CL (2 in.–24 in.)
 - 3. Bray – Resilient Seated Butterfly Valves Series 31 (2 in.–20 in.)
- B. General:
 - 1. Minimum Rated Working Pressure:
 - a. 150 psig in compliance with ASME Class 150.
 - 2. Maximum Process Fluid Temperature:
 - a. 250°F
 - 3. Suitable for air and/or water service.
- C. Construction and Materials:
 - 1. Body:
 - a. Type:
 - 1) Lugged
 - b. Material:
 - 1) ASTM A536 Grade 65-45-12 ductile iron.

2. Disc:
 - a. Material:
 - 1) ASTM A351 Grade CF8N stainless steel.
 - b. No disc stops shall be installed on the interior of the valve body.
3. Seat:
 - a. Type:
 - 1) Resilient and replaceable. Shall have a full 360° circumference around the valve body without interruption. Seat shall cover the entire inner surface of the valve body and extend over the outside face of the valve body to form a flange gasket.
 - b. Mounting:
 - 1) On the valve body.
 - 2) Seats shall have adhesive integrity of bond between seat and body or seat and disc assured by testing with minimum 75 lbs. pull as specified in ASTM D429 Method B.
 - c. Construction:
 - 1) 3 in.–20 in.:
 - a) Bonded directly into the valve body.
 - 2) 24 in. and Larger:
 - a) Bonded to a metal retention ring held in place by stainless steel retaining screws.
 - d. Material:
 - 1) EPDM.
4. Shafts:
 - a. ASTM A582 Type 416 stainless steel or ASTM A582 Type 420 stainless steel.
5. Packing:
 - a. V-type and replaceable without dismantling valve.
6. Bearings:
 - a. Shall be sleeve type that is PTFE lined and self-lubricating. Metal-to-metal thrust bearings shall not be installed on the interior of the valve body.
7. Hardware:
 - a. ASTM A276 Type 304 or 316 stainless steel.

D. End Connections:

1. Flanged:
 - a. Comply with ASME B16.1 Class 125.

E. Finishes:

1. Factory primer:
 - a. Field finish to match connecting pipe.

2.5 TYPE V511: 2 IN. AND LARGER WAFER–STYLE BUTTERFLY VALVES

A. Manufacturers:

1. Henry Pratt Co. – Monoflange MKII Wafer (3 in.–20 in.)
2. DeZURIK – Uninterrupted Seat Resilient Seated Butterfly Valves BOS-US (2 in.–36 in.)
3. Bray – Resilient Seated Butterfly Valves Series 30 (2 in.–20 in.)

B. General:

1. Minimum Rated Working Pressure:
 - a. 150 psig in compliance with ASME Class 150.
2. Maximum Process Fluid Temperature:
 - a. 250°F
3. Suitable for air and/or water service.

C. Construction and Materials:

1. Body:
 - a. Type:
 - 1) Wafer
 - b. Material (Choose ONE):
 - 1) ASTM A48 Class 40 cast iron
 - 2) ASTM A536 Grade 65-45-12 ductile iron.
 - c. Body shall have alignment lugs as needed for centering valve between flanges.
2. Disc:
 - a. Material:
 - 1) 3 in. – 6 in. (Choose ONE):
 - a) ASTM A536 Grade 65-45-12 ductile iron with a stainless-steel seating edge
 - b) ASTM A351 Grade CF8N stainless steel.
 - 2) 8 in. and Larger (Choose ONE):
 - a) ASTM A126 Class B gray iron with a stainless-steel seating edge
 - b) ASTM A536 Grade 65-45-12 ductile iron with a stainless-steel seating edge.
 - b. No disc stops shall be installed on the interior of the valve body.
3. Seat:
 - a. Type: Resilient and replaceable. Shall have a full 360° circumference around the valve body without interruption. Seat shall cover the entire inner surface of the valve body and extend over the outside face of the valve body to form a flange gasket.
 - b. Mounting:
 - 1) On the valve body.
 - 2) Seats shall have adhesive integrity of bond between seat and body or seat and disc assured by testing with minimum 75 lbs. pull as specified in ASTM D429 Method B.
 - c. Construction:
 - 1) 3 in.–20 in.:
 - a) Bonded directly into the valve body.
 - 2) 24 in. and Larger:
 - a) Bonded to a metal retention ring held in place by stainless steel retaining screws.
 - d. Material:
 - 1) EPDM.
4. Shafts (Choose ONE):
 - a. ASTM A276 Type 304 stainless steel
 - b. ASTM A276 Type 316 stainless steel.
5. Packing: V-type and replaceable without dismantling valve.
6. Bearings: Shall be sleeve type that is PTFE lined and self-lubricating. Metal-to-metal thrust bearings shall not be installed on the interior of the valve body.
7. Hardware:
 - a. ASTM A276 Type 304 or 316 stainless steel.

D. End Connections:

1. Flanged:
 - a. Comply with ASME B16.1 Class 125.

E. Finishes:

1. Factory primer:
 - a. Field finish to match connecting pipe.

2.6 TYPE V512: 12 IN. AND SMALLER PLASTIC BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Asahi/America
 - a. PVC: 57P (1 1/2 in.–8 in.)
 - b. CPVC: 57P (2 in.–8 in.)
 - 2. Hayward Flow Control
 - a. PVC and CPVC: BYV Series (2 in.–12 in.)
 - 3. NIBCO
 - a. PVC and CPVC: Model C (2 in.–10 in.)
 - 4. Spears
 - a. PVC and CPVC:
 - 1) Standard Butterfly Valve (1 1/2 in.–12 in.)
- B. General:
 - 1. Minimum Rated Working Pressure:
 - a. 150 psig in compliance with ASME Class 150.
 - 2. Maximum Process Fluid Temperature:
 - a. 140°F
- C. Construction and Materials:
 - 1. Body:
 - a. Type:
 - 1) Wafer
 - b. Material:
 - 1) PVC:
 - a) ASTM D1784 PVC or material compatible with service conditions on PVC lines.
 - 2) CPVC:
 - a) ASTM D1784 CPVC or material compatible with service conditions on CPVC lines.
 - c. Body shall have alignment lugs as needed for centering valve between flanges.
 - 2. Disc:
 - a. Material:
 - 1) PVC:
 - a) ASTM D1784 PVC or material compatible with service conditions on PVC lines.
 - 2) CPVC:
 - a) ASTM D1784 CPVC or material compatible with service conditions on CPVC lines.
 - b. No disc stops shall be installed on the interior of the valve body.
 - 3. Seat/Liner:
 - a. Type:
 - 1) Full seat design. Shall have a full 360° circumference around the valve body without interruption. Seat shall cover the entire inner surface of the valve body and extend over the outside face of the valve body to form a flange gasket.
 - b. Mounting:
 - 1) On the valve body via rib and groove engagement.
 - c. Material:
 - 1) FKM.
 - 4. Shafts (Choose ONE):
 - a. ASTM A276 Type 316 stainless steel
 - b. ASTM A582 Type 416 stainless steel
 - 5. Seals:
 - a. FKM

6. Bearings:
 - a. Shall be sleeve type that is PTFE lined and self-lubricating.
 7. Hardware:
 - a. ASTM A276 Type 304 or 316 stainless steel.
- D. End Connections:
1. Flanged:
 - a. Comply with ASME B16.5 Class 150.
- E. Finishes:
1. Field finish to match connecting pipe.
- 2.7 TYPE V513: 2 IN. AND LARGER HIGH-PERFORMANCE BUTTERFLY VALVES
- A. Manufacturers:
1. DeZURIK:
 - a. High Performance Butterfly Valves BHP (2 in.–60 in.)
 2. Bray:
 - a. High Performance Butterfly Valves McCannalok Series 41 (2 in.–66 in.)
- B. General:
1. Minimum Rated Working Pressure:
 - a. 150 psig in compliance with ASME Class 150.
 2. Maximum Process Fluid Temperature:
 - a. 500°F
 3. Maximum Process Fluid Velocity:
 - a. 20 fps
- C. Construction and Materials:
1. Body:
 - a. Type:
 - 1) Lugged
 - b. Material:
 - 1) ASTM A351 Grade CF8N stainless steel.
 2. Disc:
 - a. Material:
 - 1) ASTM A351 Grade CF8N stainless steel.
 - b. No disc stops shall be installed on the interior of the valve body.
 3. Seat:
 - a. Type:
 - 1) Resilient and replaceable. Shall have a full 360 degrees circumference around the valve body without interruption.
 - b. Mounting:
 - 1) ASTM A351 Grade CF8N stainless steel seat retainer held in place by 316 stainless steel retaining screws.
 - c. Material:
 - 1) Reinforced PTFE seat.
 4. Shafts:
 - a. ASTM A479 Type 316 stainless steel.
 5. Packing:
 - a. V-type and replaceable without dismantling valve.
 6. Bearings:
 - a. Shall be sleeve type that is PTFE lined and self-lubricating. Metal-to-metal thrust bearings shall not be installed on the interior of the valve body.
 7. Hardware:
 - a. ASTM A276 Type 316 stainless steel.

- D. End Connections:
 - 1. Flanged:
 - a. Comply with ASME B16.1 Class 125.

- E. Finishes:
 - 1. Field finish to match connecting pipe.

PART 3 - EXECUTION

3.1 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.

3.2 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. 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.
- C. See Section 01 75 00 – Startup Testing and Training.

3.3 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 ft 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 fitting.
 - 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 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
Air, Low Pressure	ALP	Exposed Submerged	ALL	304 SST PVC		40 23 39.36 40 23 39.43	220	10	15, AM		1
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. Contractor to provide stainless steel piping from blowers to discharge flange on pipes entering the storm pond. Diffuser manufacturer to provide appropriate connection to stainless steel flange and transition to PVC piping for aeration system.											

END OF SECTION

SECTION 40 23 39.36 STAINLESS STEEL PIPE AND FITTINGS – GENERAL SERVICE		
Item	Size	Description
Pipe	2 in. & smaller	Minimum Schedule 40S or as required to meet testing pressures as specified in the pipe schedule: ASTM A312-93, Type 304 Stainless Steel seamless, pickled and passivated.
	2 1/2 in. – 6 in.	Minimum Schedule 10S or as required to meet testing pressures as specified in the pipe schedule: ASTM A778 Rev A-90 “as-welded” grade, Type 304 Stainless Steel.
	8 in. & larger	Minimum Schedule 5S or as required to meet testing pressures as specified in the pipe schedule: ASTM A778 Rev A-90 “as-welded” grade, Type 304 Stainless Steel.
Joints	2 in. & smaller	Threaded or flanged at equipment as required or shown.
	2 1/2 in. & larger	Butt-welded or flanged at valves and equipment.
Fittings	2 in. & smaller	Threaded Forged: 1,000 CWP, ASTM A182 Rev C-93 Grade 304L.
	2 1/2 in. & larger	Butt Welded: ASTM A774-94 Grade 304L conforming to MSS SP-43, “as-welded” grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Branch Connections	2 in. & smaller	Tee or reducing tee in conformance with Fittings above.
	2 1/2 in. & larger	Butt-welding tee or reducing tee in accordance with Fittings above.
Flanges	1/2 in. – 4 in.	Forged Stainless Steel, ASTM A182 Rev C-93, and Grade 304L ANSI B16.5-88 Class 150 or Class 300 slip-on weld neck or raised face.
	4 in.–24 in.	Forged Stainless Steel, ASTM A182 Grade 304L, ANSI B16.5- Class 150 or Class 300 slip-on or weld neck with raised face. Bore shall match pipe.
	24 in. & larger	Forged Stainless Steel: ASTM A182 304L, ANSI B16.47 Series A Class 125 or 150 weld neck with raise face. Bore shall match pipe.
Unions	2 in. & smaller	Threaded Forged: ASTM A182 Rev C-93 Grade 304, 2,000 pound or 3,000 pound WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11-91, bore to match pipe.
Bolting	All	Forged Flanges: Type 304 Stainless Steel , ASTM A320-94 Grade B8M hex head bolts and ASTM A194-94 Grade 8M hex head nuts.
		Van Stone Flanges: Carbon steel ASTM A307-94 Grade B hex head bolts and ASTM A563-93 Grade A hex head nuts. Provide same on mating cast iron flange on valve or equipment with flat ring gasket.

SECTION 40 23 39.36 STAINLESS STEEL PIPE AND FITTINGS – GENERAL SERVICE		
Item	Size	Description
Gaskets	All Flanges	Flanged, Water, and Wastewater Service: 1/8 in. thick, unless otherwise specified, homogenous black rubber (EPDM), hardness 60 (Shore A), rated to 212°F, as specified in ANSI B16.21 and ASTM D1330 Steam Grade. Flanged, Air Services: 1/16 in. thick, Teflon, PTFE, or compressed inorganic fiber with nitrile binder; suitable for temperatures to 550°F and pressures to 1,000 psi. Ring gaskets shall not be permitted. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.
Thread Lubricant	2 in. & smaller	Teflon Tape.
Welding	All	All welding shall be performed in the shop as specified in the latest editions of Section IX of the ASME Boiler and Pressure Vessel Code and ASME Code for Pressure Piping, ASME B31.3 (severe cyclic), as applicable. All welds shall have 100% penetration. The internal weld bead shall be small, smooth and continuous with no crevices, pits or other voids. The external weld bead shall be well rounded, smooth and continuous with no anomalies. All welded connections shall be parallel and perpendicular to the extent that the piping appears to be correct to the naked eye. Procedure: Pipe edges shall be prepared by machine cutting or shaping using an aluminum oxide blade. Beveled ends shall conform to the requirements of ANSI B16.9. Clean weld joints and weld joint areas both before and after welding in accordance with ASTM A380 using stainless steel wire brushes or stainless-steel wool. Alignment: Align ends to be joined within commercial tolerances on diameter, wall thickness, and out-of-roundness. When joining pipes of different wall schedule, taper bore the interior of the larger schedule pipe to match the interior diameter of the connecting pipe with a maximum 1:3 slope. Root opening at the joint shall be as stated in the procedure specification. Welding: The direct current, straight polarity, gas tungsten-arc (GTAW) process shall be used for all welding. Welding may be by manual GTAW or automatic (orbital) GTAW processes. The inside of the pipe shall be purged with Argon gas during welding and while the weld is cooling to prevent oxidation of the weld. Tack Welds: All tack welds shall be made by a qualified welder.

SECTION 40 23 39.36 STAINLESS STEEL PIPE AND FITTINGS – GENERAL SERVICE		
Item	Size	Description
Welding (Cont.)	All	All tack welds shall be made with welding rod the same as that used for the succeeding root pass. Tack welds shall be small enough to be readily fused into the bead of the root pass. Thoroughly clean tack welds with a stainless-steel wire brush prior to the root pass to prevent pinholing or excessive porosity. Tack welds that have cracked shall be completely removed prior to making the root pass. Surface defects that will affect the soundness of the weld shall be removed, visually inspected, and rewelded. Where permitted, branch connections shall be fitted and groove-welded as specified in the details described and in Chapter V of ASME B31.3. Finished welds shall be as specified in Chapter V of ASME B31.3 (severe cyclic), as applicable. Field welding of stainless-steel piping will not be allowed.
Pipe Finish	All	Pickle all stainless-steel pipe, fittings, and finished assemblies inside and out following fabrication to remove all mill scale, weld inclusions and color; as specified in ASTM A380. Passivate inside and out as specified in ASTM A967. Outer surface shall be bead blasted per ASTM A380.

END OF SECTION

**SECTION 40 23 39.43
POLYVINYL CHLORIDE PIPE AND FITTINGS**

Item	Size	Description
Pipe	All	Schedule 40 PVC: Type I, Grade I or Class 23447-B as specified in ASTM D1785-05. Threaded Nipples: Schedule 40 PVC.
Fittings	All	Schedule 40 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 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 61 96 – Process Control Descriptions
 - 2. Section 40 63 43 – Programmable Logic Controllers
 - 3. Section 40 67 23 – Control Panels
 - 4. Section 40 70 00 – Instrumentation for Process Systems

1.2 DEFINITIONS:

- A. SCADA: Supervisory Control and Data Acquisition
- B. HMI: Human Machine Interface (Graphical Screens, Text Displays)
- C. OIT: Operator Interface Terminal
- D. PLC: Programmable Logic Controller
- E. I/O: Input/Output
- F. VFD: Variable Frequency Drive
- G. SSRVS: Solid State Reduced Voltage Starter (“Soft Starter”)
- H. RTU: Remote Telemetry Unit
- I. MTU: Master Telemetry Unit
- J. MCC: Motor Control Center
- K. Operating Program: Operating system, SCADA, or other core software.
- L. Integrated Operating Platform: System of installed, connected, and configured hardware, operating programs, and networking equipment.
- M. PLC and HMI Programming: Software configuration of operating programs to implement process control strategies.
- N. Control System Specialist: A company specializing in process control hardware and software, including instrumentation, PLCs, networking, installation, and configuration.
- O. Application Engineer: A company performing the PLC and HMI programming to implement process control strategies.

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.
- 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.
 - 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 PLC and HMI programs for vendor supplied equipment packages, on electronic media, suitable for future troubleshooting or modifications by others.
- 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.

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
- B. The Control System Specialist shall be responsible for providing and installing all instrumentation, PLC control panels, computer equipment, networking equipment, Programmable Logic Controller (PLC) programming, Human Machine Interface (HMI) graphics development and configuration, and other control system hardware as specified for a complete process control system installation.
- C. In general, the Control System Specialist shall:
 - 1. Provide PLC programming and HMI screen development to implement process control of equipment as 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 – 2,000 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 – 2,000 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 programmable logic controller 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 cabinet housing the associated programmable logic controller as shown on Drawings.
- F. The Contractor shall make the necessary power connections and signal connections from the field devices (i.e., instruments, control valves, etc.) to the programmable logic controllers.
- G. The Contractor shall configure and verify proper operation of the Integrated Operating Platform, included but not limited to:
 - 1. The computers, PLCs, 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 PLCs, computer systems, SCADA software and hardware, 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 Control System Specialist shall provide notice to the Engineer a minimum of thirty (30) days in advance of the test. The Owner and/or Engineer may witness these tests at the Owner's discretion.
2. The purpose of the Factory Readiness Test is to verify that all hardware and wiring within each control panel has been properly constructed and ready for shipment to the project site.
3. The Control System Specialist shall assemble all hardware components within the specified enclosure, including the instruments, PLCs, 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 PLC 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 each PLC 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.

7. The Control System Specialist may load a test program in the PLCs in order to facilitate the Factory Readiness Test.
8. Upon satisfactory completion of the control panel hardware and wiring portion of the test, the Control System Specialist **shall** load the PLC and HMI programming to begin functional testing of control strategies.
9. Each analog and discrete I/O signal will be checked through the PLC to the HMI screens to verify proper mapping of tags.
10. Process conditions and field equipment feedback will be simulated or forced in order to prove proper PLC response and logic functionality.
11. If during the Factory Readiness Test the Engineer or Owner finds that the system does not operate correctly 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.
12. 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 PLC 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 PLC control panel hardware is operating and communicating properly.
 - d. The installation is ready to load PLC and HMI 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 PLC 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 PLC 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 PLC register, panel light, etc.
8. Discrete output signals shall be tested by forcing a value in the PLC 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 PLC register, digital panel meters, etc.
10. Analog outputs shall be tested by entering values in the PLC 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 Control System Specialist shall load the PLC and HMI 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 PLC and HMI programming.
4. The Control System Specialist shall be available to assist with equipment operations, as necessary.
5. For this test, all equipment shall be installed, calibrated, and functioning as required in the contract documents.
6. Each analog and discrete I/O signal will be checked through the PLC to the HMI screens to verify proper mapping of tags.
7. Functionality of the system will be checked to ensure conformance with process control strategies.
8. PLC control loops will be tuned to achieve stable process control.
9. 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 – PLC and HMI Programming

1.2 DEFINITIONS

- A. Integrated Operating Platform:
 - 1. System of installed, connected, and configured hardware, operating programs, and networking equipment.
- B. PLC and HMI 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, PLCs, networking, installation, and configuration.
- D. Application Engineer:
 - 1. A company performing the PLC and HMI programming to implement process control strategies.

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 PLC program and SCADA HMI.
 2. Local control will be provided by a LOCAL-OFF-REMOTE 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 SCADA.
 3. Remote control will be provided by a virtual ON-OFF-AUTO selector on the SCADA HMI.
 - 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 PLC 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 PLC program and SCADA HMI.
 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 SCADA.
 3. Remote control will be provided by a virtual ON-OFF-AUTO selector and MANUAL SPEED SETPOINT on the SCADA HMI.
 - 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 HMI. 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 PLC 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 SCADA. 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 SCADA HMI.
 - 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 PLC 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 PLC.
2. Remote control will be provided by a virtual MANUAL-AUTO selector on the SCADA HMI.
 - 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 PLC program will control valve operations based on the automatic control strategy described herein.

F. PLC Calculated Alarms:

1. Analog Signal Diagnostic Alarms:
 - a. These PLC calculated alarms will be generated for all analog input signals.
 - b. High Alarm:
 - 1) PLC generated alarm if the value exceeds operator high value alarm setpoint.
 - c. Low Alarm:
 - 1) PLC generated alarm if the value falls below operator low value alarm range setpoint.
 - d. Out of Range:
 - 1) PLC generated alarm if measurement is out of range, indicating an instrument fault. PLC shall hold last good value while measurement is out of range.
 - e. Broken Loop:
 - 1) PLC generated alarm if signal broken loop is detected. PLC shall hold last good value while broken loop is active.
2. Equipment Alarms:
 - a. These PLC calculated alarms will be generated for all equipment with PLC control. All alarm delay timers and deadbands shall be operator-adjustable. These alarms only apply to remote SCADA control and will not be generated when equipment is in a LOCAL control state.
 - b. Pumps/Motors:
 - 1) Command Fail:
 - a) PLC 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) PLC generated alarm if running feedback is not received before a set time-delay after run command is given.
 - 3) Fail to Stop:
 - a) PLC generated alarm if running feedback is not lost before a set time-delay after run command has been removed.
 - 4) Uncommanded Change Alarm:

- a) PLC generated deviation alarm if equipment changes states (running, speed) without being given a command.
 - c. Gates/Valves:
 - 1) Command Fail:
 - a) PLC 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) PLC generated alarm if open feedback not received before a set time-delay after open command is given.
 - 3) Fail to Close:
 - a) PLC generated alarm if closed feedback not received before a set time-delay after close command is given.
 - 4) Uncommanded Change Alarm:
 - a) PLC generated deviation alarm if equipment changes states (open/close status, position) without being given a command.
- 3. PLC Diagnostic Alarms:
 - a. These PLC calculated alarms will be generated for all new PLCs provided as part of the project.
 - b. PLC Card Fault:
 - 1) The PLC shall generate an alarm for any I/O card faults as available from the platform.
 - c. PLC Heartbeat:
 - 1) The PLC shall have an alternating "heartbeat" bit for use in communications diagnostics.
 - d. PLC Communications Fault:
 - 1) A PLC 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.

END OF SECTION

SECTION 40 61 96.01 – PROCESS CONTROL DESCRIPTION – NORTH STORM POND

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
- 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:
- Section 40 61 13 – Process Control System General Provisions
 - Section 40 61 96 – Process Control Descriptions – General
 - Section 40 68 63 – PLC and HMI Programming

1.2 REFERENCES

- A. Drawing Number 08-I661 – North Storm Ponds Process and Instrumentation Diagram.

1.3 EQUIPMENT AND INSTRUMENTATION

- A. Blowers:

Equipment Tag	Name	Existing/ Proposed	Type	Driver	Operation
66B001	Blower #1	Proposed	PD	EM	V
66B002	Blower #2	Proposed	PD	EM	V
66B003	Blower #3	Proposed	PD	EM	V
C = Centrifugal PD = Positive-Displacement EM = Electric Motor PO = Pneumatic-Operated V = Variable-Speed F = Fixed-Speed					

- B. Instruments:
- Discrete Instruments: N/A
 - Analog Instruments:

Equipment Tag	Name	Existing/ Proposed	Nominal Range
66LIT101	North Storm Pond Level #1	Proposed	0 - 15 FT
66LIT201	North Storm Pond Level #2	Proposed	0 - 15 FT
66PIT001	North Storm Pond Blower Header Pressure	Proposed	0-10psi

C. Control Panels and Local Control Stations:

Equipment Tag	Name	Existing/ Proposed
CP-67RIO1	North Storm Pond Electrical Building Control Panel	Proposed

D. Controllers:

Equipment Tag	Name
67RIO1	North Storm Pond Electrical Building PLC

1.4 PROCESS DESCRIPTION

- A. The North Storm Pond is used to store excess storm flows coming into the Moore WWTP. While in use, the water stored in this pond will be continuously aerated with the proposed blowers and diffuser grid. The water level in each half of the storm pond will be monitored using the proposed radar level indicators, and blowers will throttle airflow up/down based on the water level in the pond. A common discharge header for the blowers, equipped with butterfly valves for isolation, allows for multiple combinations of blower capacity to each half of the storm pond. VFDs for the blowers will be housed in the nearby electrical building, as well as the RIO panel.

B. Automatic Mode:

There will be one automatic mode that the Operator will select from the SCADA HMI.

Storm Pond Aeration Mode:

In the Storm Pond Aeration automatic mode, the blowers will operate in accordance with the level of water in the pond measured by 66LITX01. When the automatic mode is enabled, the blowers will operate in the following intervals:

Basins Full (SWD = 14' or EL 1168.0'), all 3 blowers running at 100%

Basins 75% full (SWD = 10.5' or EL 1164.5'), all 3 blowers running at 75%

Basins 50% full (SWD = 7' or EL 1161.0'), 2 blowers running at 100%

Basins 25% full (SWD = 3.5' or EL 1157.5'), 1 blower running at 75%

Basins 11% full (SWD = 1.5' or EL 1155.5'), all blowers off

Each basin interval shall be an operator adjustable setpoint capable of being modified from the SCADA HMI.

HMI CONTROLS

C. Control Setpoints:

1. The following table lists the expected new adjustable control setpoints that will be added to the HMI 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

Aeration Basin 11% Full	0-2ft	1.5ft	In Storm Pond Aeration mode: If the level in the pond is at or below this setpoint, the lead blower will stop
Aeration Basin 25% Full	2-6.5ft	3.5ft	In Storm Pond Aeration mode: If the level in the pond is at this setpoint, the lead blower will run at 75%
Aeration Basin 50% Full	7-10ft	7ft	In Storm Pond Aeration mode: If the level in the pond is at this setpoint, two blowers shall be running at 100%
Aeration Basin 75% Full	10.5-13.5ft	10.5ft	In Storm Pond Aeration mode: If the level in the pond is at this setpoint, three blowers shall be running at 75%
Aeration Basin Full	13.5-14ft	14ft	In Storm Pond Aeration mode: If the level in the pond is at this setpoint, three blowers shall be running at 100%
Single Blower Minimum Speed Setpoint	0-100%	TBD	Minimum speed setpoint when a single blower is running.
Single Blower Maximum Speed Setpoint	0-100%	100%	Maximum speed setpoint when a single blower is running.

D. Process Variables

- The following table lists the expected new process variables related to the control strategy that will be added to the HMI 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
North Storm Pond - North Water Level	ft	0-15
North Storm Pond - South Water Level	ft	0-15
North Storm Pond - Blower Header Pressure	Psi	0-10

E. Alarms

- The following table lists the expected alarms that will be added to the HMI 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
Blower VFD fault	Fault generated by the blower VFD.
Blower Header Pressure High	PLC generated alarm when 66PIT001 reads above 7psi.
Basin High Level	PLC generated alarm if level measurement exceeds 15ft.

1.5 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.

There are no Hard Interlocks included in this section.

B. Soft Interlocks

1. The following table lists software interlock conditions that must be satisfied for pump control. Setpoints for the interlocks shall be adjustable from the HMI.

There are no Soft Interlocks included in this section.

1.6 FAILURE MODES

- A. The following table lists potential failures and the expected process control system response.

Failure	Process Control System Response
Basin Level Meter Fail	Shut down blowers and alarm.

1.7 COMMUNICATION INTERFACES

- A. Data will be communicated over the SCADA network from the Admin Building for data needed to control the new north pond blowers. The following table identifies the major items expected to be communicated.

No data external to the North Storm Pond site is essential to the functionality of the facility.

END OF SECTION

SECTION 40 63 43 – PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The work for furnishing all materials, labor, equipment, tools, supplies, and incidentals necessary for the installation and testing of all programmable logic controllers (PLCs).
- B. Related Sections:
 - 1. Section 40 61 13 – Process Control System General Provisions
 - 2. Section 40 66 33 – Fiber Optic Communication Systems
 - 3. Section 40 67 23 – Control Panels
 - 4. Section 40 70 00 – Instrumentation for Process Systems

1.2 DEFINITIONS

- A. SCADA: Supervisory Control and Data Acquisition
- B. HMI: Human Interface (Graphical Screens, Text Displays)
- C. OIT: Operator Interface Terminal
- D. PLC: Programmable Logic Controller
- E. I/O: Input/Output
- F. RTU: Remote Telemetry Unit
- G. MTU: Master Telemetry Unit
- H. Operating Program: Operating system, SCADA, or other core software.
- I. Integrated Operating Platform: System of installed, connected, and configured hardware, operating programs, and networking equipment.
- J. PLC and HMI Programming: Software configuration of operating programs to implement process control strategies.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Refer to section 40 61 13 – Process Control System General Provisions for submittal requirements.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Support:
 - 1. The PLC system manufacturer shall maintain, as a part of a national network, engineering service facilities within 100 miles of the project, to provide startup service, emergency service calls, repair work, service contracts, maintenance, and training. Emergency service shall be available within 24 hrs. of notification.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection:
 - 1. Delivery, storage, and handling shall be as specified in Manufacturers' recommendation and the requirements of other sections herein.

PART 2 - PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLERS

- A. Plant-wide PLC Systems:
 - 1. All PLCs included in a control panel as part of the SCADA process control system provided by the Control System Specialist shall meet the following requirements:
 - a. Processor Module:
 - 1) Manufacturer:
 - a) Allen-Bradley CompactLogix 5370 L33 Series
 - 2) Components:
 - a) Memory: 4 MB
 - b) Ports:
 - i. (1) USB
 - ii. (2) RJ-45 Ethernet
 - b. The following I/O modules as required for the application.
 - 1) 1769-IA16: 16-Channel AC Digital Input Module
 - 2) 1769-IB16: 16-Channel DC Discrete Input Module
 - 3) 1769-OW16: 16-Channel Relay Output Module
 - 4) 1769-IF8: 8-Channel Analog Input Module
 - 5) 1769-OF8: 8-Channel Analog Output Module
 - 6) 1769-FPD: Field Potential Distributor Module
- B. Equipment Manufacturer Supplied PLC Systems:
 - 1. PLCs included in a control panel as part of a mechanical equipment package shall be CompactLogix.
- C. Features:
 - 1. Each PLC or RIO shall be installed with a minimum of 25% spare I/O points of each type utilized in its I/O structure. Each spare I/O point shall be wired to interposing relays and terminal blocks in same fashion as other I/O points.
 - 2. Each PLC shall have a removable nonvolatile memory card installed with capacity greater than or equal to processor internal memory. The controller shall be configured to load a copy of the program from nonvolatile memory whenever there is no project in the controller and power is applied.
 - 3. The PLCs shall be capable of and shall be configured to provide stand-alone operation in the event of a communications link failure.
 - 4. The necessary interface cables, communications cables, power cables, bus extension cables, modular card slot fillers, and other ancillary parts shall be furnished and installed as integral parts of the control system.
 - 5. Nameplates shall be provided for each module, device, and other equipment with appropriate data such as the equipment number, rating, serial number, and manufacturer.
 - 6. All I/O cards shall be furnished with removable terminal blocks to simplify card wiring and replacement.
- D. Spare Parts:
 - 1. See Section 40 67 23 – Control Panels.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall utilize personnel who are skilled and experienced in the installation, setup, and configuration of the PLCs being furnished under this contract.
- B. Any PLC, furnished by the Control System Specialist or as part of an equipment manufacturer package, shall be accessible for future program monitoring and revisions. If password protection of any kind is implemented, the manufacturer vendor or Contractor shall supply all passwords or other security information to the Owner and the Engineer.
- C. The Contractor shall furnish the Owner final as-built copies of all documented PLC programs, including manufacturer equipment packages, on electronic media, suitable for future troubleshooting or modifications by others.
- D. All components and assemblies shall be installed as specified in the manufacturer's installation instructions.

END OF SECTION

SECTION 40 66 33 – FIBER OPTIC COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. 50/125 multi-mode, outdoor optical fiber cable (OM3).
 - 2. Optical fiber cable connecting hardware, patch panels, and splices.
 - 3. Cabling identification products.
- B. Related Requirements:
 - 1. Section 40 66 13 – Networking Equipment
 - 2. Section 40 67 13 – Computer Equipment Racks

1.2 DEFINITIONS

- A. BICSI:
 - 1. Building Industry Consulting Service International.
- B. Cross-Connect:
 - 1. A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. RCDD:
 - 1. Registered Communications Distribution Designer.

1.3 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Action Submittals:
 - 1. Product Data:
 - a. For each type of product
 - 2. Shop Drawings:
 - a. Reviewed and stamped by RCDD
 - b. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - c. System Labeling Schedules:
 - 1) Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - d. Cabling administration drawings and printouts.
 - e. Wiring diagrams to show typical wiring schematics including:
 - 1) Telecommunications rooms plans and elevations
 - 2) Telecommunications pathways
 - 3) Telecommunications system access points
 - 4) Telecommunications grounding system
 - 5) Cross-connects
 - 6) Patch panels
 - 7) Patch cords
 - f. Cross-connects and patch panels
 - 1) Detail mounting assemblies and show elevations and physical relationship between the installed components.
 - 3. Optical fiber cable testing plan

- C. Informational Submittals:
 - 1. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
 - 2. Source quality-control reports
 - 3. Product Certificates: For each type of product
 - 4. Field quality-control reports
- D. Closeout Submittals:
 - 1. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.
- E. Maintenance Material Submittals:
 - 1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Patch-Panel Units: One (1) of each type
 - b. Plugs: Ten (10) of each type
 - c. Jacks: Ten (10) of each type

1.4 QUALITY ASSURANCE

- A. The Contractor shall designate in writing the qualified Fiber 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 Fiber System Specialist shall be subject to approval of the Owner and the Engineer.
- B. The minimum qualifications for the Fiber System Specialist shall include:
 - 1. An established firm in operation as a fiber optic design and installation company.
 - 2. Staffed with experienced personnel capable of executing all aspects of the project.
 - 3. BICSI RCDD certification for design of the fiber optic system.
 - 4. BICSI Installer certification for installation of the fiber optic system.
 - 5. Demonstrated experience with design and installation of multi-mode fiber optic installations.
- C. Installer Qualifications:
 - 1. Cabling Installer must have personnel certified by BICSI on staff.
 - 2. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
 - 3. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 4. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- D. Testing Agency Qualifications:
 - 1. Testing agency must have personnel certified by BICSI on staff.
 - 2. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.5 SCOPE

- A. The scope of the optical fiber cabling installation for this project includes:
- B. Treatment Plant Multi-Mode Fiber Optic System
 - 1. Provide a 12-strand multimode fiber optic cabling system between buildings at the treatment plant as depicted on the contract drawings, to provide a communication link between buildings for process control and SCADA HMI networks.
 - 2. Provide a 12-strand multimode fiber optic cabling system between buildings at the treatment plant as depicted on the contract drawings, to provide a communication link between buildings for business network connectivity.

3. The scope of the Fiber System Specialist will include all items, as needed, up to and including fiber patch panel enclosures. This shall include all cabling, splices, boxes, taps, patch panels, testing, and other items as required for a complete system.
4. The Fiber System Specialist shall be responsible for the design and selection of cabling and hardware required to achieve a reliable communication link without the use of fiber amplifiers or compensators.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site
 1. Test optical fiber cable to determine the continuity of the strand end to end.
 2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.7 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with water pipe.

1.8 WARRANTIES

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance:
 1. Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested as specified in test procedures of this standard.
- B. Surface-Burning Characteristics:
 1. As determined by testing identical products as specified in ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 2. Flame-Spread Index: 25 or less
 3. Smoke-Developed Index: 50 or less
- C. Telecommunications Pathways and Spaces:
 1. As specified in TIA-569-D.
- D. Grounding:
 1. As specified in TIA-607-B.

2.2 50/125 MICROMETER MULTI-MODE, OUTDOOR OPTICAL FIBER CABLE (OM3)

- A. Description:
 1. Multimode, laser-optimized 50/125-micrometer, 12 fibers, tight buffer, optical fiber cable, listed for the application.
- B. Manufacturers (Subject to requirements):
 1. 3M
 2. Belden
 3. CommScope
 4. Corning Cable Systems
 5. General Cable

- 6. Superior Essex
 - 7. Or equal.
- C. Standards:
- 1. As specified in TIA-492AAAC for detailed specifications.
 - 2. As specified in TIA-568-C.3 for performance specifications.
 - 3. As specified in ICEA S-87-640 for mechanical properties.
- D. Maximum Attenuation:
- 1. 2.3 dB/km at 850 nm; 0.6 dB/km at 1300 nm.
- E. Minimum Overfilled Modal Bandwidth-Length Product:
- 1. 1500 MHz-km at 850 nm; 500 MHz-km at 1,300 nm.
- F. Armor:
- 1. Corrugated steel armor underneath outer jacket for crush protection.
- G. Jacket:
- 1. Jacket Color: Aqua.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be as specified in TIA-598-D.
 - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 in.
- H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as specified in UL 444, UL 1651, and NFPA 70.

2.3 FIBER OPTIC SPLICING

- A. Provide fiber optic splices along the fiber optic route at required intervals due to spool length limitations.
- B. All splices shall be fusion type with a maximum attenuation loss of 0.5 dB.
- C. Splices shall be made within a fiber splice closure located in a below grade box to protect the splice from physical damage. The closure shall be designed for use in below grade applications to protect against moisture intrusion.

2.4 OPTICAL FIBER CABLE HARDWARE

- A. Standards:
 - 1. As specified in Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
 - 2. As specified in TIA-568-C.3.
- B. Cross-Connects and Patch Panels:
 - 1. Modular panels housing multiple-numbered, duplex cable connectors.
 - 2. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- C. Patch Cords:
 - 1. Factory-made, dual-fiber cables in 36-inch lengths.
- D. Connector Type:
 - 1. Type SC

- E. Plugs and Plug Assemblies:
 - 1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
 - 2. Insertion loss not more than 0.75 dB
 - 3. Marked to indicate transmission performance
- F. Jacks and Jack Assemblies:
 - 1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
 - 2. Insertion loss not more than 0.25 d
 - 3. Marked to indicate transmission performance.
 - 4. Designed to snap-in to a patch panel or faceplate

2.5 GROUNDING

- A. As specified in TIA-607-B.

2.6 IDENTIFICATION PRODUCTS

- A. As specified in TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

- A. Testing Agency:
 - 1. Engage a qualified testing agency to evaluate cables.
- B. Factory test multimode optical fiber cables as specified in TIA-526-14-B and TIA-568-C.3.
- C. Factory test pre-terminated optical fiber cable assemblies as specified in TIA-526-14-B and TIA-568-C.3.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Wiring Method:
 - 1. Install fiber cable in conduit
- B. Wiring within Enclosures:
 - 1. Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. As specified in NECA 1, NECA 301, and NECA/BICSI 568.
- B. General Requirements for Optical Fiber Cabling Installation:
 - 1. As specified in TIA-568-C.1 and TIA-568-C.3.
 - 2. As specified in BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at specified outlets, terminals, cross-connects, and patch panels.
 - 4. Secure and support cables at intervals not exceeding 30 in. and not more than 6 in. from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
 - 8. Pulling Cable: As specified in BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 - 9. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- C. Group connecting hardware for cables into separate logical fields.

3.4 GROUNDING

- A. Install grounding as specified in BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.
- B. As specified in TIA-607-B and NECA/BICSI-607.

3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling as specified in TIA-606-B.
- B. Cabling Administration Drawings:
 - 1. Show plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications pathways and cables.
- C. Cable and Wire Identification:
 - 1. Label each cable within 4 in. of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as specified.
- D. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with TIA 606-B:
 - 1. Flexible vinyl or polyester that flexes as cables are bent

3.6 FIELD QUALITY CONTROL

- A. Testing Agency:
 - 1. Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service:
 - 1. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- C. Tests and Inspections:
1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment, and patch cords, and labeling of all components.
 3. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Horizontal and multimode backbone link measurements: Test at 850 or 1,300 nm in one direction as specified in TIA-526-14-B, Method B, One Reference Jumper.
 - 2) Attenuation test results shall be less than those calculated as specified in the equation in TIA-568-C.1.
- D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- E. Remove and replace cabling where test results indicate that it does not comply with specified requirements.
- F. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.7 DEMONSTRATION

- A. System Demonstration and Final Acceptance Test:
1. The Contractor shall conduct a 10-day Final Acceptance test of the completed installation. The test shall start after the Engineer has received marked record (as-built) drawings from the Contractor and when directed by the Owner/Engineer.
 2. The system shall operate with 100% reliability during the test period. Failure of hardware shall require repair or remedy of the defect to the satisfaction of the Engineer within a two-hour period. 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.
 3. The Contractor shall complete the Operations and Maintenance Manuals including all updated documentation of programmable devices to the satisfaction of the Engineer.
 4. The Contractor will be allowed two attempts at successfully completing the Final Acceptance Test. After that time, the Contractor will become responsible to reimburse the Owner for liquidated damages.
- B. 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.
- C. Maintenance Instruction:

1. Operating and maintenance instructions, along with a separate parts list, shall be furnished in three 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.
2. Warranty: All equipment and workmanship furnished under this contract shall be guaranteed to be free of defects in materials and workmanship for a period of 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 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
 - 2. Section 40 63 43 – Programmable Logic Controllers

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): Each control panel with a PLC 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 PLC-RSC series as manufactured by Phoenix Contact or equal. 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, 120 VAC 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.
- 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) Or 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) Or 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 600V 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: 480 V AC 3-phase – phase A
 - k. Orange: 480 V AC 3-phase – phase B
 - l. Yellow: 480 V 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% 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 480 VAC, 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 1,400% 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 wire 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, 600V, 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 120V 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 300V, 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 form C relays with contacts rated at 120 V AC. Analog signals shall be isolated from each other.

2.8 PROGRAMMABLE LOGIC CONTROLLERS (PLC)

- A. Refer to Section 40 63 43 – Programmable Logic Controllers for PLC requirements.

2.9 OPERATOR INTERFACE TERMINALS (OIT)

- A. General:
 - 1. Where specified in Drawings or within an equipment section, an OIT shall be mounted on the front of the control panel for display and control of process-specific graphics.
 - 2. OITs shall:
 - a. Allen-Bradley Panelview Plus 7.
 - b. Minimum Screen Size: 10 in. diagonal.
 - c. Provide Ethernet/IP communication capability compatible with Allen-Bradley family PLCs.
 - d. Provide devices with 2GB memory card.
 - e. Provide nonglare screen protector. For HMIs installed outdoors, provide hinged weatherproof cover.
 - f. OITs may also be referred to throughout contract documents as Human Machine Interface (HMI).

2.10 NETWORK DEVICES

- A. Media Converters:
 - 1. Provide copper to fiber media converters where specified in Drawings or where required to interface with external cabling.
- B. Surge Protection:
 - 1. Copper Ethernet cables entering control panels from other sources shall be protected against static discharge, lightning, and faulty wiring with network surge protective devices. The devices shall have integral RJ-45 connectors with all lines protected.

2.11 UNINTERRUPTIBLE POWER SUPPLY (UPS)

- A. Each control panel provided with a PLC shall contain a UPS to provide seamless and continuous operation of control panel equipment during power outages.
- B. The UPS shall provide backup power:
 - 1. True sine wave output with online double conversion configuration
 - 2. Fault, overload, and replace batteries indicators.
 - 3. Voltage input: 120 VAC single phase
 - 4. Voltage output: 120 VAC single phase
 - 5. Output power capacity: 1,000 watts/1,500VA minimum
 - 6. Internal or external bypass.
 - 7. Hot-swap batteries $\geq$ 2min. (at 25°C, full load = 600W, p.f. between 0.6 – 0.75)
 - 8. UPS to be manufactured by Allen Bradley, or equal.

2.12 SPARE PARTS

- A. Provide spare parts in the quantities specified:
 - 1. One PLC processor module of each type furnished.
 - 2. Two PLC I/O modules of each type furnished.
 - 3. One communication module of each type furnished.

4. One OIT of each type furnished.
5. Six replacement fuses, all types and sizes.
6. One replacement lamp of each color, for pilot lights.
7. One of each color replacement lens caps for pilot lights.
8. One starter coil for each NEMA size furnished.
9. One, 3-pole set of replacement overload heaters of each size range used.
10. One, 3-pole set of starter contacts of each NEMA size used.

- B. For plant-wide PLC control panels provided by the Control System Specialist, provide 1 set of spare parts that are common to multiple panels. For equipment manufacturer supplied systems, provide one set of spare parts for each control panel.
- C. Spare parts shall be boxed or packaged for long-term storage. Identify each item with manufacturer's name, description, and part number on the exterior of the package.

2.13 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 insure 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 of 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 1,000 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 – PLC AND HMI PROGRAMMING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. The PLC and HMI programming work to be performed by the Control System Specialist, consisting of labor, licensing, software, and incidentals for the programming of all PLCs, OITs, HMI 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. Section 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. SCADA:
 - 1. Supervisory Control and Data Acquisition
- B. HMI:
 - 1. Human Machine Interface
- C. OIT:
 - 1. Operator Interface Terminal
- D. PLC:
 - 1. Programmable Logic Controller
- 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. PLC and HMI 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 PLC and HMI 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 PLC and HMI 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 PLC 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 HMI 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 HMI 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 PLC, 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. Each PLC shall be configured to provide the system a heartbeat function that will enable the system to periodically check for proper communications. The HMI application shall issue an

alarm if communication fails. A PLC 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 HMI.
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. HMI 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 PLC diagnostic screen will display PLC module statuses, as well as any communication alarms. This screen will also depict the local control panel network and any connected devices (OIT, PLC, 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 HMIs, 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 PLC 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 PLC.
 - 3. Operator:
 - a. Start and stop HMI applications.
 - b. Adjust process parameters.
 - 4. View:
 - a. HMI navigation privileges only.
- C. User management shall use 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 PLC 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 HMI:
 - 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 PLC. Alarm configurations and settings will be selectable and/or adjustable via the HMI.
- F. Coordinate self-healing and reset required alarms with Owner. All alarms shall be acknowledged via the HMI.
- G. All alarm setpoints shall be adjustable from the HMI.
- H. Preconfigure analog device feedback high-high, high, low, low-low, rate-of-change, and out-of-range alarms.
- I. Other specific alarms are designated in the control loop descriptions.

3.5 PROCESS EQUIPMENT AND DEVICES

- A. HMI 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 HMI. 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 PLC logic and HMI 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 PLC, 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 HMI, achieving commanded state, local mode change, or software mode change.
- E. Equipment and/or devices with remote control feedback to the HMI 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 HMI 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.

- E. Calculate daily and monthly minimum, maximum, average, and total values for each flow process variable and display values on HMI.
- F. Process overview displays shall indicate the highest priority, active, unacknowledged alarm for the area. The indication shall include the following features.
 - 1. Alarm border with a priority symbol around the area or unit in alarm.
 - 2. Alarm border and priority symbol shall reflect the color associated with the alarm priority.
 - 3. The priority symbol shall include the priority value.

3.7 SYSTEM FUNCTIONALITY

- A. The process control system shall be set up initially with the basic functionality as specified in Section 40 61 96 – Process Control Descriptions. These descriptions shall be used as a guide for controlling various items by location and the Control System Specialist shall be expected to continually refine the system functionality throughout the execution of the project. Each automatic, manual, and operator-initiated set point shall be configured with upper and lower limits to keep the process operating within an expected operating range. The Control System Specialist shall coordinate the functionality of each item in the control description with the Contractor, Owner, and Operator. The Control System Specialist shall provide support for all functions in the HMI screens.

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

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 HAZARDOUS LOCATION APPROVALS

- A. Where installed within a hazardous location, instruments shall bear agency approvals for the identified class, division, and group of the hazardous location.
- B. Hazardous location boundaries shall be as defined by NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities. Consult the Engineer or Authority Having Jurisdiction for a determination when hazardous location identification is uncertain.
- C. Provide intrinsically safe wiring methods for connection of instruments located within a hazardous location.

2.7 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.

2.8 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 ft. 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 120 VAC/24 VDC 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.
 - 2. Whether or not indicated on Drawings, provide one (1) stilling well for each radar level instrument provided.
 - a. Stilling well shall be of appropriate length and diameter for application.
 - b. Stilling well shall be constructed of corrosion-resistant material such as schedule 80 PVC pipe.
 - c. Supply each stilling well with 316 stainless steel mounting hardware.
- 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, 1-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. Stilling Wells:
 - 1. Mount each radar level instrument within stilling well. Adjust as required to accurately perceive level of process material.
- E. 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:

Sensor Tag	Transmitter Tag	Application	Measurement Range
50LE101	50LIT101	North Digester Tank 1 Level	0 - 25 FT
50LE401	50LIT401	South Digester Tank 1 Level	0 - 25 FT
50LE201	50LIT201	North Digester Tank 2 Level	0 - 25 FT
50LE501	50LIT501	South Digester Tank 2 Level	0 - 25 FT
50LE301	50LIT301	North Digester Tank 3 Level	0 - 25 FT
50LE601	50LIT601	South Digester Tank 3 Level	0 - 25 FT
66LIT101	(Integral)	North Storm Pond Level 1	0 - 15 FT
66LIT201	(Integral)	North Storm Pond Level 2	0 - 15 FT

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 Approved 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
50LSH101	North Digester Tank 1 High Level	Match Existing
50LSM101	North Digester Tank 1 Mid Level	Match Existing
50LSL101	North Digester Tank 1 Low Level	Match Existing
50LSH401	South Digester Tank 1 High Level	Match Existing
50LSM401	South Digester Tank 1 Mid Level	Match Existing
50LSL401	South Digester Tank 1 Low Level	Match Existing
50LSH201	North Digester Tank 2 High Level	Match Existing
50LSM201	North Digester Tank 2 Mid Level	Match Existing
50LSL201	North Digester Tank 2 Low Level	Match Existing
50LSH501	South Digester Tank 2 High Level	Match Existing
50LSM501	South Digester Tank 2 Mid Level	Match Existing
50LSL501	South Digester Tank 2 Low Level	Match Existing
50LSH301	North Digester Tank 3 High Level	Match Existing
50LSM301	North Digester Tank 3 Mid Level	Match Existing
50LSL301	North Digester Tank 3 Low Level	Match Existing
50LSH601	South Digester Tank 3 High Level	Match Existing
50LSM601	South Digester Tank 3 Mid Level	Match Existing
50LSL601	South Digester Tank 3 Low Level	Match Existing

END OF SECTION

SECTION 40 73 26 – DIFFERENTIAL AND GAUGE PRESSURE TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes:
 - 1. Differential and gauge pressure 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.

1.5 WARRANTY

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

PART 2 - PRODUCTS

2.1 PRESSURE MEASUREMENT DEVICES

- A. Manufacturers:
 - 1. Endress+Hauser PMC71 (gauge) PMD75 (differential)
 - 2. Siemens Sitrans P320
 - 3. Rosemount 3051
- B. Description:
 - 1. Digital pressure measurement device for with integral transmitter and display, for gauge and differential pressure applications in liquids and gases.
- C. Measuring Range:
 - 1. As specified in schedule.
- D. Features and Performance:
 - 1. Power Supply: 24V DC
 - 2. Accuracy: Plus or minus 0.05%
 - 3. Output Signal: 4 mA DC – 20 mA DC
 - 4. Process Temperature Range: (-4)°F–250°F
 - 5. Materials: Type 316 stainless steel
 - 6. Location: As specified in Drawings.
 - 7. Local digital display, NEMA 4X rated
- E. Accessories:
 - 1. Providing mounting hardware accessories as required for mounting application.

2. 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 and compatible with installed location.
- B. Coordinate location and orientation of transmitters with final piping and equipment installations.
- C. Locate transmitters to be easily read during operation and easily accessible for maintenance.
- D. Provide pulsation dampeners in pressure transmitter sensing lines when located at pump discharge.
- E. Provide with remote pressure compensation tube when required for supplied instrument with length as required.
- F. 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. Pressure Transmitter Schedule:

Instrument Tag	Application	Measurement Range
66PIT001	North Storm Ponds Blower Header Pressure	0-10psi

END OF SECTION

SECTION 40 75 43 – DISSOLVED OXYGEN PROBES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Dissolved Oxygen Probes
 - 2. Transmitters
- B. Related Requirements:
 - 1. Section 40 70 00 – Instrumentation for Process Systems

1.2 REFERENCE STANDARDS

1.3 COORDINATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

1.4 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.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

1.6 WARRANTY

- A. Furnish three-year manufacturer's warranty for probes and appurtenant devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The dissolved oxygen meters furnished under this contract shall be as manufactured by:
 - 1. Hach Company LDO Model 2

2.2 DESCRIPTION

- A. Dissolved Oxygen Sensor
 - 1. The dissolved oxygen sensor shall be a submerged probe type sensor.
 - 2. The sensing element shall be coated with a luminescent material and shall utilize luminescence quenching as the main principle of measurement.
 - 3. Range: 0 to 20.0 mg/L
 - 4. Accuracy:
 - a. ± 0.05 mg/L below 1 mg/L
 - b. ± 0.1 mg/L below 5 mg/L
 - c. ± 0.2 mg/L above 5 mg/L
 - 5. Response Time:
 - a. $T_{95} < 60$ seconds
 - b. $T_{90} < 40$ seconds

6. Hazardous Classification. Rated for installation in a Class 1, Division 1 location by manufacturer.
 7. Resolution: 0.01 mg/L
 8. Repeatability: ± 0.1 mg/L
 9. Instrument cables shall be provided by manufacturer. Length as required for termination to transmitter/controller. See contract drawings for individual sensor and transmitter locations.
 10. Sensor shall be installed using manufacturer-provided pole mount kit capable of mounting to existing handrail. Any additional mounting hardware shall be 316 stainless steel.
 11. Sensor shall be factory calibrated. Calibration shall not be required for the life of the instrument.
 12. The sensor shall be reagentless, requiring no electrolyte solutions to replenish or membranes to replace.
- B. Universal Transmitter/Controller
1. Hach SC4500.
 2. Features:
 - a. Provide local indication of monitored dissolved oxygen and communicate readings to SCADA.
 - b. Number and type of sensor inputs required for the application.
 - c. Analog output module with five (5) 4 mA – 20 mA outputs.
 - d. Minimum of two (2) programmable output relays.
 - e. Control Power: 120 VAC, single phase, 60 Hz.
 - f. Housing Material: NEMA 4X.
 - g. Hazardous Classification. Rated for installation in a Class 1, Division 2 location by manufacturer.
 3. Provide mounting hardware to mount controller on existing handrail unless otherwise indicated on contract drawings. Mounting hardware shall be 316 stainless steel.
- C. Accessories
1. Automatic air cleaning kit

PART 3 - EXECUTION

3.1 EXAMINATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

3.2 INSTALLATION

- A. See Section 40 70 00 – Instrumentation for Process Systems for requirements.

3.3 FIELD QUALITY CONTROL

- A. Testing:
1. Test probe to demonstrate that it meets specified accuracy requirements.
- 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. Dissolved Oxygen Probes Schedule:

Instrument Tag	Application	Measurement Range
50AIT101	North Digester Tank 1	0-10 mg/L
50AIT401	South Digester Tank 1	0-10 mg/L
50AIT201	North Digester Tank 2	0-10 mg/L
50AIT501	South Digester Tank 2	0-10 mg/L
50AIT301	North Digester Tank 3	0-10 mg/L
50AIT601	South Digester Tank 3	0-10 mg/L

END OF SECTION

SECTION 40 75 56 – TOTAL SUSPENDED SOLIDS METERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification section covers the work necessary to furnish all materials for complete and operable total suspended solids monitoring systems.
- B. All meter components shall be of the same manufacturer to obtain standardization of performance, operation, spare parts, maintenance and manufacturer's services.
- C. Section Includes:
 - 1. Total Suspended Solids Meters
 - 2. Transmitters
- D. Related Requirements:
 - 1. Section 40 70 00 – Instrumentation for Process Systems

1.2 GENERAL

- A. 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 services.
- B. Unit Responsibility: The Work requires that the suspended solids monitoring system, complete, with all accessories and appurtenances be the end product of one responsible system manufacturer or system supplier. The supplier shall furnish and/or coordinate all components and accessories as necessary to place equipment in operation in conformance with the specified performance, features, and functions indicated.

1.3 SUBMITTALS

- A. Submittals shall be made as required in Section 01 33 00, SUBMITTALS of Division 01, GENERAL REQUIREMENTS.
 - 1. Shop Drawings:
 - a. Make, model, and weight of each equipment assembly.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Detailed mechanical and electrical drawings showing the equipment dimensions, size, components, and locations of connections.
 - d. Power and control wiring diagrams, including terminals and numbers.
 - 2. Manufacturer's Instructions: Written or published information that documents Manufacturer's recommendations, guidelines, and procedures for receiving, storing, installing, operating, and maintaining the suspended solids meter and accessories.
 - 3. Quality Control Submittals:
 - a. Special shipping, storage and protection, and handling instructions.
 - b. Manufacturer's printed installation instructions.
 - c. Manufacturer's Certificate of Proper Installation.
 - d. Unit Process Start-Up Form.
 - e. Suggested spare parts list to maintain the equipment in service for a period of 2 year and 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.

1.4 OPERATIONAL AND MAINTENANCE DATA

- A. The Manufacturer/Supplier shall be responsible for supplying written instruction, which shall be sufficiently comprehensive to enable the operator to service and operate the meter and all equipment supplied by the manufacturer.
- B. Operation and maintenance instruction shall be specific to the equipment supplied in accordance with these specifications. Instruction manuals applicable to many different configurations and meters, and which require the operator to selectively read portions of the instructions shall not be acceptable.
- C. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.
- D. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.5 DELIVERY, STORAGE, HANDLING

- A. Equipment shall be delivered to the Contractor completely factory assembled. Individual equipment components shall be crated in structurally adequate packing containers to prevent damage during shipping, facilitate easy handling, and to provide suitable protection from weather for extended storage at the jobsite prior to installation. Packing containers shall be permanently labeled with appropriate equipment identification, shipping address, and return address. Packing list shall be provided with equipment at time of delivery.
- B. Electrical equipment shall be kept thoroughly dry at all times and shall be stored indoors. Equipment storage shall be protected and maintained in accordance with the manufacturer's recommendations. Equipment shall not be stored directly on the ground.
- C. The Contractor shall utilize equipment and tools of adequate size suitable for unloading, transporting, storing and supporting the equipment during installation. Caution shall be employed to prevent equipment damage resulting from abrupt contact with other materials or equipment.
- D. Care shall be taken to observe all manufacturer recommended storage procedures for sensors prior to project completion, such as if sensor must be unsubmerged for a period of time post-installation, to avoid damage to instrument.

1.6 WARRANTY

- A. The manufacturer shall warrant the equipment to be of quality construction, free from defects in materials and workmanship. The warranty shall become effective upon acceptance by the Owner or Owner's authorized agent.
- B. The equipment, apparatus, and parts furnished shall be warranted for a period of one (1) year, excepting only those items that are normally consumed in service, such as fuses, oil, grease, packing, gaskets, O-rings, etc. The manufacturer shall be solely responsible for the warranty of the equipment and all components.
- C. Upon request from the Engineer and/or the Owner, the manufacturer shall demonstrate proof of financial responsibility with respect to performance and delivery date. In addition, the manufacturer shall provide proof of evidence of facilities, equipment, and skills required to produce the equipment specified herein and provide technical service and replacement parts.

- D. Components failing to perform as specified by the Engineer, or as represented by the manufacturer, or proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the Owner.
- E. The manufacturer shall provide an application performance guarantee with submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The suspended solids meters furnished under this contract shall be as manufactured by:
 - 1. Hach Company Solitax HS-Line
 - 2. Approved Equal
- B. Approval for an equivalent suspended solids meter will be considered if the proposed equivalent meter meets the specifications as described herein and an actual one (1) week on-site meter demonstration is performed. The manufacturer shall submit the total suspended solids data collected during the one (1) week demonstration to the Engineer and Owner for review and consideration.

2.2 DESCRIPTION

- A. Suspended Solids Sensor
 - 1. The suspended solids sensor shall be an immersion type sensor.
 - 2. The sensing element shall emit infrared light to be detected by nephelometric and backscatter photoreceptors as the main principle of operation.
 - 3. Sensor face shall include an integrated wiper for self-cleaning.
 - 4. Measurement units shall be user-selectable and offer the following options:
 - a. g/L
 - b. mg/L
 - c. ppm
 - d. % solids
 - 5. Range: 0 to 50 g/L
 - 6. Accuracy: < 1% of measured value with calibration.
 - 7. Response Time: $1s < T_{90} < 300s$
 - 8. Repeatability: < 3%
 - 9. Instrument cables shall be provided by manufacturer. Length as required for termination to transmitter/controller. See contract drawings for individual sensor and transmitter locations.
 - 10. Sensor shall be installed using manufacturer-provided pole mount kit. Any additional mounting hardware shall be 316 stainless steel.
 - 11. Calibration method shall be sample specific, based on gravimetric TSS analysis with a correction factor procedure.
- B. Universal Transmitter/Controller
 - 1. When provided from the same manufacturer, controller shall be shared with other similar measurement devices including Dissolved Oxygen (DO).
 - 2. Sensor shall be provided with a universal transmitter/controller to provide local indication of monitored total suspended solids readings, and to communicate readings to SCADA.
 - 3. Controller shall be capable of communicating with multiple analog or digital process instruments.
 - 4. Controller shall have at least two sensor channels.
 - 5. Display shall be LCD with LED backlighting and a resolution of 240 x 160 pixels.
 - 6. Operating Range Temperature Range: -20 to 60 °C, 0 to 95% relative humidity (non-condensing).
 - 7. Controller shall have at least two configurable 4-20mA analog outputs.

8. Controller enclosure shall have NEMA 4X rating and be capable of installation in a Class 1, Division 2 environment.
9. Controller shall include four configurable electromechanical SPDT relay outputs.
10. Provide any necessary mounting hardware to mount controller at locations depicted on contract drawings. Mounting hardware shall be 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall assume full responsibility for coordination of the entire project, including verification that all electronic systems and equipment components are compatible. The general contractor shall initially operate each equipment system, and shall make all necessary adjustments so that each system is placed in proper operation condition.
- B. Equipment and materials utilized or supplied for this project must be approved by the Engineer prior to installation. Approval for installation or incorporation in this project will be made only after submittal of manufacturer's shop and installation drawings, test results, or other data as required and as specified herein.
- C. Installation of equipment shall be in full conformance with the manufacturer shop drawings and requirements as approved by the Engineer. Wherever a conflict arises between manufacturer's instructions and the contract documents, the contractor shall follow the Engineer's decision at no additional cost to the owner.

3.2 WORKMANSHIP

- A. The Contractor shall install equipment and materials furnished under this bid in a workmanlike manner, utilizing craftsmen skilled in the particular trade. The finished installation shall portraint a neat, plumb and clean appearance.

3.3 MANUFACTURERS SERVICES

- A. Provide the services of a representative of the meter manufacturer to assist in adjusting and testing the equipment, supervising initial operation, and assisting in making final adjustments and the tests specified. This may be necessary to assure the Engineer and Owner that the equipment is in satisfactory operating conditions. This service shall be a minimum of one (1) trip, each consisting of one (1) four (4) hour day on the jobsite.
- B. See Section 01 60 00, PRODUCT REQUIREMENTS, and Section 01 79 00, DEMONSTRATION AND TRAINING.
- C. Provide MANUFACTURER's Certificate(s) in accordance with DIVISION 01, GENERAL REQUIREMENTS.

3.4 ATTACHMENTS

- A. Total Suspended Solids Meter Schedule:

Sensor Tag	Transmitter Tag	Application	Measurement Range
50AE102	50AIT102	North Digester Tank 1 Total Suspended Solids	0 – 25000 mg/L
50AE402	50AIT402	South Digester Tank 1 Total Suspended Solids	0 – 25000 mg/L
50AE202	50AIT202	North Digester Tank 2 Total Suspended Solids	0 – 25000 mg/L

50AE502	50AIT502	South Digester Tank 2 Total Suspended Solids	0 – 25000 mg/L
50AE302	50AIT302	North Digester Tank 3 Total Suspended Solids	0 – 25000 mg/L
50AE602	50AIT602	South Digester Tank 3 Total Suspended Solids	0 – 25000 mg/L

END OF SECTION

DIVISION 43
PROCESS GAS AND LIQUID HANDLING,
PURIFICATION AND STORAGE EQUIPMENT

SECTION 43 11 33 – POSITIVE DISPLACEMENT BLOWER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Work necessary to completely furnish, install, put into operation, and test the positive displacement blowers as shown on the drawings and as specified herein, including all related equipment, variable frequency drives and local control panels, materials, and appurtenances.

B. Related sections:

1. Section 05 50 00 – Metal Fabrications
2. Section 09 96 00 – High Performance Coatings
3. Section 26 29 23 – Variable-Frequency Motor Controllers
4. Section 40 05 06 – Process Piping Specialties
5. Section 40 05 51 – Common Requirements for Process Valves
6. Section 40 67 23 – Control Panels

C. Unit Responsibility:

1. The Work requires that the Blower Package, consisting of the hybrid positive displacement blowers and components complete with all accessories and appurtenances is provided and installed, including but not necessarily limited to:
 - a. Hybrid positive displacement blowers
 - b. Inlet filter/silencer
 - c. Discharge silencers
 - d. Structural stands
 - e. Relief valves
 - f. Flexible pipe connectors
 - g. Check valves
 - h. Premium efficiency motors
 - i. Air filter maintenance gauges
 - j. Pressure gauges
 - k. Temperature gauges
 - l. V-belt or Direct drive
 - m. Butterfly valves in blow off circuit
 - n. Individual acoustical enclosures, complete with acoustical vents, filters, differential pressure gauge, enclosure ventilation and associated instrumentation
 - o. Vibration isolators
 - p. Discharge pressure switch
 - q. Variable Frequency Drives
 - r. Local Control Panels
 - s. Appurtenances as required

- D. The Contractor will be responsible for supplying the Blower Package. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment. The Contractor 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 shall be responsible to the Owner for providing the complete and functional Blower Package as specified herein.

- 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.

1.2 SUBMITTALS

- A. Subject to the requirements of Section 01 33 00 – Submittal Procedures.
- B. Shop Drawings:
 - 1. Make, model, weight, and horsepower of each component.
 - 2. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
 - 3. Detailed mechanical and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and details of anchorage and of connections to other work, and weights of associated equipment.
 - 4. External utility requirements (quantity and connection details) such as air, water, power, drain etc., for each component.
 - 5. Motor nameplate data, motor manufacturer, and any motor modifications.
 - 6. Wiring diagrams for motors, including terminals and numbers.
 - 7. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
 - 8. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
 - 9. Instrumentation and Control Submittals: In conformance with Division 26 – Electrical.
- C. Quality Control Submittals:
 - 1. Manufacturer's Certificate of Compliance: Commercial products, including painting/coating systems.
 - 2. Special shipping, storage and protection, and handling instructions.
 - 3. Test procedures.
 - 4. Test results, reports, and certifications.
 - 5. Manufacturer's Certificate of Proper Installation.
 - 6. Operation and maintenance manual.
- D. Noise Control:
 - 1. Sound pressure levels radiated from equipment furnished shall not exceed 80 dbA (mean, A-weighted) at 3 ft. ($RE\ 2 \times 10^{-5}\ N/m^2$) for free field condition when specified units are in operation.
 - 2. Sound Pressure Level Measurements: Take measurements at 6 points, 3 ft. from acoustic enclosure, with piping and silencers installed, at the following locations:
 - a. 1 point at each end of unit.
 - b. 2 points on either side of unit at approximate midpoints of motor and blower casings.
 - 3. Run certified acoustic tests on each blower at place of manufacture and submit 4 certified copies of test results for each blower to Engineer before shipment.
 - 4. Ship blowers after Engineer has approved noise certification.
- E. Provide instrumentation and alarms as indicated on the P&ID Drawings and as specified in Division 26 – Electrical.
- F. Contract Closeout Submittals:
 - 1. Service records for maintenance performed during construction.

1.3 QUALITY CONTROL

- A. Balancing:
 - 1. Rotating elements of equipment, except small, commercially packaged equipment, shall be statically and dynamically balanced at the factory prior to final assembly. The Contractor shall furnish certified copies of all test results.

1.4 OPERATION AND MAINTENANCE DATA

- A. O&M Manuals:
 - 1. Content, format, and schedule for providing as specified in Section 01 77 00 – Closeout Procedures.
- B. Maintenance Summary Forms:
 - 1. As specified in Section 01 77 00 – Closeout Procedures.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 60 00 – Product Requirements.
- B. Delivery of Materials:
 - 1. Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.
- C. Storage:
 - 1. Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.
- D. Protection of Equipment:
 - 1. Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be always kept thoroughly dry. Pumps, motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings shall be stored in weathertight and heated storage facilities prior to installation. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

1.6 WARRANTY

- A. Provide 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. Spare parts identified within this specification shall not be used to address warranty repairs.
- C. See Section 01 78 36 – Warranties and Bonds for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. 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.
- B. 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.

- C. Third party blower packagers must be preapproved by Engineer prior to bid. No substitutions will be allowed after bid opening.
- D. Approved Manufacturers:
 - 1. Aerzen
 - 2. Gardner Denver.
 - 3. Universal Blower PAC.
 - 4. Atlas Copco.

2.2 GENERAL REQUIREMENTS

- A. Service Factors:
 - 1. Service factors shall be applied in the selection and design of components where so indicated in individual sections. When not indicated there, minimum service factors shall be 1.25.
- B. Safety Devices:
 - 1. The completed work shall include all necessary permanent safety devices, such as machinery guards, emergency stops and similar items required by OSHA, and other federal, state, and local health and safety regulations. Provide screens or guards at exposed rotating shafts, rotors, couplings, pulley, wheel, bolts, chains, or similar components.
- C. Flanges and Pipe Threads:
 - 1. 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.
- D. Bearings:
 - 1. Conform ABMA (American Bearing Manufacturers Association, Inc.).
 - 2. Except where otherwise specified, bearings of process equipment shall have a minimum L-10 life expectancy of 100,000 hrs.
- E. Lifting Lugs:
 - 1. Provide for equipment components over 100 lbs.
- F. Anchor Bolts:
 - 1. Provide type 316 stainless steel anchor bolts, number and size as recommended by manufacturer.
- G. Nameplates:
 - 1. 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, characteristics, and appropriate data describing the machine performance ratings.

2.3 SUPPLEMENTS

- A. See supplements to this Section for additional equipment system product, component, or accessory information.

2.4 SERVICE CONDITIONS

- A. See Supplemental Data Sheets for this Section.

2.5 SYSTEM PERFORMANCE AND FUNCTIONAL REQUIREMENTS

- A. See Supplemental Data Sheets following this Section.
- B. The blowers shall be hybrid rotary positive displacement type, belt driven by a horizontal electric motor. Blowers shall have two helical screw impellers rotating in opposite directions in a common casing. Impellers shall be positioned by timing gears to maintain proper clearances. Impellers and timing gears shall be mounted on shafts supported by antifriction bearings. Blower systems shall be provided with combination inlet and outlet silencers designed for mounting of blower and motor.

2.6 EQUIPMENT AND/OR MATERIALS

- A. Blower:
 - 1. Materials shall be manufacturer's standard for the intended service unless otherwise specified herein.
 - 2. The blower casing shall be a one-piece construction with separate head plates and shall be close grain cast iron strongly ribbed to prevent distortion at the specified operating conditions.
 - 3. The impellers shall be ductile or cast iron and shall be three fluted helical screw type and shall operate without rubbing, liquid seals or lubrication.
 - 4. The impellers shall be positively timed by a pair of accurately machined heat-treated alloy timing gears.
 - 5. The shafts shall be ductile iron, integrally cast with the impeller, or shall be stainless steel.
 - 6. Each shaft and impeller assembly shall be supported by cylindrical or spherical roller bearings sized for a minimum B-10 rating for 100,000 hrs.
 - 7. The bearings and gears shall be splash lubricated.
 - 8. Baseplate shall be cast iron or fabricated steel, with grout holes, reinforced to withstand anticipated loadings. Factory-mount blower and motor.
 - 9. Anchor bolts shall be specified in Section 05 50 00 – Metal Fabrications. Number and size as recommended by manufacturer.
- B. Motor:
 - 1. See Supplemental Data Sheets following this Section.
- C. Accessories:
 - 1. Blower inlet and discharge silencers shall be designed specifically to reduce pulsations from rotary lobe blowers at the blower operating timing gear speed. For timing gear speeds below transition speeds, use a multi-chambered reactive type of silencer and for timing gear speeds at or above transition speed, use a multi-chambered reactive and absorptive type silencer packed with copper wool or hairfelt packing. Inlet velocities shall not exceed 5,700 ft. per minute and outlet air velocities shall not exceed 7,000 ft. per minute. Inlet and outlet flanges shall match the piping size as shown on the Drawings and the blower flanges. Flange drilling shall be 125 lb. ANSI standard. Provide drain coupling and plug. Outlet flange height shall meet the installation requirements as specified in Drawings. The inlet silencers and discharge silencers shall be provided by the blower manufacturer.
 - 2. Inlet Filter:
 - a. Paper cartridge style or 2-Stage pleated media type, minimum 24 in. by 24 in. by 2 in. each, using replaceable pleated lofted fiber elements with final media efficiency of not less than 45% per ASHRAE Standard 52-76, with resettable tell-tale "replace filter" indicator for each filter, housed in a weather-protected hood.
 - 3. Silencers:
 - a. Manufacturers (Choose ONE):
 - 1) Burgess-Manning, Model BMSI, BMSS.

- 2) Progentex Inc., Series DRS.
- 3) Universal AET, Series RD, SD, RIS.
- 4) Stoddard Series L/C21, D13, D32/33.
- b. Construction: Welded steel.
- c. Discharge Silencer: Furnished with copper wool or hairfelt packing absorption material.
- d. Silencers Sizing: For design conditions and specifically designed for use with positive displacement blowers, size as indicated on the Drawings unless a larger size is recommended by the manufacturer.
- e. Mounting of Silencers: As specified in Drawings.
- f. Minimum Noise Attenuation of Silencers:

Octave Band Center Frequency (Hertz)	Attenuation (dbA)
63	18
125	23
250	27
500	31
1,000	31
2,000	29
4,000	25
8,000	21

4. Blowers shall be provided with flexible connectors at the inlet and outlet flanges. Flexible connectors shall be pressure spool single arch expansion joint type with 125 lb. ANSI flange and retaining rings. Flexible connectors shall be rated for 300°F operating temperature and as specified in Section 40 05 06 – Process Piping Specialties.
5. Air Safety Relief Valves:
 - a. Shall be supplied and installed by the Manufacturer for each blower, as specified in this section.
 - b. Shall be mounted on each blower's discharge.
 - c. Shall be located within the blower's acoustical enclosure.
 - d. See Section 40 05 51 – Common Requirements for Process Valves.
 - e. Relief Valve:
 - 1) High-capacity, full-nozzle type; 3 in. minimum valve inlet, sized to relieve full blower capacity with 1% accumulation; 10 psi gauge set pressure.
 - 2) Manufacturers:
 - a) Kunkle Valve Co.
 - b) Or engineer approved equal.
6. A NEMA 12 terminal junction box (TJB) shall be supplied and mounted on the blower skid. These devices shall be prewired to the TJB:
 - a. motor temperature sensors associated with each phase (A, B, C) of the motor windings.
7. For each blower, provide a NEMA 4 discharge pressure switch to be installed in the discharge piping and located within the blower's acoustical enclosure. Each pressure switch shall have an adjustable range of 0 psig – 15 psig and shall be set lower than the relief valve setting. The trip point repeatability shall be better than 1% of actual pressure. The contact will close to shut down the blower, and the rating shall be 10 amps at 120 V. Each pressure switch is to be provided by the blower manufacturer.
8. A direct drive or V-belt drive shall be included with each blower package. If applicable, the drive shall take up rails and be provided as part of the package. The service factor for the drive shall be a minimum of 1.6 under maximum load conditions. The drive shall be covered by a belt guard as specified in OSHA standards.
9. Vibration isolation pads shall be provided for each blower as recommended by the blower manufacturer.

10. An acoustical enclosure shall be provided for each blower. The enclosure shall be weatherproof, suitable for installation outdoors, and designed to guarantee 80 dBA or less in the free field. The enclosure outer material shall be zinc coated steel with a powder coat finish of 50 – 100 microns dry film thickness. The enclosure shall include a vent system and no less than two (2) removable panels for easy access and maintenance. The ventilation system shall be an internal high efficiency system designed to maintain the temperature inside the enclosure at not more than 10°F above the ambient temperature. Temperature and associated controls shall be provided to control operation of the enclosure's ventilation system. Panels are to be lined with acoustic-grade foam with sufficient thickness to provide the required sound attenuation. The acoustical enclosure shall be provided by the blower manufacturer.
 - a. Galvanized sheet-metal construction.
 - b. With noise attenuating walls and with ventilation openings ported, ducted, shielded, and lined with acoustic absorptive material as required to achieve specified noise levels.
 - c. Rain-tight and dust-tight, suitable for outdoor unprotected installation.
 - d. With ventilation system designed for not more than 10°F air temperature rise with aeration blower operating at maximum load.
 - e. With fan interlocked with blower motor to start when blower starts and to stop with an adjustable time delay after the blower motor stops.
 - f. With a Weather-protected Ventilation Air Intake Filter:
 - 1) Of disposable, dry type, pleated lofted cotton and polyester fiber media construction securely bonded to a welded galvanized wire backing with a frame of heavy-duty paperboard.
 - 2) Sized for not more than 400 ft per minute face velocity.
 - 3) With ASHRAE Standard 52-76 cleaning efficiency of not less than 25%.
 - 4) With thickness not less than 2 in.
 - 5) With an easily visible and resettable "replace filter" indicator with retained indication independent of blower on/off status.
 - g. With removable access panels located for maintenance and inspection access to the housed equipment, each weighing no more than 40 lbs, or hinged if weight exceeds 40 lbs.
11. Butterfly Valves:
 - a. Constructed as specified in Division 40 – Process Integration.
 - b. Lined with 10 mils of epoxy suitable for temperatures to 250°F.
 - c. Sealed with EPDM seals suitable for temperatures of 250°F.
12. Check Valves:
 - a. A discharge check valve shall be provided for each blower.
 - b. The check valve shall be suitable for low pressure air service.
 - c. Check valve shall be dual disc, wafer style with torsion spring induced closure with a cracking pressure of 0.25 psig.
 - d. See Section 40 05 51 – Common Requirements for Process Valves for more information.
 - e. Valve manufacturers:
 - 1) Val-Matic.
 - 2) DeZurik.
 - f. Valve Components:
 - 1) Valve body: ASTM A536 ductile iron, Steel for NPT, or Cast-Iron wafer style.
 - 2) Disc: ASTM B 584, Alloy C83600 cast bronze or aluminum.
 - 3) Spring: Air Service Series 8900W, ASTM A276, Type 316 stainless steel.
 - 4) Pins and Thrust Bearings: ASTM A276, Type 316 stainless steel.
 - 5) Seals, Viton or EPDM rated for minimum 250°F.
13. Pressure Gauges:
 - a. Liquid filled case with minimum 4 in. dial face:

- b. Type on Suction Side of Blower: Vacuum gauge calibrated in inches of water.
 - c. Type on Discharge Side of Blower: Pressure gauge calibrated in psig.
 - d. A suitable tee handled corporation stop or ball valve and snubber shall be installed between each gauge and connection to air piping.
- 14. Switches:
 - a. High Discharge Pressure Switch:
 - 1) As recommended by blower manufacturer
 - 2) Activation illuminates an alarm and shuts down the blower.
- 15. Other Safety Devices and Controls:
 - a. As recommended by blower manufacturer.

2.7 ELECTRICAL COMPONENTS AND ACCESSORIES

- A. General:
 - 1. Conform with Division 26 – Electrical.
 - 2. Provide all necessary electrical components and wiring for a complete, functional system.
 - 3. All electrical equipment and appurtenances shall be designed and constructed for continuous outside exposure.
- B. Wiring:
 - 1. The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall be as specified in Division 26 – Electrical, and NFPA 70. Insulation shall be rated 600 V, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.
- C. Electrical Raceways:
 - 1. Electrical wiring shall be installed in conduit meetings as specified in Division 26 – Electrical.
 - 2. Raceways shall be installed as specified in NFPA 70 and Division 26 – Electrical.
- D. Motors:
 - 1. Provide squirrel-cage ac induction motors as specified in this section and Division 26 – Electrical.
 - 2. For additional requirements, refer to the Motor Data Sheets at END OF SECTION.
- E. Variable Frequency Drives:
 - 1. Provide Variable Frequency Drives for each blower, in accordance with the Drawings and requirements of Specifications Division 26 – Electrical.

2.8 INSTRUMENTATION AND CONTROLS

- A. All instrumentation and control components shall be provided as specified in Division 26 – Electrical and Division 40 – Process Integration.
- B. Provide Local Control Panels for each blower, in accordance with the Drawings and requirements of Specifications Division 26 – Electrical and Division 40 – Process Integration.

2.9 TOOLS AND SPARE PARTS

- A. Tools:
 - 1. The work includes one complete set of special tools recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in

toolboxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts:

1. All equipment shall be furnished with the specified manufacturers spare parts, as indicated in the individual equipment sections.
2. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 lbs. and dimensions less than 2 ft wide, or 18 in. high, or 3 ft in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.
3. Provide, at a minimum, the following spare parts for the equipment:
 - a. One complete set of any special tools required to dismantle the blowers
 - b. Complete set of gaskets and O-ring seals
 - c. Complete set keys, dowels, pins, etc. for each blower
 - d. One complete set of bearings
 - e. 4 complete sets of ventilation and air intake filters
 - f. 4 lubrication oil filter cartridges (if required)
 - g. 3 sets of drive belts
 - h. 3 sets of enclosure filters
 - i. One uninstalled enclosure fan

2.10 FABRICATION

A. Shop Assembly:

1. The system shall be factory assembled and tested.

B. Shop/Factory Finishing:

1. Shop prime and final coatings shall conform to Section 09 96 00 – High Performance Coatings, System No. 4. Blower manufacturer may submit acceptable data for the Engineer's review and possible acceptance that illustrates the Blower Manufacturer's standard shop prime and shop final coatings meet Section 09 96 00 – High Performance Coatings, System No. 4. If the submitted data is deemed unacceptable by the Engineer as non-equivalent quality, the Blower Manufacturer will be required to submit and install the specified System No. 4.

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordination shall include space and structural requirements, clearances, utility connections, signals, outputs, and features required by the manufacturer including safety interlocks.

3.2 ASSEMBLY AND PREPARATION FOR SHIPMENT

- A. Each drive unit, including motor, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as shafts, baseplates, impellers, spare parts, and anchorage materials, shall be separately crated, clearly marked as to the contents, and shipped on the same shipment as the drives.

- B. For shipment, exposed surfaces subject to rust, such as mounting flange faces, etc., shall be covered with a rust-preventive compound:
 - 1. Kendall No. 5
 - 2. Or Approved Equal.

3.3 FIELD QUALITY CONTROL

- A. Functional Testing:
 - 1. Prior to plant startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test. Provide certification of test results. Tests and certification shall be as specified in Section 01 75 00 – Startup Testing and Training.

3.4 INSTALLATION

- A. As shown on the Drawings. All anchors, bolts, and accessories shall be 316 stainless steel. The manufacturer shall provide templates for anchor bolt locations.
- B. Lubricants:
 - 1. Include oil and grease for initial operation.
- C. Blower and Driver Installation:
 - 1. Install as specified in Manufacturer's recommendations. Mount blower, motor, and silencer as specified in Drawings. The size of the concrete bases shall be determined by the dimensions of the blower, motor, and silencer and shall be at least 12 in. wider and longer than the equipment package and in accordance with the details shown. Bolts shall be accurately placed with templates. Coat bolt thread projections with lubricant to facilitate future nut removal.
 - 2. Level base by means of steel wedges (steel plates and steel shims). Wedge taper shall not be greater than 1/4 in/ft. Use double wedges to provide a level bearing surface for the blower and driver base. Secure each pair of wedges in their final positions with one tack weld on each side after leveling is complete. Accomplish wedging so that there is no change of level or springing of the baseplate when the anchor bolts are evenly snugged tight.
 - 3. Adjust blower assemblies such that the driving units are properly aligned, plumb, and level within blower manufacturer's tolerances with the driven units and all interconnecting shafts and couplings so that a proper hot alignment results. Flexible couplings shall not be considered to compensate for misalignment.
 - 4. After the package has been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, non-shrinking grout of the proper category, as required. After grouting is fully hardened, fully tighten all foundation bolts.
 - 5. All strain from attached piping shall be eliminated from the blower and any evidence of blower or driver misalignment, noisy operation, or other signs of improper setting shall be corrected by the Contractor. Blower and drivers shall be doweled to the baseplates after final alignment has been checked under operating conditions. Care during storage, installation, and lubrication shall be as specified in the manufacturer's recommendations.

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.

B. See Section 01 75 00 – Startup Testing and Training.

3.6 MANUFACTURER'S CERTIFICATES

A. Provide as specified in Section 01 75 00 – Startup Testing and Training.

3.7 SUPPLEMENTS

A. The datasheets require for this section, are list after the END OF SECTION.

END OF SECTION

North Storm Pond Blowers

PROJECT: Moore WWTP North Storm Pond Improvements
 OWNER: City of Moore
 EQUIPMENT NAME(S): North Storm Pond Blower #1-3
 EQUIPMENT TAG NUMBER(S): 66B001, 66B002, 66B003

MANUFACTURERS

MODEL

<u>Aerzen</u>	
<u>Gardner Denver</u>	
<u>Atlas Copco</u>	
<u>Universal Blower PAC</u>	<u>ATTENU-PAC Blower</u>

SERVICE CONDITIONS

PERFORMANCE REQUIREMENTS

Relative Humidity: <u>80</u> %	Max. Design Capacity: <u>4421</u> scfm
Ambient Temp: <u>100</u> °F	Max. Rated Discharge Pressure: <u>7.1</u> psig
Ambient Pressure: <u>14.7</u> psia	Discharge Connection: <u>12</u> inches

EQUIPMENT DESCRIPTION

Blower Type: <u>Positive Displacement</u>	Casing: <u>Cast Iron</u>
Number of Impellers: <u>2</u>	Integral Ductile Iron or
	Shaft: <u>Steel</u>
	Helical Screw or Hybrid
Timing Gears: <u>Alloy Steel</u>	Impellers: <u>Lobe</u>
Bearings: <u>Cylindrical or Spherical Roller</u>	Lubrication: <u>Oil</u>
Max. Discharge Temperature: <u>217</u> °F	Drive Type: <u>V-belt or Direct Drive</u>
Impeller Const.: <u>Cast or Ductile Iron</u>	Service Factor: <u>1.6</u>
Mounting Type: <u>Baseplate</u>	Brg Life (B-10): <u>100,000 hrs</u>

MOTOR DATA

Type: Squirrel-cage induction meeting requirements of NEMA MG1.
 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 (Max): 250 hp

Voltage: 460 V

Phase: 3

Max. Synchronous Speed: 2404 rpm

Enclosure Type: TEFC

Mounting Type: ☒ Horizontal ☐ Vertical

Load Class: Variable Torque

☐ Multispeed, Two Speed: _____ rpm

☒ Variable Frequency Motor Controller: See Division 26 – Electrical.

Winding: ☒ One ☐ Two

Service Factor: ☒ 1.0 ☐ 1.15

Motor nameplate horsepower shall not be exceeded at any operational point.

Additional Motor Requirements: See Section 26 05 93 – Electric Motors

Provide: ☒ Space Heater ☒ Oversize main terminal (conduit) box for motors

Shaft: ☐ Split ☐ Hollow

Upthrust: ☐ High (< 30%) ☐ Extra High (<175%)

SPECIAL FEATURES/NOTES
Provide combination inlet and outlet silencer for mounting blower and motor as specified. Provide air filter rated for outdoor installation. Provide acoustical enclosure. Maximum pressure loss through blower enclosure (inlet/discharge silencer included) is 0.5 psig at blower capacity.

END OF SECTION

SECTION 43 31 83 – ADJUSTING AND BALANCING ODOR CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Adjusting and balancing of the existing odor control system at the Headworks Building and Digester facility.
- B. Section does not include:
 - 1. Testing, adjusting, or balancing any building heating, ventilation, air conditioning, refrigeration, hydronic or any other systems.
 - 2. Adjusting and balancing of existing odor control systems at facilities other than the Headworks Building and Digester facility unless specifically noted otherwise.
- C. Performance testing of odor control equipment is specified in the specification sections pertaining to that equipment.
- D. An initial balance shall be made to facilitate odor control startup and a final balance made after all equipment is started and functioning.

1.2 REFERENCES

- A. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." (for NEBB Agencies)
- B. AABC "National Standards for Total System Balance" and "Test and Balance Procedures" (for AABC Agencies).
- C. ASHRAE Handbook, Latest Edition

1.3 SYSTEM DESCRIPTION

- A. The existing odor control system was in place and online in April 2013. There is one existing blower with a second redundant blower. There are two 50 HP blowers (1+1 standby), each rated for 20,000 CFM with a total design static pressure of 8.92 in. W.C. This project includes modifications to the odor control duct work and a new makeup air unit to supply 20,000 CFM to the Headworks Building.

1.4 QUALITY ASSURANCE

- A. Agency Qualifications:
 - 1. The Agency performing the adjusting and balancing shall be regularly engaged in the practice of testing, adjusting and balancing ventilation systems. Experience in adjusting and balancing odor control systems is preferred but is not a requirement.
 - 2. The Agency and personnel performing the adjusting and balancing shall be certified by one of the following:
 - a. National Environmental Balancing Bureau (NEBB); or
 - b. Associated Air Balance Council (AABC)
- B. Comply with the following:
 - 1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." (for NEBB Agencies).

2. AABC "National Standards for Total System Balance" and "Test and Balance Procedures" (for AABC Agencies).
3. Recommendations in the latest ASHRAE Handbook.

1.5 SUBMITTALS

- A. Qualification Data: Submit documentation of the balancing agency showing certification (NEBB or AABC) of agency and personnel.
- B. Submit information describing the personnel, and instruments to be used.
- C. Submit a sample report containing, at a minimum:
 1. Name, address and phone number of Agency.
 2. Identify the Owner, Contractor, Engineer and Project on an inside cover sheet.
 3. Site drawing noting locations where measurements will be taken. Copies of the construction drawings may be used for this purpose provided any field changes to duct systems have been incorporated.
 4. Sample forms to include the following at a minimum:
 - a. Duct traverse reporting form (to include final damper position settings)
 - b. Blower data reporting form (to include speeds and differential pressures)
 - c. Forms to report damper positions
 5. Systems readiness checklists.
- D. Reports: Submit testing, adjusting, and balancing reports after completion of testing. The reports shall document that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems.

1.6 PROJECT CONDITIONS

- A. All odor control ductwork modifications shall be completed and the new makeup air system shall be installed and started prior to beginning balancing, including installation of all media.
- B. Covered channels basins shall be filled to their normal operating levels and any equipment in the basin shall be operating.
- C. Contractor shall coordinate the requirements of this specification with the startup and testing requirements of the new makeup air unit system. A final balance shall be made after all equipment is started and functioning.

PART 2 - PROCEDURES

2.1 MISCELLANEOUS

- A. Contractor shall supply additional sheaves and belts for all fans as required to make adjustments to blowers, either existing or new. Sheaves shall be new and shall be of the type and material as recommended by the manufacturer (Hartzell) of the blower.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with the project requirements. Notify Engineer of any conditions that might prevent accurately balancing the system.
- B. Examine the system for dampers, fans, equipment and locations for making measurements. Verify systems have been lubricated and greased, that belts are aligned and tight, and that odor control systems are functioning. Mark on the duct the proposed locations for measuring airflows and pressures.
- C. Examine the equipment data including fan performance curves. Do not operate fans "off the curve" or against a closed damper. Examine fan and odor control equipment installation and startup reports.

3.2 PREPARATION

- A. Prepare system readiness checklists that include the following at a minimum:
 - 1. Ductwork is complete with all connections made.
 - 2. Dampers are installed and functioning.
 - 3. Fans are operable, free of vibration and rotating in the correct direction.
 - 4. Building HVAC systems are installed, functioning and balanced (if required elsewhere in the documents).
 - 5. Access for taking measurements is present.
- B. Perform readiness checks before adjusting and balancing the system.

3.3 GENERAL PROCEDURES FOR ADJUSTING AND BALANCING

- A. Perform full duct traverses in at least two directions for each location.
- B. Drill holes in duct to measure pressure and flow at the selected location. Holes shall be no larger than needed to insert tube or probe into the duct and shall be plugged upon completion of testing.
- C. Open all dampers in the system to their full open position.
- D. Start odor control fans and adjust inlet vane dampers until fans are producing the specified air flow. Report inlet and exhaust static pressures. Fan adjustment, if needed, shall be by Contractor and fan manufacturer.
 - 1. Adjust fan by replacing sheaves and belts to achieve the specified airflow if the specified airflow cannot be achieved by adjusting the inlet vane dampers. Adjustable sheaves shall not be used.
 - 2. Not all fans have inlet vane dampers; fans without inlet vane dampers shall be adjusted by adjusting other dampers in the foul air collection system or by replacing sheaves and belts.
- E. Adjust balancing dampers to until specified air flows are present in the ducts.
- F. After all dampers have been adjusted repeat airflow measurements at all locations. Adjust damper positions until specified airflow is achieved. Repeat measurements until two consecutive measurements differ by less than 2%. Report final airflows only; preliminary and interim airflows are not to be included in the report.

- G. System shall be balanced to within 3% of the specified air flows.
- H. Mark damper positions at final set points neatly and indelibly for future reference.
- I. Lock damper in final positions if damper design permits.

3.4 RECORD AND REPORT DATA

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms. Emphasis should be given to recording damper positions within 5%, blower speeds, and pressures at blowers and processes.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

3.5 DEMONSTRATION

- A. Training:
 - 1. Train the Owner's maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures.
 - 2. Schedule training with Owner through the Engineer with at least 5 days prior notice.

END OF SECTION

DIVISION 44
POLLUTION CONTROL EQUIPMENT

SECTION 44 42 17 - PVC COARSE BUBBLE AERATION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: The Work necessary to furnish all labor, materials, equipment and incidentals required, completely install, adjust, protect, put in operation and test the Coarse Bubble Aeration Equipment for the North Storm Pond as shown on the Drawings and as specified herein.
- B. Related sections:
 - 1. Section 01 33 00 – Submittal Procedures.
 - 2. Section 01 60 00 – Product Requirements.

1.2 GENERAL

- A. 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.
- B. 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.
- C. Unit Responsibility: The Work requires the Coarse Bubble Aeration Systems complete with all accessories and appurtenances (including, but not necessarily limited to, drop legs, manifolds, lateral pipes, piping supports, couplings, diffusers, retainers, gaskets, orifices, drain lines, moisture purge system, nuts, bolts, anchors, taps, valves) be the end product of one responsible Manufacturer. The Manufacturer shall assume all responsibility for mating the Coarse Bubble Aeration Systems to the Aeration Distribution Systems piping to obtain the performances specified. 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.
- 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 SUBMITTALS

- A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES.
- B. In addition to the requirements of Section 01 33 00, SUBMITTAL PROCEDURES, submit the following additional specific information:
 - 1. Shop Drawings:
 - a. Make, model, and weight of each equipment assembly.
 - b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction with accompanying chemical compatibility data.
 - c. Performance data showing compliance with specification requirements. Include:

- 1). Complete head loss calculations for the aeration equipment starting from the Manufacturer's limit of responsibility (drop leg through diffuser orifice and water in each half of pond) as shown on the Drawings.
- d. Detailed mechanical and structural drawings showing the equipment fabrications, all plans, elevations, and cross section details of construction, dimensions and anchor bolt locations and interface with other items. Include:
 - 1). Dimensions, size, and locations of connections to other work, and weights of equipment associated therewith.
- e. Details, including materials of construction, of the Diffuser Element
- f. Details showing how the diffuser element holder is attached to the distribution header.
- g. Details of piping supports, expansion joints, and pipe taps.
- h. Details showing how the drop leg, manifold and distribution lateral supports will be connected to the North Storm Pond.
- i. Certify that the diffuser Manufacturer has coordinated with manufacturer of blower and air filtration system for compatibility with diffuser system (i.e. blowers meet removal requirements of the filters).
- j. Diffuser Testing Plan as specified herein.
- k. PVC Solvent.
2. Quality Control Submittals:
 - a. Certified copies of the results of all Factory Functional and Field Performance Test reports after tests have been completed.
 - b. Certified copies of the dynamic wet pressure (DWP) test report prior to delivery of diffusers.
 - c. Certified copies of the oxygen transfer efficiency (OTE) test report.
 - d. Special shipping, storage and protection, and handling instructions.
 - e. Manufacturer's printed installation instructions. Include:
 - 1). Description of the Contractor's proposed method for ensuring a level installation of all equipment and methods of tightening of bolts, diffuser hold-down rings, etc.
 - f. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
3. Contract Closeout Submittals:
 - a. Service records for maintenance performed during construction.
 - b. Warranty.

1.4 FACTORY TESTING

- A. Prior to initiation of production, the Contractor shall submit for the Engineer's review a testing plan to ensure consistently good quality and uniformity of the diffuser assemblies. A sampling plan shall be included. After testing, test results for all diffusers tested shall be submitted for approval and tested diffusers shall be identified.

1.5 OPERATION AND MAINTENANCE DATA

- A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 77 CLOSEOUT PROCEDURES.
- B. Maintenance Summary Forms: As specified in Section 01 77 CLOSEOUT PROCEDURES..

1.6 WARRANTY

- A. Provide 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. 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 as modified to conform to the performance, functions, features, and materials of construction as specified herein.
- B. Manufacturer of components and accessories specified herein shall be as follows:
 - 1. EDI (Environmental Dynamics International)
 - 2. SSI (Stamford Scientific International, Inc.)

2.2 GENERAL REQUIREMENTS

- A. See Section 01 60 00, PRODUCT REQUIREMENTS, for specific requirements related to the equipment specified herein.
- B. All equipment shall be supplied complete. Parts shall be proportioned to have liberal strength, stability and stiffness and shall be especially adapted for the intended service. Ample room and facilities shall be provided for inspection, repairs, and adjustments.
- C. All equipment furnished herein is intended to be submerged. Materials for piping/accessories are to be schedule 40 PVC (air header/distribution manifold) or 304L stainless steel.
- D. The number of diffusers, laterals, and manifolds shown on the Drawings shall be considered the minimum acceptable and is provided primarily for Contractor's informational purposes. It shall be the responsibility of the Manufacturer to ensure the actual equipment furnished meets all requirements specified herein.
- E. The equipment shall be suitable for operation with compressed air at temperatures entering the header of 215°F.
- F. Manufacturer shall coordinate with blower manufactures to ensure compatibility of components furnished, include air intake filters. Provide documentation to Engineer demonstrating such coordination.

2.3 NORTH STORM POND SERVICE CONDITIONS

- A. The Coarse Bubble Aeration Systems will be located in the two halves of the North Storm Pond.
- B. The supplied diffuser systems shall be capable of providing the oxygen rates and efficiencies given the following site conditions:
 - 1. Maximum Ambient Air Temperature: 100°F.
 - 2. Minimum Ambient Air Temperature: 0°F.
 - 3. Site Elevation: 1169.00 FT AMSL.
- C. The entire system, including the drop leg, manifold, and laterals shall allow for expansion and contraction under the following conditions:
 - 1. Winter conditions, low water pond (0°F).
 - 2. Summer conditions, low water pond (100°F).

3. Operation with air supply at 200°F and pond full.
4. Operation with air supply at 200°F and water level 1-ft above diffusers.

D. Side Water Depth:14.0 FT.

Standard Conditions are defined as 14.7 psia, 20°C/68°F and 40% relative humidity.

2.4 NORTH STORM POND DESCRIPTION

- A. The North Storm Pond is divided into two equally sized halves. Blowers are proposed on the east side of the pond, with a combined header and two separate drop legs (one for each side of the pond). See drawings for dimensions/layout.
 1. The North Storm Pond shall be provided with coarse bubble diffusers as specified herein and shown on the Drawings.
- B. All of the equipment specified herein is intended to be a complete aeration system capable of transferring atmospheric oxygen into the storm flows and keeping the ponds sufficiently aerated. The following components are part of this system and shall be installed as shown on the Drawings and as specified herein:
 1. Piping: Connection to contractor provided drop legs, manifolds, lateral pipes, piping supports and couplings to PVC headers.
 2. Diffusers: Coarse bubble diffusers, diffuser connectors, and orifices.
 3. Diffuser Accessories:
 - a. Fixed joints.
 - b. 316 stainless steel bolts, nuts and gaskets for flange joints.
 - c. 316 stainless steel anchor bolts.
 - d. Accessory piping, taps, and valves as specified.
 4. Other equipment as required for provision of a completely operational aeration system.

2.5 DIFFUSER PERFORMANCE REQUIREMENTS

- A. The maximum dynamic pressure losses through the installed aeration systems (including flow control orifices, diffusers, and water level in the North Storm Pond) starting from connection to contractor provided drop legs, at below air flows per grid, at maximum operating water depths, with required diffusers in place, can be found in the table below.

Total Pressure Required at Connection to Dropleg	
North Storm Pond	6.70 psi

- B. North Storm Pond
 1. Furnish for each grid as defined: connection to contractor provided drop leg, manifold header, coarse bubble diffusers, and flow control orifices to operate at the following air flow rates per grid:

North Storm Pond Design Requirements	
<u>North Half of Pond</u>	
Floor Length	248' 0"
Floor Width	153'-0"
Max Side Water Depth	14 FT
Max Air Flow Rate	6,632 SCFM
<u>South Half of Pond</u>	

Floor Length	248' 0"
Floor Width	153'-0"
Max Side Water Depth	14 FT
Max Air Flow Rate	6,632 SCFM

2.6 PIPING

- A. Unless otherwise specified, all piping shall be in accordance with Division 40.
- B. Contractor to provide stainless steel piping from blowers to discharge flange on pipes entering the storm pond. Coarse bubble aeration equipment manufacturer shall provide appropriate connection to this stainless steel flange and transition to schedule 40 PVC piping for aeration system.
- C. All welded piping and parts shall be manufactured from sheets and plates of 304 stainless steel with a 2D finish conforming to ASTM A240
- D. Air header and distribution manifold shall be schedule 40 PVC.
- E. Connections to droplegs and manifolds shall be supplied with flexible couplings, expansion joints, pipe supports, etc as required by the manufacturer for alignment of the system and to meet expansion and contraction requirements.
- F. The dropleg connections and headers shall include the piping, factory installed connector tees and joints as required.
- G. The diffusers shall be level to plus or minus 3/8-in. All diffuser piping and diffusers shall be capable of being leveled to this tolerance and remaining level under all operating conditions.
- H. Header supports shall be of Type 316 stainless steel and shall be mounted on Type 316 stainless steel anchor bolts mounted to the floor.
 1. Provide supports with a mechanism to provide for plus or minus 2-in vertical and ½-in lateral adjustment for alignment of the manifold in the field.
- I. All piping gaskets shall be butyl rubber, neoprene, or a composition suitable for air to 245 degrees F. Gasket material shall be suitable for long term immersion in wastewater.
- J. All welding (where applicable) shall be performed at the factory and shall use MIG, TIG, or plasma-arc welding inert gas processes. ER316L filler wire shall be added to all welds to provide a cross-section area equal to or greater than the parent material. Butt welds shall penetrate to the interior surface and shall incorporate gas shielding to interior and exterior joint. Field welding is not permitted.
- K. Clean all stainless steel surfaces after fabrication and welding by using the following procedure:
 1. Pre-clean all outside weld areas to remove weld splatter with the use of stainless steel brushes and/or deburring and finishing grinding wheel.
 2. Finish clean to remove all carbon deposits, light oxide films and similar contaminants by full immersion pickling and rinsing, to aid the regeneration of a uniform corrosion resistant chromium oxide film as follows:
 - a. Completely immerse all stainless steel assemblies and components in an acid solution as described by ASTM A380-88. The acid shall be a nitric-hydrofluoric solution as defined by ASTM A380.

- b. Corrosion protection techniques not using full immersion methods will not be acceptable.
- 3. At least two weeks prior to cleaning the equipment, the Manufacturer shall notify the Engineer of the schedule so that the Engineer can observe the procedure, if desired. If full immersion pickling is not observed by the Engineer, the Manufacturer shall verify that cleaning has been performed per the above specification.

2.7 COARSE BUBBLE DIFFUSERS AND ASSEMBLIES

- A. Furnish coarse bubble diffusers and assemblies required to supply the total air flows as specified without exceeding the maximum allowable headloss.
- B. Each air diffuser assembly shall incorporate a non-clog coarse bubble diffuser element with no flexible or moving parts, a flow control device with orifice inserts (if required), an inverted air reservoir, air exit ports, cast end cap at inlet end and a full length deflector.
- C. Diffusers shall be fabricated of PVC.
- D. Diffuser assemblies shall be shipped to the jobsite assembled and properly crated and protected for shipment and handling.
- E. Design diffuser for operating range of 10 – 30 scfm.
- F. All diffusers shall be designed to provide full wide band aeration with a minimum air release perimeter of 48-in per diffuser. Release air uniformly along a minimum 2-ft band beyond each side of the header. Exit ports discharging air into liquid shall be located on horizontal planes at two levels.

2.8 TOOLS AND SPARE PARTS

- A. Spare Parts:
 - 1. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration shall be properly protected by encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.
- B. Provide the following spare parts and special tools:
 - 1. Coarse bubble diffusers and ancillary equipment equal to 10% of the total number of coarse bubble diffusers provided for the North Storm Pond. This shall include diffusers, inlet nozzles, orifice inserts and all required bolts, hold-down rings, nuts and gaskets.
- C. Spare parts shall not be used during warranty period.
- D. All spare parts shall be packed in suitable storage containers and legibly marked as to the contents.

2.9 FABRICATION

- A. Shop Assembly: The system shall be factory assembled and tested.

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01 60 00, PRODUCT REQUIREMENTS.
- B. All diffusers shall be packed in suitable strong cartons or boxes. Diffusers of the same permeability rating shall be stamped on each carton in legible numerals.
- C. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay between time of shipment and installation, including any prolonged period at the site.
- D. No shipment shall be made until the Contractor has an approved shop drawing submittal.

3.2 INSTALLATION

- A. All equipment shall be installed in accordance with the Manufacturer's instructions and as shown on the Drawings.
- B. Clean air mains, blowers, filters and drop legs prior to installing diffuser elements.
- C. Protect diffuser elements from freezing at all times.
- D. Protect diffuser elements from un-pressurized submergence in wastewater.

3.3 FIELD QUALITY CONTROL

- A. Functional Test: After the installation of all aeration system equipment, the equipment shall be subject to field acceptance tests as specified herein.
- B. Mounting Tests: Support and tie-down provisions of the piping shall be tested to ensure that they have a factor of safety of 10 against calculated buoyant forces.
 - 1. Upon installation of the supports and prior to installation of piping, all of the supports of each type shall be tested. Testing shall include no less than 10% of the supports of each type, chosen at random. Each support chosen for test shall be attached to a lever which shall be placed on a fulcrum. A static load shall be applied to the opposite end producing a vertical extracting force on the support tie-down equal to 10 times the calculated maximum buoyant force to which the support tie-downs will be subjected in normal operation as detailed above. The application of the test load shall be such that the entire pipe support, including pipe hold down strap, is tested. Upon a test failure, the entire system will require testing under the above specified conditions. Repair and replace all equipment not meeting the test requirements.
- C. Inspection of Piping: The piping shall be inspected for proper joints, supports and tie-downs, end plugs and drain relief valves.
- D. Level Test: Pond shall be filled with clear water to the top of the diffusers. The level of the diffusers shall then be checked to see that they are at an elevation differential that the Manufacturer has recommended. Should it be necessary to correct the elevation of any diffuser assembly as a result of this check, such action shall be taken prior to proceeding further.
- E. Uniformity and Leakage Test: Pond shall be filled with water to a depth of 1' above the diffusers. The air supply will be turned on to minimum and maximum air flow rates as specified herein and air supplied evenly to all headers. The surface of the water will then be visually inspected to see

that air flow is uniformly distributed across the tanks and that no air leaks are present within the piping system. All piping joints will be soap bubble tested to ensure no air leaks are present. If, in the opinion of the Engineer, there are areas of consistently low or high air quantity release, or leaks within the piping system, make all necessary adjustments to correct these deficiencies.

1. During the uniformity and leakage test the aeration system pressure shall be monitored and recorded.

- F. Operations Test: Perform an operations test by filling the pond with clean water to the design depth and operating the aeration system at design conditions for 5 consecutive days. After the operations test is complete, drain the tank and inspect the aeration system for any damage. Repair any damage to the satisfaction of the Engineer and the Manufacturer's Representative.
- G. Cost of Testing: All of the above field tests, including the filling, dewatering, and cleaning of the ponds, shall be conducted at the expense of the Contractor. The costs of all re-testing, if required, shall also be borne by the Contractor.

3.4 MANUFACTURER'S SERVICES

- A. A Manufacturer's representative for the equipment specified herein shall be present at the jobsite for the minimum person-days listed for the services here under, travel time excluded:
 1. (1) person-day for installation assistance, inspection, and certification of the installation. Provide Certificate.
 2. (1) person-day during operational field testing.
 3. (1/2) person-day for pre-startup 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.
- C. See Section 01 75 00 STARTUP TESTING AND TRAINING.

3.5 MANUFACTURER'S CERTIFICATES

- A. Provide Manufacturer's certificate(s) in accordance with Section 01 75 00 STARTUP TESTING AND TRAINING.

END OF SECTION